Analysis of Research-Extension-Farmer Linkage in North West Ethiopia
The Case of Participatory Finger Millet Technology Development and Delivery in Mecha Wereda of the Amhara Region

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By
Shimelis Altaye Bogale

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Acronyms and Abbreviations

AARC.........................Adet Agricultural Research Center
ACSI .... Amhara Credit And Saving Institutions
AKIS ....Agricultural Knowledge And Information Systems
ANOVA......................Analysis of Variance
ANRS.........................Amhara National Regional State
ARARI.......................Amhara Regional Agricultural Research Institute
ARC ....Agricultural Research Center
ARDO ....Agriculture and Rural Development Office
ATMS ....Agricultural Technology Management System Model
BOARD..........................Bureau of Agriculture and Rural Development
BPR ....Business Processing and Reengineering
CACC ....Central Agricultural Census Commission
CC .... Contingency Coefficients
CSA ....Central Statistical Authority
DA ....Development Agent
EARO ....Ethiopian Agricultural Research Organization
EIAR ....Ethiopian Institute of Agricultural Research
EPID ....Extension and Project Implementation Department
FAO ....Food and Agricultural Organization
FREAC ....Federal Research Extension Advisory Council
FREG ....Farmers Research Extension Groups
FRG .... Farmers Research and Extension Groups
FTC .... Farmers Training Center
IAR ....Ethiopian Institute of Agricultural Research
IFAD ....International Fund For Agricultural Research
ISNAR ....International Service For National Agricultural Research
Ml ....Maximum Likelihood
MOA ....Ministry of Agriculture
NGOS .... Non-Governmental Organizations
OLS .... Ordinary Least Squares
PADETS ....Participatory Demonstration and Extension Training System
PAS .... Peasant Associations
RCBP .... Rural Capacity Building Project
RED .... Research Extension Division
REFAC .... Research Extension Farmers Advisory Council
RELC .... Research Extension Liaison Committee
R .... Pearson Correlation Coefficient
RREAC .... Regional Research Extension Advisory Council
RTTL .... Research and Technology Transfer Linkages
SD .... Standard Deviation
SIDA ....Swedish International Support
SNNP ....Southern Nations And Nationalities and Peoples
T & V ....Training And Visit
TLU ....Tropical Livestock Unit
TOT ....Transfer of Technology
USA ....United States of America
USAID.......................United States Agency For International Development
VIF ....Variance Inflation Factor
χ^2 ....Chi Square
ZREAC......................Zonal Research Extension Advisory Council

ABSTRACT

The study examines research-extension-farmers linkage system in relation to finger millet technology development and delivery, and the identification of factors influencing linkages in North West Ethiopia due to the fact that the present research-extension-farmers linkage scenario in Ethiopia in general and in the study area in particular has been inefficient and ineffective in achieving the prescribed goal of increasing food production and improving the quality of life of farmers. In this study, random sampling procedure.was used to select 5 sample PAs and 100 sample farm households. Moreover, 18 researchers from three research organizations and 26 extension agents from three extension organizations were selected purposfully.The requiered data were collected using both primary and secondary sources. Results of the study revealed that the influence and participation of farmers, extension agents, and researchers in the generation and wider testing of new finger millet technologies have been minimal. Farmers' awareness of improved finger millet technologies and researcher's awareness of best farmers' finger millet practicies were low. Moreover, participation of farmers, researchers, and extension agents in setting both research and extension agenda; use of collaborative activities such as joint adaptive trials, and surveys, has been a bare minimum. Likewise, their mechanisms of exchange of resources, feedback, and coordinating the overall activities and systems performance were found to be weak. Their low use of such activities underscores the lack of complete or partial linkage existing between researchers, extension agents and farmers. To this end, mutual respect and recognitions of partners competence is rarely present in the technology system of research and extension. In sum, research and extension are not always perceived as two components sharing a common goal, that of making relevant technologies available to farmers. Results of the econometric model indicated that farming experience of the household, distance to all weather roads and market, frequency of extension contact, leadership position, and attending training and workshops, were found to have significant impact on determining linkages of farmers' with research and extension. On the other hand, extension agents' overburden in diverse tasks, physical resource constraints, educational level of the agents, structural, motivational and incentive problems, were important variables that had significantly influenced extension agents' linkages in participatory finger millet technology development and delivery with researchers and farmers. Simialrily, financial constraints of the research organizations, extension agents work involvement in diverse tasks, professional work experience of researchers, and use of stakeholders meeting as sources of research agenda setting, were found to have significant impact on determining researchers linkages with extension and farmers. The overall finding of the study underlined or the author recommended the high importance of systems perspectives regarding strong research-extension-farmers linkages with a transparent, responsible and accountable linkage policy based on the consent of all stakeholders. It should be noted that policy makers, managers, and research and extension personnel should recognize that research and extension are part of a single system and that the mission of this system is to make relevant technologies available to farmers. Therefore, policy and development interventions should give emphasis to linkages, and should treat it as an integral part in the technology generation and transfer process through provision of sound leadership, better incentive mechanisms, adequate financial, physical, and human resources, reducing the work overload of extension staffs. What is more, effective leadership that makes research and extension accountable for their actions is also needed.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Recent studies (Rathore *et al.*, 2008; Oladele, 2001) have found that one of the major weaknesses in the generation, wider testing, dissemination and adoption of improved agricultural technologies in developing country is the absence of or chronically weak linkages among the major institutional actors in the agricultural knowledge and information systems (AKIS), especially weak linkages among researchers, extensionists and farmers. For agro-technologies to be relevant to local needs, the mentioned actors must play important roles in identifying research problems, adapting the recommendations to local conditions and providing feedback to researchers about the innovations that have been developed.

Agbamu (2000) claimed that weak research-extension-farmer linkages limit agricultural technology transfer, leading to low levels of technology adoption by farmers and hence low agricultural production and productivity. This is caused by a lack of coordinated planning, poor communication between linkage partners, and absence of follow through with actual linkage resource planning or implementation and little or no involvement of farmers in linkage planning. In addition, lack of a systems perspective and of a transparent and agreed-upon linkage policy, inappropriate linkage strategies and management, and donor driven development strategies hinders linkages (Eponou, 1993).

In Ethiopia, the Agricultural Research and Extension organizations both at the national and regional levels were established as instruments for promoting agricultural development and improving the quality of life of farmers, and that effective linkage between these organizations help them to achieve their goal. Nevertheless, the Agricultural Extension system of Ethiopia has been frequently re-structured and re-organized (Edlu, 2006) several times. Similarly, several attempts have been made to improve the effectiveness of Agricultural Research at both the national and regional levels and various approaches to regional cooperation, ranging from informal networks to regional organization. Such as re-organizing the whole research system with a focus on decentralization or on merging research and extension service in the same ministry (Teklu, 2001). Despite the fact that the linkage organizations are heavily invested in by the government, the problem of weak linkages, existing gaps and poor inter-organizational relation still exists. With a weak public extension service, other agencies including

NGOs, community-based organizations and private sector agencies have come up to fill the gap. However, these providers neither are regulated nor structured (Agbamu, 2000).

According to Teklu (2001) to solve linkage problems and to catalyze joint technology development and transfer, several attempts and linkage strategies has been made by the National Agricultural Research and Extension system of Ethiopia both at the national and regional levels. The strategies includes, Research Extension Farmer Advisory Council (REFAC) at the national , regional and zonal levels, Research Extension Liaison Committee (RELC), Farmers Research Groups (FRG), Farmers Research and Extension Groups (FREG), Farming System Diagnostic Survey, Pre-extension and popularization of improved technologies, Participatory seed multiplication, etc. These linkage strategies comprise of researchers, extensionists, farmers, input suppliers, NGO's and other relevant actors on which they are supposed to participate in linkage activities from technology generation to adoption. Even though such efforts have been made, yet the intended linkage among the major actors have-not been achieved. Hence, this thesis seeks to intervene the linkage of research, extension, and farmers for the formulation of reasonable linkage policy, which foster participatory technology development and transfer in line with the needs of farmers.

1.2 Statement of the Problem

An agricultural technology system is a complex set of functions and linkages. To increase agricultural productivity and farm household income, by maintaining the resource base and addressing equity concerns, requires an interactive technology system whereby farmers, research, extension, input suppliers, NGOs and other agencies work together in a co-coordinated manner (Rolling et al., 1992).

An agricultural technology development and delivery system requires, above all, good linkage strategies particularly between research and extension services. Agricultural research findings are of little use if farmers do not adopt them. Agricultural research, must, therefore, be related to farmers' problems. Hence, the development of demand-driven technology, their extensive dissemination, efficient utilization and enhanced adoption is a function, among many other factors, of effective research-extension-farmer linkage strategy (Teklu, 2001).

In the contrary, the existence of poor linkages or partnership between the major actors may lead to low levels of technology generation, adoption, and it ultimately hinders the achievement of the desired goal of food security (Oladele, 2001). Hence, the problem of poor links among researchers, extension staffs, and farmers almost guarantees that research results will not reach farmers and remain on the shelf and if they do, farmers will not be able to use them. Consequently, the poor communication between linkage partners hinders linkages and leads to duplication of efforts regardless of the seriousness of financial constraints in the Research and Extension organizations (Oladele, 2001). However, the most obvious cases are those where researchers and technology transfer workers are ignorant of each other's activities. In practice, research stops too early and extension starts too late in what should be a continuous process. In addition, basic extension directors as well as middle level managers within these respective organizations operate in an independent manner with little appreciation or understanding of how the, management of their organization or program affects the overall system performance (ibid).

These problems are not unique to Ethiopia. In that, the absence of effective linkages between research-extension-farmers has been cited repeatedly as one of the major problems in the Ethiopian Agricultural Research and Extension systems. There had been no fora where this linkage problem had not been raised because of which it has become a concern among policy makers, researchers, development workers, and funding organizations (Teklu, 2001). Belay (2002) also indicated that due to weak research-extension linkage, farmers made a very marginal contribution in designing and formulating extension activities. He also noted that neither the farmers nor the frontline extension agents were consulted in the course of policy formulation.

Teklu (2001) indicated the absence of well-formulated, properly defined, and institutionalized research-extension-farmers linkage strategies in Ethiopia. As a result, farmers participation in setting both research and extension agenda has been limited. Proper staffing and provision of budget to institutions/stakeholders involved in ensuring research-extension-farmers linkage has been in adequate. The involvement of input multiplying and distributing agencies in the linkage fora in general and technology development and transfer activities in particular have not been active and well coordinated. Lack of conducting proper follow-up, monitoring and evaluation of research-extension-farmers linkage activities on ad hoc basis, and incentive mechanisms for staffs involved in research, extension, and multiplication activities are not considered. Accordingly, both the research and extension organizations operate separately with different linkage mechanisms. Hence, they are not adequately participate in joint planning and review forums; execution of collaborative professional activities; exchange of resources; dissemination of knowledge and information, feedback, and coordination, etc.

As a result, the present research-extension-farmers linkage scenario in Ethiopia in general and in the study area in particular has been inefficient and ineffective in achieving the prescribed goal of increasing food production and improving the quality of life of farmers. Therefore, the constraints that hinder research-extension-farmers linkage in the study area potentially affect the agricultural out put of farmers, especially, the majority of small, subsistence, and resource poor farmers. Thus, ensuring linkages and technology transfer activities is of minimal importance in the absence of attempts to look into the dynamics involved in the technology development and transfer system. However, little research attempts have been made in blending the various aspects of technology development and transfer with research-extension-farmers linkage activities or mechanisms.

Thus, this thesis seeks to fill the gap by analyzing the agricultural technology system including the demographic, institutional, resource related, socio-economic, organizational, system contextual, managerial and other factors that influence successful linkages between public research bodies, extension organizations, and farmers of Meha district, based on cross sectional research designs. The district was selected as it has been engaged on linkage activities with research and extension for long years. In addition, it is known for its lions share in both area and volume of finger millet production in the study zone. Hence, the district could help to get useful information on the nature and extent of the research-extension farmers' linkage in finger millet technology development and transfer.

The outcomes of the thesis therefore, relevant for a demand-driven, multiple-stakeholder, group-based technology generation and transfer system for increased agricultural production and productivity in West Gojam, Mecha wereda of North West Ethiopia.

1.3 Research Objectives

1.3.1 General objective

The general objective of the study is to analyze the research-extension-farmers linkage in Mecha Wereda of the Amhara Region with due emphasis on finger millet technology generation and transfer

1.3.2 Specific Objectives

The specific objectives of the study were:

- To identify and characterize the linkage mechanisms and their functions of research and extension organizations;
- To determine researchers and extension agents awareness and correct knowledge of, farmers' best local finger millet varieties; and farmers' awareness of improved finger millet varieties;
- To identify the factors influencing the performance of linkage between research, extension, and farmers

1.4 Research Questions

The study, on which this thesis bases, seeks to answer the following research questions:

- How is the involvement of researchers, extension agents and farmers in linkage activities or mechanisms?
- What major sources of ideas do researchers and extension agents' use for setting their work priorities, and what major sources do farmers use for obtaining farming information and improved finger millet technologies?
- How are the characteristics of finger millet technologies delivered to farmers with respects to local landraces, and farmers' selection criteria?
- What characteristics or traits is required to adopt a given finger millet variety in the study area?
- Are researchers, extension staff and farmers' congruent in terms of their perceptions of the critical factors limiting farmers' adoption of improved finger millet varieties?
- What factors influenced the performance of research-extension-farmers linkage in technology development and delivery in general and the joint participation of researchers, technology transfer agents, and farmers in linkage mechanisms in particular?

1.5 Significance of the Study

This study has several significances to the relevant actors. It raises awareness to policy makers about the importance of linkages and to design linkage policies that promote system perspectives, joint planning and evaluation, demand–driven, multiple–stakeholder, grouped based technology generation and transfer. Besides, it gives insights for development workers and relevant actors to signify need of intervention in the areas of research-extension-farmers linkage and its role in technology development and generation. Finally, it also used to document the information generated for academic purpose.

1.6 Scope and Limitation of the Study

The study is limited to the analysis of research-extension-farmer linkages in finger mille technology generation and disseminations regarding on the agricultural technology uptake pathways including the socio-economic, resource related, policy, structural and other conditions that influence successful linkages for improved agricultural technology generation and transfer in west Gojam Zone of the Amhara region. The study is restricted to the analysis of research bodies, extension offices and farmers in their relationship at, institutional linkage mechanisms and the factors influencing the performance of linkages. Consequently, the study target at researchers from three research organizations, and extension agents from Regional, Zonal, and District levels Office of Agriculture and Rural Development, and finger millet producing farmers of Mecha district. In addition to the spatio-temporal issue, this study also had resource limitation, especially time limitation).

1.7. Organizations of the Thesis

This study is organized into five chapters. The first chapter describes the central theme of the study topic by providing background information to the problem, objectives, research questions, significances, limitations, and scope of the study. The second chapter describes relevant literature review, theoretical and conceptual framework on research-extension-farmers linkage, and describing finger millet production and constraints. Moreover, various country experiences of linkage studies including Ethiopia are also explored. The third chapter explores the methodologies of the study, including descriptions of the study area, sampling procedures, data sources and types. Moreover, it presents the working hypothesis, definitions of the variables, and the econometric model used. Chapter 4 presents the results and discussions of the surveyed data using descriptive statistics and logit model. Finally, chapter five provides the summaries, conclusions and recommendations of the finding.

CHAPTER TWO
REVIEW OF LITERATURE

This chapter reviews relevant literatures based on the different theoretical, empirical and methodological reviews of studies on linkages being investigated in this study. It has three sub-sections. The first section defines linkages, linkage mechanism, and other relevant concepts related to the analyses of linkage according to different authors. This helps to clarify the concepts used making it easier to understand the discussion that follows. The second section presents the main theoretical perspectives in the literatures. Finally, the last chapter summarizes the most important empirical evidences that are closely related to the study being conducted. Moreover, it provides background information on the technology being tested in relation to linkage, i.e., finger millet production or importance. Lastly, this section provides a conceptual framework for the study. Different authors use different approaches to achieve their objectives. Reviewing a broader range of empirical studies enrich the scope and depth of the research. Such assessment describes the larger ongoing dialogue on linkages, filling in gaps and extending prior studies.

2.1. Definitions of Key Operational Concepts

Research: refers to all public-sector institutions and organizations that carryout research in the broadly defined area of agriculture (ISNAR, 1987).

Extension or Technology Transfer: refers to all public bodies that attempt to bring research results in the form of new agricultural technologies and new information to farmers, and the agents which offer such activities are named as 'technology transfer agents or workers', 'extension agents or workers or personnel' (ISNAR, 1987).

Farmers: In this paper, it represents either those farmers who cultivate finger millet varieties, local, improved or both in their farming experience. Hence, they are the ultimate users of finger millet technology, they contribute to its flow by providing indigenous knowledge and information, determining the attributes of technologies, and defining what is needed from research and extension.

Agricultural Knowledge and Information Systems (AKIS) : refers to ' a number of interdependent actors that engage in, manage, generate, transform, transmit, store, retrieve, integrate, diffuse and use information and knowledge (Rolling *et al.*, 1992).

Agricultural Technology System: defined by Kaimowitz *et al.* (1992), as a holistic approach having sub-elements makes up the system. It is composed of different institutional actors (individuals, groups, farmers, private and public sector organizations, and others) engaged in developing and delivering new or existing technology.

Linkages: refers to any kind of exchange and collaboration that can take place between farmers, research and extension institutions. Besides, it implies the communication and working relationship established between two or more organizations pursuing commonly shared objectives in order to have regular contact and improved productivity (Roling, 1989).

A linkage Mechanism/Activity: is any structural or managerial device or procedure used to enhance the complimentarity of technology generation and transfer process. It also refers to the mutual and reciprocal connection between research, extension and farmers (ISNAR, 1987, 1993).

Structure: refers to the formal institutional building blocks and administrative arrangements in place for generating and transferring technology, and how they relate to one another (FAO, 1997).

Organization: Principally to the way, the content of work is divided up with in the formal structure. For example, the work may be organized along discipline lines, by commodity, or by agro ecological zone (FAO, 1997).

2.2 Theoretical Perspectives of Research-Extension-Farmers' Linkage

2.2.1 Purposes and Principles of Research-Extension-Farmers' Linkage

Evolving new agricultural technology and its quick dissemination requires a series of integrated and communicating linked systems among the agencies concerned. This involves three sub-systems: a research system, responsible for generating and evolving new agricultural technology and innovations; a linking (extension) system responsible for transfer of new technology, facilitating its adoption and also reporting back field problems to the research system (feedback); and the client system (farmers), the ultimate users of technology. The presence of effective linkage between these actors in developing countries is a key condition for effective and responsive agricultural technology system (FAO, 1997). According to Zuidema (1989) for developing such effective links, it is important to understand six principles that determine the success of linkage activities. A necessary condition for groups or institutions to participate effectively in linkage activities is that they should share a common purpose;

the groups or institutions should perceive that it is advantageous for them to participate in linkage activities; there should be common ground or proximity of location between each group or institution to facilitate collaboration; linkage activities should be compatible with other activities of each group; there should be rewards for individuals participating in linkage activities; and communication between members of different groups should be effective with free flow of information between groups.

2.2.2. Linkage Types and Mechanisms

Stoop (1988) identified four major types of linkages, based on ways and channels of communication.

'Formal' versus 'Informal' linkages: Formal linkages refer to linkages that are specified and agreed to by organizations. Informal linkages are direct person-to-person contacts, based on the need for collaboration between individuals. Since informal linkage is an effective and low-cost method, it should be encouraged along with formal linkages.

'Top-down' versus 'Bottom-up' linkages: In top-down linkage, information flows from scientists to extension and then to producers. Bottom-up linkages refers to the flow of information from producers to scientists. Information from farmers is based on their practical knowledge.

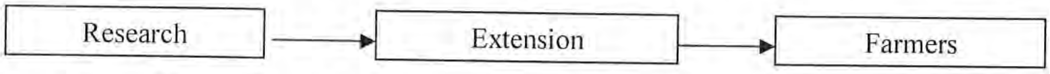
'Internal' versus 'External' linkages: Internal linkages refer to linkages among scientists working in different disciplines and on different commodities, whereas external linkages are linkages with major clients, such as farmers, policy-makers, etc. External linkages help identify gaps in research priority and assess the utility of research programmes.

'Downstream' versus 'Upstream' linkages: These linkages are a part of external linkages. Upstream linkages occur between research and policymaking. The aim here is to secure adequate funding and political support for research. Downstream linkages occur between researchers and producers, to set research agendas and to establish priorities.

2.2.3 Research-Extension-Farmer Linkage and Technology Transfer Models

2.2.3.1 The Linear Model

The conventional transfer-of-technology models are the top-down and feedback models. In the top-down model (Figure 2.1), technology transfer is a one-way process where technologies developed by scientists are passed on to extension services to be transferred to users. The weakness of this model is that it does not involve farmers in identifying the constraints and adapting the research to local conditions. This model has failed in areas where the farming system is complex (Stoop, 1988).

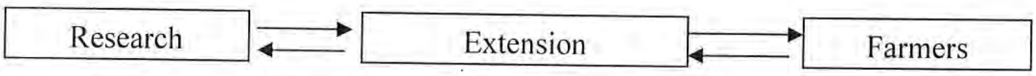


Source: Stoop, 1988

Figure 2.1 the Top-Down Technology Transfer Model

2.2.3.2 The Feedback Technology Transfer Model

The feedback model is an attempt to overcome the weaknesses of the top-down model. In this model, the response of users to the new technology is gathered. However, this feedback is considered weak as the users remain passive recipients of technology and the feedback function solely rests with the extension service (ibid).

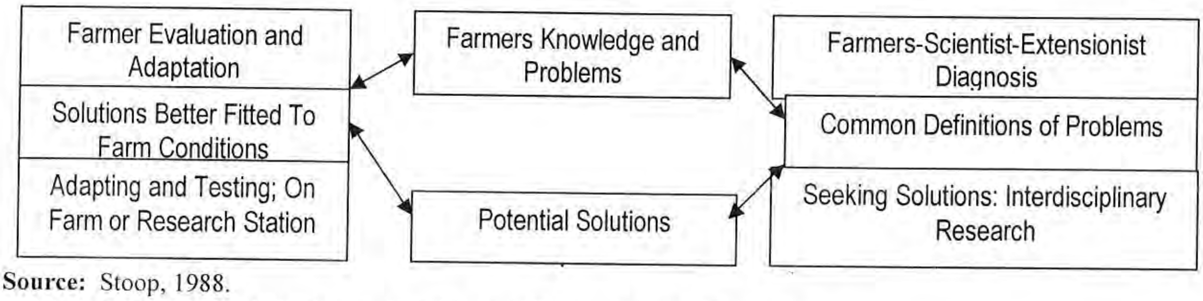


Source: Stoop, 1988.

Figure 2.2 the Feedback Technology Transfer Model

2.2.3.3 The Farmer-Back-To-Farmer Model

The farmer-back-to-farmer model (Figure 2.3) is designed to improve two-way communication. In this model, farmers and extension personnel are actively involved in the research process. It is based on the assumption that FSR/E = farming systems research/extension research must begin and end with the farmer. The model involves diagnosis to define problems; interdisciplinary team research to develop potential solutions; on-farm and experiment station testing and adaptation of proposed solutions to farmer's conditions, and farmer evaluation and adaptation of the technology and monitoring of its adoption (ibid). The degree of farmer participation and integration between on-station and on-farm research is high in this model.



Source: Stoop, 1988.

Figure 2.3 'Farmer-Back-To-Farmer' Technology Generation and Transfer System

2.2.3.4 Participatory Technology Development Model

Participatory technology development emerged as a response to the need of resource poor farmers who cannot be effectively served by the linear model. In this model farmers have control over technology development process, employs indigenous knowledge and experimentation, and managers and experts play a catalyst and facilitator role. Here there is close link between research, extension and farmers (ISNAR, 1993). Accordingly, ISNAR identified six linkage functions encompassing different linkage mechanisms to link research, extension and farmers' for participatory technology development and delivery. These are:

Planning and Review Functions: The main purpose of joint planning and review is that to obtain technology transfer concrete input to technology design and to meet the technological needs of farmer. The basic assumption here is that researcher's knowledge about farmers' condition is sometimes limited and extension workers have proximate knowledge and understanding about farmers' needs and problems. Therefore, both farmers and extension workers can provide valuable feedback to the researchers in order to design appropriate, problem solving and well-suited technologies.

Collaborative Activities: It enhances effectiveness and efficiency of both actors through exchange of knowledge, experience, that leads to effective linkage among stakeholders and able to meet needs of farmers and other end users of agricultural technologies. Joint surveys, joint adaptive trials, are some of the mechanisms.

Exchange of Resources: The other purpose of linkage is to share limited and scarce resources and reduce duplication of efforts. The exchange may cover both human, financial, material and technology.

Dissemination of Knowledge and Information: Facilitating or fostering a two-way flow of information or knowledge among the key actors of agricultural development system is another purpose of having effective linkage mechanism for participatory technology development. Publications, training and workshops are some of the mechanisms. However, presence of such mechanisms alone could not bring sustainable integration between those actors rather there should be other mechanisms.

Evaluation and Feedback: ISNAR (1993) also noted that linkage mechanisms also serve as a means for evaluation and feedback. Scientists need feedback on the agricultural technologies they developed so that they can adjust their research programs. It will again enhance the performance of the technology system and in turn adoption of the technology developed. However, getting it difficult in relation to responsibility that the researcher or extension personnel.

Coordination: This was noted by ISNAR as the six functions for participatory technology development and delivery. The purpose of coordination is to facilitate a smooth transition between two tasks or activities of the same task performed by research and extension. This is often the case for research-extension liaison positions, or coordinators positions, which coordinates the activities between research and extension, ranging from problem identification to evaluations of research results.

Generally, this model was one of the key areas that the researcher adopted to investigate in the technology system of the study area.

2.2.4 Management and Approaches of Linkage Mechanisms

Having appropriate linkage mechanism alone does mean nothing. To have effective linkage (FAO, 1997) suggested proper management and monitoring of the mechanisms. Hence, managers are highly responsible in identifying the system of linkage needed, choose appropriate mechanisms, make resource available for it, constantly monitored, and take corrective measures.

While selecting the appropriate mechanism, (ISNAR, 1993) noted that, managers should take the following points in to consideration. Type of linkage problem to be solved- that is, its nature, size and location. The adequacy of the mechanism in addressing the specific problem. The ability of all participants to use the mechanisms properly. The financial capacity of entire system and its components to operate and sustain the mechanism. Managers can improve joint planning and review; enhance performance of collaborative tasks; strengthen linkage by establishing contract-client relationship with technology transfer and providing proper working conditions and motivation for staff rotation improve the flow of information and knowledge between research-extension-farmers; encourage feedback; improve coordination. However, ISNAR claimed that use of single mechanism is not sufficient to ensure effective linkage rather mix of them is necessary.

According to (FAO, 1997) a major drawback to existing linkage approaches is a lack of a systems perspective. The new approaches suggested recently have successfully minimized this drawback. These are the Agricultural Knowledge and Information System (AKIS); The Agricultural Technology Management System Model (ATMS); and ISNAR's Research and Technology Transfer Linkages Framework (RTTL).

2.2.4.1 Agricultural Knowledge and Information System (AKIS)

AKIS examines the research-extension interface from a knowledge-system perspective, with basic, applied and adaptive research, subject-matter specialists, village-level workers and farmers all seen as components of the system. 'An AKIS is the set of agricultural institutions, organizations, persons and their linkages and interactions, engaged in the generation, transformation, transmission, storage, retrieval, regulation, consolidation, dissemination, diffusion and utilization of knowledge and information, with the purpose of working synergically to support opinion formation, decision making, problem solving and/or innovation in a given sector.

2.2.4.2 Agricultural Technology Management System model

ATMS comprises 'all institutions, individuals and their interdependent relationships aimed at the generation, assessment and diffusion of improved agricultural technologies in order to increase agricultural production and incomes'. This model helps in identifying opportunities for improving the overall management of agricultural technology activities in a country. The model adopts a systems approach with the technology sector at its core. The technology sector has generating, transfer, and utilization components. The system operates in a politico-bureaucratic structure that is composed of representatives of government and decision-makers. The system has an interface with an exogenous system of technology generating and transferring institutions. The structural conditions under which it operates include world markets for inputs and outputs, the resource base of the country and the initial distribution of resources and economic and political power within the country. The policy environment limits the behavior of the technology sector. Approaches for improving research and extension linkages in ATMS include both formal and informal linkages.

2.2.4.3 Research and Technology Transfer Linkages Framework/RTTL

RTTL was developed by ISNAR and specifically designed for the study of linkages. This model considers three broad sets of contextual factors - political, technical and organizational - that condition the choice, operation and effectiveness of linkage mechanisms among participants within the national agricultural technology system. It also attempts to introduce the notion of performance indicators.

The political environment is very narrowly defined to mean institutional politics, and technical factors are those related to the specific type of activities and methodologies associated with technology development and delivery. The organization and management factors involve such issues as the division of tasks, resources, authority among different organizations, units and individuals, and the internal management and informal dynamics of the organizations and their components. The political and technical factors influence the linkage mechanisms and the performance of the technology system directly. In addition, they exert their influence indirectly through the organizational factors. The performance criteria considered in the model are integration, technology availability and relevance, responsiveness and sustainability. Moreover, mechanisms of solving managerial factors includes: redefining job descriptions to strengthen relationships; establishing joint reviews of research and extension activities; improving individual incentives for collaboration; changing evaluation procedures to emphasize collaboration; exchanging personnel, e.g., posting extension staff in a research organization; joint training for expanded roles in a technology system; joint use of facilities and services such as soil testing laboratories; joint participation in on-farm trials and demonstrations; promoting informal linkages; and exchanging information using jointly developed protocols.

Approaches for improving research and extension linkages in RTTL include both formal and informal linkages. The formal linkage mechanism could be at individual or institutional level. At individual level, the formal linkages are integration of functions and the appointment of linkage officers; at institutional level, the linkages are integration of functions, creation of linkage units, integration through regular joint activities and integration through ad hoc activities. Summarizing, mechanisms of solving structural and organizational factors includes: combining research and extension functions into one unit; de-centralizing research and extension activities into regional institutions; establishing communication-cum-information departments; fielding subject-matter specialists in extension; staffing extension liaison positions in research institutions; redefining roles and responsibilities between research and extension units; developing inter-agency agreements for collaboration; physically locating research and extension units together; providing for farmer participation in research activities; liaising with private organizations and NGOs; a research-extension liaison officer.

2.3 Empirical Literatures

2.3.1 General Review of Empirical Studies

Different people and institutions have conducted a number of empirical studies on research-extension-farmers linkages more outside and in Ethiopia (scarce but related to linkages in some factors). Hence, the studies summarized below are carefully selected from foreign countries as they relate to this particular study. These studies have confirmed that research-extension-farmers linkages are influenced by different factors. Factors associated with the technology–system context, structural and organizational factors, resource factors, and managerial characteristics can influence successful linkages of researchers, extension agents, and farmers.

2.3.1.1 Characteristics of the Technology–System Context

ISNAR (1987) indicated that the research-extension services have been criticized for two reasons: first, the research problems being investigated are generally not in accordance with the priority needs of farmers; second, the technologies and information generated by the research system have not been effectively transferred to the farmers. The major reason for these problems is the weak or ineffective linkage between research, extension and farmers functions. The context in which an agricultural technology system operates strongly influences the performance of links between research and technology transfer. Key forces in the outside environment are national –agricultural sector policies, donor behavior, and the existing farming systems targeted by research.

Policy: Eponou (1990) investigated informal linkage mechanisms and technology transfer in Cote d'Ivoire. The author considers the case of rice commodities, and found that self-sufficiency becomes a national priority when the price is high on international markets. Consequently, additional resources are made available for domestic rice production by supporting both research and extension. In some instances, special organizations with well- defined mandates have been set up. However, leadership or responsive policy decisions, and additional resources disappear as soon as rice imports are no longer perceived as a threat to the national economy, and hence disappearance of the existing strong research-extension linkages. The author recommended that policy maker must assume leadership by promoting the complimentarity of research, technology transfer, and the other development instruments of the system; by enforcing accountability; and by clearly defining mandates through system perspectives.

The Structure of Farming System: (Ekpere and Idowu, 1990) investigated the linkage mechanism and technology transfer in maize sub-systems of Nigeria. They claimed that the farming system is so diverse that even normal operations of technology systems by research and extension were problematic. Mainly due to scarcity of adequate and quality skilled transfer agents to communicate the complex needs of farmers to researchers. Even projects initiated in a given year had to be cancelled or suspended for lack of adequate financial back up for the diverse agro ecologies, there by collapse of the existing linkages. Hence, the authors recommended that funds and adequate resources should be earmarked for linkages. Added, limiting the scope of either research or extension activities is a better alternative than eliminating funds for linkages.

Donor Involvement: Palmieri (1990) claimed, donor involvement, always necessary, could nevertheless be a source of problem. Lack of coordination between a donor and the national system leads to conflicting procedures and goals, disagreement over resource allocations, and unnecessary competition. The results can be seen in projects that are non-sustainable, and fluctuation in the performance of linkages between research and extension. Palmieri (1990) discussed the effect of a project funded in 1984 by the Inter American Development Bank. Its goal was to increase agricultural productivity in Costa Rica by strengthening research and extension within the Ministry of Agriculture and Livestock through provisions of adequate human, financial, and physical resources arrangement by region and service (research and extension budget were separate). However, since the project ended, operating funds have been almost nonexistent, with 80% to 90% of the budget for the Directorate of Research and Extension spent on salaries. The field level workers involved in research and extension thus have no resources for fuel, vehicle maintenance, or living expenses, and it is common to see them use their own money to carry out their work. The result has been minimal execution of field-level operations. Any positive results of the externally funded project have been negated by the long-term implications of having added additional staff at the time of project implementation. The author recommended that donors must ensure that all the institutions involved in their projects have the required resources needed to establish effective links with the institutions being financed. Linkages between donor projects and the national system must be strong enough to allow smooth integration of donor-supported work into the system

2.3.1.2 Structural and Organizational Characteristics

Weak links between research, extension and farmers are mostly blamed on the structure and organization of agricultural systems of the nation. Many empirical study results (FAO, 1997; Eponou, 1993; Rathore *et.al,* 2008) identified a number of linkage related problems, which are prevalent in most developing countries, in relation to structure and organizational characteristics.

Missing Tasks or Functions: Indeed, many critical tasks, which are crucial for generation and transfer of technologies, are missing. Identification of farmers' priority problems and needs, priority setting, consolidation of technology, etc. are critical steps to be accomplished jointly with the involvement of major stakeholders. Unfortunately, such steps are rarely followed in most countries, specifically, in

Latin American, and some Asian countries (e.g., the whole system in Indonesia has been reorganized three times since 1974 (ISNAR, 1993).

Missing Linkages: According to Eponou (1993), linkage may be missing at decision-making and operational levels. Such failures are mostly due to bureaucratic and institutional barriers. ISNAR studies (1993) conducted in seven different developing countries evidenced that such problems are sever when research and extension are located in different ministries or ruled by different legal bylaws even they are under the same organization.

Idle and Ineffective Linkage Mechanisms: Regardless of the presence of formal linkage mechanisms, the respective organizations do not use most of them totally or poorly. For instance; for effective linkage research programs formulation, annual joint planning and review, technology review meetings, publication of annual reports and so on are supposed to be conducted by those partners. However, in some occasions researchers present their results and plan the future without the presence of others. Problems related to this are reported by (Ekpere and Idowu, 1990) in Nigeria, and (Eponou, 1990) in Cote d' Ivorie.

Moreover, (Kaimowitz *et al.,* 1989) also showed the **responsibility of managing linkage activities**, conducting adaptive research, communication of research results, or, feedback from users to researchers is not generally assigned to individuals, or institute that manages in accountable manner in developing countries. Extension workers would like researchers to produce more timely research findings, write recommendations in the local language (s) and make them available.

Frans Doorman (2003) conducted a study on Linkages between Research, Extension and Farmers in the case of Rice in the Dominican Republic, and found that linkages between rice researches, extension agents and farmers are weakly developed. Due to **institutional constraints and attitudes** prevalent among most officials, farmers lack ways of indicating their needs and priorities to rice researchers. As a result, recent technology developed and transferred consists of a technological package that in many cases is not, or is only partly, applicable to small farm production conditions. The case used to illustrate this predicament is that of the sowing of a second rice crop out of season. The author concluded that by starting the generation of new technology with the analysis of production conditions and resulting problems at farm level, the role of farmers in setting research policies could be increased.

Research Extension-Farmers linkage system in Nigeria was studied by Oladele (2001) and found that **farmers' awareness of and participation** in extension activities were low. Farmers would easily accept agents' advice on farming when they speak the same language and are of the same gender. The use of personal contact and model farmer are effective links to other farmers, nevertheless extension agents often use print media. Researchers were more involved in demonstration of technology. Researchers and extension agents were not frequently coming together on linkage issues and many activities engaged by the agents do not bring about linkages. In addition, linkage activities of researchers were more of meetings, conferences, seminars but less of trials and field days and farmers were not involved in linkage activities of report, seminar, priority setting and technical committee. Researchers were not favorably disposed to many of the organizational procedures used in their institutes while management procedures came short of extension agents' expectation leading to researchers that were not generally satisfied with their work. Extension agents were not favorably disposed to their work, working conditions, reward system and their level of involvement in decision making. The author recommends that linkage activities of farmers demand the need for generating more awareness among farmers with respect to extension activities. Frequent visits by farmers to research institutes would also strengthen links. Resources for establishing demonstration plots should be provided to enhance farmers' regular attendance at demonstration. Agricultural institutes should focus on a single mandate of research or extension, as extension services of agricultural program were more vigorous than their research activities. Proper and effective management procedure should also be introduced to offset the bureaucratic settings as indicated by researchers and extension agents in terms of motivation to work, authoritarian leadership and lack of organizational autonomy. Human resource development and rewarding system, mutual and reciprocal links through joint priority setting, joint use of facilities and financial resources should be strengthened.

Rathore *et al.* (2008) also conducted the Analysis of Research–Extension– Farmer Linkage in the Arid Zone of India and found that field-level extension personnel were having more contact with the farmers but they were able to provide knowledge up to the limited extent. The experts were not found to have regular contact with the farmers. The higher officers were frequently busy with various meetings of Zonal Research and Extension Advisory Committee, monthly workshops, etc. Although there was formal mechanism of linkage existing at various levels, it was not so effective in real sense. The authors suggest, Farmer– Scientists' interaction should be organized in the village itself for better linkages. At the same time, scientists should get an opportunity to meet the extension personnel in farmers' field. Farmers' problems should reach the scientists well in time either directly or through agriculture supervisors so that they may be solved at the earliest. There should be more specialized staff at the field level for immediate solution to farmers' problems. The presence of agriculture supervisor of the respective area should be made mandatory in any training or meeting organized for farmers.

2.3.1.3 Resource Factors

Resource problems; **human, financial, and physical resources**, influenced strong research-extension-farmers linkages. ISNAR (1993) summarized the quality; quantity and management of resources are the major source of linkage problems. It mainly stresses on issues like; **motivation and rewards, status differences,** and **human resource mix** as a problem for linkage in relation to human resource. ISNAR (1993) studies of linkages in seven developing countries claimed that most of researchers as well as extension workers are not receiving the right motivation and reward for the respective institution. This is because the rewarding system only focus on the number of articles published on scientific journals; i.e., rewards for journal publication may be higher than for extension activities, and the monthly salary is too low to motivate team to work hard. Hence, it leads to high staff turnover and thereby shortcutting linkages.

Status Differences: FAO (1997) indicated that there might be wide differences in value systems, educational backgrounds and communication methods between research and extension workers. Extension workers perceive researchers as working in ivory towers (as they are considered professionals, with more academic qualifications and training and therefore given higher status) and producing technologies which are not useful at farm level. At the same time, researchers question extension workers' capability to understand research outcomes, to communicate properly with farmers and to provide valuable inputs (Seegers and Kaimowitz, 1989). Similarly, Eponou (1990) also reported similar finding.

2.3.1.4 Managerial Problem

Similarly, with the above problems ISNAR also claimed the less knowledge and understanding of managers have of linkage mechanisms, the less chances of establishing and sustaining the appropriate mechanisms for their particular system. Poor management of linkages in the countries experiences on linkages can arise when decision-making is not concentrated on one unit or when attitudes towards financial resources are inflexible usually due to bureaucracies. It also claimed that research and extension managers of developing countries lack the essential skills for running their organizations, including those for managing linkages, unable to provide leadership, to build a team, to communicate effectively, or to deal with conflicts, and thereby influenced research-extension-farmers linkage.

2.3.2. Empirical Studies Conducted in Ethiopia

The agricultural sector has failed to fulfill its standing role in the country's economy due to unfavorable policy environment, agro-ecological factors, and institutional failures such as weaknesses in research and extension. With the growth of human and livestock population, the resource base of the country is increasingly coming under threat. As a result, the country's food security has been gradually eroded (Kebebe, 2005). The findings summarized below are carefully selected from Ethiopia as they relate to this particular stud. Hence, the following paragraphs briefly describe the challenges of agricultural extension system of Ethiopia in the past and the present.

During Imperial Era

The agricultural extension service was not properly organized due to unclear objectives, unclear targeting of beneficiary farmers, unclear extension methods to be followed and lack of proper organization and definition (Aynalem, 2003). Elias and Agajie (2001) and Tesfaye (2003) also agree that there were no coordinated activities of technology transfer during the pre-1953 period. The period was marked with sporadic activities of introducing external technologies and the clients were the better off. As a result, the targets were mainly the landowners, and not the small holders. There were no research centers, the number of trained personnel was limited, and there had not been any problem identification work conducted a priori. In general, there was no well-defined extension system with defined extension objectives, targets, extension contents and communication methods (ibid).

Stommes and Sisaye (1979) stated the agricultural extension in the 1960s briefly: since more than 60 per cent of the peasant populations live at least a half-day walk from all-weather roads and since the few extension agents had been assigned along all major highways, there was relatively little contact between extension agents and farmers. The feudal nature of the social structure in rural areas had also limited contacts and advice of the extension agents to big landlords and influential farmers. Engagement in non-extension activities, limited number of personnel, fewer technological options, inadequacy of input and credit facilities, and poor research-extension linkage weakened the extension system.

Belay (2003) also indicated until the middle of the 1960s, policymakers paid little attention to the development of peasant agriculture. For instance, during the First Five-Year (1958-l962) and the

Second Five-Year (1963-1967) development plans, despite its importance to the national economy, agriculture received only 13.7 per cent and 21.3 per cent of the total investment, respectively. Even worse, almost all the investment allotted to the agricultural sector was channeled to the expansion of large-scale commercial farms engaged in the production of cash crops for export and raw materials for local industries. Besides, the land tenure system had a crippling effect on the contribution that the extension system could have made to the millions of smallholder farmers, as the aristocrats and the church owned most of the farmland. Consequently, the restrictive credit system discriminated against the landless tenants. Thus, the beneficiaries of the extension system were mainly the commercial farmers and those smallholders in and around project areas (Belay, 2003).

During Marxist Regime

To summarize, the 1974-91 periods is marked by a land reform that abolished the tenant-landlord relationships and private ownership of land, and by the introduction of institutional innovations such as *kebeles* and cooperatives. National agricultural research and extension systems were also strengthened. But increased incidence of drought, unstable political and institutional environment, government's policy of controlling prices and free movement of agricultural products from surplus to deficit areas, dislocation of rural communities through hurried resettlement and villagization programs, and the mobilization of young farmers for the military retarded agricultural development. Reports indicate that agriculture grew at an annual average rate of 0.6% between 1973 and 1980 and at 2.1% per annum between 1980 and 1987 (Habtemariam, 2004). The contribution that agricultural extension could make to agricultural development during the 1974-91 periods was seriously undermined by such factors as giving utmost priority to state and collective farms at the expense of smallholder individual farmers. Besides, DAs were involved in many other tasks in addition to extension, extension messages also carried political objectives, and extension planning was highly centralized, less flexible, and top-down. Though, the clients of extension became the smallholders after the 1974 land reform, involving clients of extension in the planning process remain unchanged and farmers were treated as passive recipients of innovations (Elias and Agajie, 2001).

Era of Decentralization

Belay (2002) indicated that farmers made a very marginal contribution in designing and formulating extension activities. He also noted that neither the farmers nor the frontline extension agents were consulted in the course of policy formulation. Belay (2003) showed that extension agents tend to work with those model farmers who show an interest in the extension packages. One of the criteria used to evaluate the performance of extension agents is the number of farmers adopting the technology packages in their area of work. In other words, quotas, the minimum number of farmers who should take up the technology packages are imposed on extension agents. As a result, the extension agents use whatever means available to persuade farmers to adopt the packages and thereby meet their quotas. Therefore, lack of effective extension service is one of the major constraints influencing the utilization level of extension packages. Belay (2003) added that, the new extension system, PADETES, was not as participatory as its name implied as local extension agents selected 70-80% of participants. Besides, the focus of the extension workers remained on participant farmers. Belay's study depicted that only 13.3% of the sample respondents had been visited by the extension agent in the 1998/99 main cropping season while farmers participating in the package programs were visited on average 4.4 times during the same period. His study also revealed that as high as 30% of the sample respondents from the extension program participants group stated that they did not intend to participate in the program again. Close to one-third of the respondents with intention not to participate next year stated that packages that they were involved were not profitable than their own technologies. Yet, secondary generation problems associated with the promotion of high input agriculture such as availability of inputs and markets for produces were not properly addressed.

Some point at the competence of DAs, lack of adaptation trials for some site-specific technologies (*e.g.* lack of location specific fertilizer recommendation), and DAs physical capacity to monitor up to 300 farmers as major reasons for limitations in the acceptance of technologies by some farmers. The capacity at the local level to verify suitability of technologies for local specificities remains extremely low. During the 1994/95 Production Year alone, over 1,700 demonstration plots were lost for various reasons. The annual performance evaluation reports of MoA pointed out that seed and fertilizer quality, unavailability of seeds in sufficient quantity, quota based plans well over the capacity of staff, and inadequate follow-up as major problems observed in the implementation of extension package programs (ibid).

Belay (2003) concluded that extension programs were formulated without considering farmers' needs and capabilities, and called for farmers' participation in the planning and execution of extension programs, further research-extension linkage in undertaking adaptability trials before wider dissemination of extension packages, giving emphasis to farmers knowledge, changing the way the input credit arrangements are organized and enforced.

To summarise, one could say that the general trend of agricultural extension in Ethiopia followed the international paradigms for agricultural development that were prescribed by international institutions and bilateral donors (community development and package programs of the 1960s and 1970s, for example). The tendency seems to have been from integrated and multi-faceted programmes in smaller and focused areas to smaller and thinner programs dispersed in a wider area. The organization of extension kept on changing and there has not been a well-defined agricultural extension policy and implementation strategy. Underdevelopment of information and communication technologies, weak research-extension linkage has also limited extension workers access to relevant information. Extension projects have nearly always been top down, heavily influenced by donor agencies. There have been frequent changes in approach and focus.

2.3.3 Finger Millet Production in the Amhara Region of Ethiopia

Finger millet *(Eleusine coracana)* is mainly grown as a grain cereal in the semi-arid tropics and subtropics of the world under the rain fed conditions. It is a staple food crop in the majority of drought prone areas in the world and often considered as a component of food security strategies. In Africa, finger millet is grown most commonly by small-scale farmers, and is often intercropped with other cereals, legumes or vegetables. It is an important staple food in East and Central Africa where it serves as a food security crop. It plays vital roles in the livelihoods of resource poor farmers in the east African region (Oduori, 2005). In Eastern Africa, it is produced in Ethiopia, Uganda, Kenya, Tanzania, Rwanda, Burundi, Democratic Republic of Congo, Sudan and Somalia (ibid). In Ethiopia, it is an indigenous crop grown by subsistence farmers. Sole cropping is the common practice in rotation with other annual crops, preferably legumes. The production area is estimated at 305,000 hectare with the productivity of about one ton per hectare (CSA, 2004). The crop is produced in Tigray, Amhara, Oromia, Benishangul-Gumuz, SNNPs, and Gambela regional states. In Ethiopia, it is mainly used for making the staple food-*Injera* and local drinks- *Arekie* and *Tella* (1). Its straw is a major source for animal feeds and for making thatching roof. Finger millet grows on a wide range of altitudes and on a variety of soils and very responsive to fertilizer and good management (2). By virtue of its hardy nature, it can give reliable yield under circumstances where other crops give negligible yield. Despite its importance, the average productivity of the crop in the country is very low. Multiple reasons constitute for this, lack of improved varieties, poor crop management practices, labour requirement (especially for weeding, harvesting and milling) (Alemayehu.et al., 2008). Moreover, the Amhara region alone accounts 52% of the total finger millet area and grain production of the country. It is produced in all administrative zones of the Amhara region except North Shoa. The total production area allotted for finger millet production in the region is 0.3 million ha with a production of 7.6% of total cereal yield and with an average yield of 8q/ha. North Gondar, West Gojam, and Awi zones are the largest in area allocation while North Wolo, Awi and South Gondar zones rank highest in average yield (CACC, 2003). In 2004/05, 30 million quintals (i.e., 3 million tons) of cereals were produced on a total area of 2.5 million hectares in the Amhara region. About 6% of the area and 5% of the produce was finger millet. Zonal production statistics of the three major finger millet production Zones in the Amhara Region shown in Appendix Table 2.1.

2.3.4 Conceptual Framework

The above summaries of studies both in and outside Ethiopia presented a set of factors that influenced research-extension-farmers linkages for technology development, delivery, and adoption. The factors slightly vary from one study to the other. However, there are common factors that could extract from each study. Generally, with the variations, the factors can be categorized as farm household demographic characteristics, socio-economic, institutional, psychological (like technological variables), technology-system contextual, organizational, structural, managerial, physical, financial, and human resource factors. The inherent shortcoming of all the studies is their failure to present a detailed and combined analysis of the factors that can influence linkages. Moreover, they failed to present detailed quantifications on how the linkages were affected by a change on each explanatory variable. In consequence, they missed to describe to what marginal level does each factors influenced researchers, extension agents, and farmers' linkages. Likewise, which are among the contributory factors that hampered linkages is a missing link in all the studies. So, all of the studies described the nature and extent of research-extension-farmers linkages as a single factor through simple tools of either explanatory, descriptive using simple frequencies or percentages and qualitative methods more of like case studies. Thus, this study analyzed the key factors that significantly influenced the level of integrations of researchers, extension agents, and farmers in linkage mechanisms through detailed analysis of the variations and impact of each of the variables.

In short, the analytical or conceptual framework of this study was developed based on the assumptions and theoretical models of participatory technology development, and research and technology transfer linkages framework discussed earlier. As illustrated in figure 2.4 below, different factors (explanatory variables) supposed to affect linkage mechanisms of researchers, extension agents, and farmers (dependent variable). Particularly those, which contribute to the variations on participation in linkage mechanisms among researchers, extension agents, farmers, were taken into consideration.

Figure 2.4 Conceptual Framework of the Study

Source: Adapted from Research and Technology Transfer Linkages Framework and Participatory Technology Development Model developed by ISNAR.

The next chapter presents the research methodology adopted in the study. Also included a brief description of the study area.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Description of the Study Area

This chapter presents a brief overview of the study zone and highlights the demographic, physical, socio-economic and institutional characteristics of the study *wereda* based on various information sources including the respective government sectors of the *wereda*. Finally, it provides the methodologies adopted for the study.

3.1.1 West Gojam Zone

The study zone, West Gojam Zone, is among the 11 administrative zones of the Amhara region, where the capital city of the region, Baihr Dar, is based. The zone consists of 15 districts and it has a wide range of cultures, agro-ecological diversities, resource endowments, dominant agricultural farming systems and other off-farm activities like fishing and different poverty levels. Besides, the zone hosts one university (Baidar University); five Research organizations (Amhara Regional Agricultural Research institute; Adet ARC; Baihr Dar Mechanization Research center, Andasa Livestock Research center; and Baihr Dar Fishery Research center). Moreover, the Amhara Regional State; BoARD, West Gojam Zone Agricultural and Rural Development Bureau; Ethiopian Seed Enterprise Agency; Baihr Dar Textile and Garment Factory; Blue Nile; Lake Tana; Koga project, and different local and international NGO'S, etc exist in the zone.

According to the CSA estimates in 2005, West Gojam zone had 2.6 million inhabitants and the total area is nearly 10.5 thousand km^2. Much of the land use is covered by wet land (i.e., 33%), while plantation forest and cultivated lands follow (Appendix Table 3.1).

3.1.2 The Study Wereda (*Mecha*)

3.1.2.1 Location

Mecha is one of the 15 districts in West Gojam zone of the ANRS. The capital town of *Mecha* district is *Merawi* town and located at about 540 km North of the capital city, Addis Ababa. The district has 39 rural *kebele's* and three-urban *kebele* administrative. Among, the study was conducted in five peasant associations called *Enamerit, Enguti, Ambomesk, Pikolo Abay,* and *Kudemie*. It is located between 11^0

10' and 11^0 25' North latitude and 37^0 2' and 37^0 17' East longitude in Blue Nile basin, within the Highland of Ethiopia (Figure 3.1).

3.1.2.2 Physical Characteristics

The physical characteristics of a given area influence the socio-economic condition of the population inhabiting it. The following section describes the major physical characteristics of *Mecha wereda.*

Topography and Climate: the most common feature of relief in the *wereda* is plain land (i.e., 88%), followed by mountains (11%), and valley (1%).The temperature ranges from 14-37°C. The monthly mean temperature is 25.8^{o}C. Some 70% to 85% of the study area ranges in altitude from 1800-2500 m asl. It has three major agro-climatic zones, i.e., *dega* (above 2300 m asl), *woinadega* (1500-2300 m asl), and *kola* (below 1500 m asl). This varied ecology lends itself well to diversified agriculture. The annual rainfall ranges from 1200-1500. The mean annual rainfall is 1480 mm, of which 90% falls in the months May through October. One effective rainy season extends from June to September. A long dry season follows with intermittent showers, especially in April to May, that are not sufficient to grow crops but are used in land preparation.

Vegetation Cover, Land Use and Soil Type: Accelerated population growth and increasing demand for agricultural land, fuel wood and construction material, puts pressure on the natural vegetation cover of the *wereda.* Much of the area is plain land while cultivated lands, plantation forest, and grazing land, follow. Especially, the wereda is also known for massive expansion of eucalyptus trees. Farmers do not have many different soil types to choose from. The information from wereda office of Agriculture and Rural Development revealed that the dominant soil type close to 93% in area coverage is red soils, followed by brown (4%) and black (3%). Soil in the *wereda* is generally characterized by moderate fertility. Moreover, concerted efforts has been going on by the government and donors through launching massive water shade project, namely called Koga project in the study *wereda.* It aimed for sustainable natural resource management and improving productivity through production by both irrigation and main season by mere emphasis on highly degraded areas with limited production potential and the poorest farmers. The Koga watershed lies in the Blue Nile Basin and consists of land drained by the Koga River above its confluence with the Gilgel Abay (Little Nile). The Koga River flows south to Northwest with a total length of 49 km to Gilgel (Little) Abay and Lake Tana; its tributaries effectively drain the total catchment area, which is 27,850 ha.

3.1.2.3 Socio-economic Characteristics of the Study Area

3.1.2.3.1 Demographic Characteristics

Based on 2010 CSA result, the total area of *Mecha* district, where the study is based, is 1,481.64 per square kilometer with a population of about 308,444. Among, 155,799 were males and 152,645 were females. Close to 92.85% of the *wereda's* population lives in rural areas.

The population density of the district is about 208.2 people per square kilometer, demonstrating higher population density as compared to the regional average 105 person per square kilometer.

3.1.2.3.2 Major Livelihoods of the Study Area

As typical in Ethiopian Highlands, mixed farming, where crops are grown for food and cash, and livestock are kept for complementary purpose, as a means of security during food shortage, and to meet farmers' cash needs. Mixed farming is equally important at *dega*, *kola*, and *woinadega* areas of the *wereda*. According to the wereda Finance and Economic Development Office, agriculture sectors forms the base of the overall development trusts of the district, where by close to 94% of the population drives their livelihood from agriculture. Other non-farm activities such as trade, petty trade, restaurant carpentry, spinning, hair dressing handcrafts accounts the remaining 6%.

Crop Production: Agriculture in the study *wereda* is virtually small scale, subsistence oriented and crucially dependent on rainfall. The major crops types usually grown are maize, finger millet, *teff*, horticultural crops, *oils*, spices, pulses, wheat, barley and other annual crops, under sole and mixed cropping practice. However, the district is highly known for both in area and volume of finger millet and maize production. Besides, in *Mecha* district, apart from the principal crops grown, eucalyptus tree plantations contributed a great deal to the substantial decline in the area coverage of major crops. Eucalyptus plantations are significantly replacing crop fields for the sheer reason of fetching more money than most cereals could for a unit piece of land (Alemayehu *et al.*, 2008). Eucalyptus trees also grow faster than other trees used in timber production. Some farmers have been able to own vehicles and flourmills by selling eucalyptus trees. The trees are used for construction and fuel wood or charcoal making. Every farmer allocates a piece of his crop fields to plant eucalyptus trees. In four to five years, he will sell them for an attractive price. That will help the family earn more income and improve its way of life. The farmers surely are aware of the dangers hanging due to planting these trees, but keep on doing it because of the return. The crop fields near eucalyptus plantations suffer greatly due to the shading and antibiosis effect of the trees. The trees also drain the underground water reserve. The fields affected can be neighboring farmers' fields and that can cause friction between them. Despite all these drawbacks farmers continue to grow them. They give priority to earning more money and feeding their families than caring for the protection of the environment (ibid).

Livestock Production: Livestock play a significant role in the mixed farming system of the area. Their main contribution is in providing draft power, cash generation, food, and as a status symbol. Livestock types kept by the farmers include cattle, sheep and goats, horse, donkey and poultry. Oxen are kept to provide draft power, cows to provide farm households with milk and butter for consumption and sale, donkeys and horses for transporting goods, whilst sheep, goats and poultry are mainly kept for sale as well as for their meat. The feed sources commonly used for livestock, include natural grazing, and crop residues. The contribution of natural pasture as sources of feed is very limited due to the extensive coverage of the land by crops and plantations. Consequently, natural grazing for cattle in particular is limited to farm boundaries, few communal grazing lands, rents, and the lower slopes of the hillsides. Goats and sheep are, however entirely fed from the natural vegetation in the bushes and hillsides.

3.1.2.4 Institutional Characteristics of the Study Area

Agricultural Extension Service

The *Wereda* agriculture and rural development office through its technical experts and development agents provides agricultural extension services in the study *wereda* with a primary objectives of; improving production and productivity of small-holder farmers through introduction of improved agricultural technologies, provision of technical advice to farmers, providing basic agricultural education, and demonstration about the use of agricultural inputs, etc. At present, the extension approach being using 3 diploma graduate DAs in each *kebele* or village (trained on crop production, animal husbandry, and natural resource management). The DA to farmers' ratio is about 1:550.

Agricultural Credit and Input Supply: Availability of credit and inputs is an important part of the extension system that is required to increase agricultural production with agricultural technologies, like fertilizer, improved seed, improved breeds of animals, farm implements, etc. According to Agricultural unit office information, the major inputs distributed in the study area in the last ten years were fertilizer (DAP and Urea) and improved maize varieties. There are two formal institutions providing credit in the *wereda*: the Amhara Credit and Saving Institutions (ACSI), and the 17 farmers' cooperatives. A group loan system where loan period and interest period are two years and 18% respectively is employed by ACSI. The institution provides loan for petty trading and other non-farm activities.

The cooperatives provide credit and saving service to their own members with an interest rate of 7.5%-12%. The 17 cooperatives: stabilize market by selling their purchase in time of shortage; minimize seasonal fluctuation in the price of produce through buying during harvest; supply agricultural inputs and other industrial consumer goods with reasonable price; provide services like flourmill; periodically distribute profit to their members. Permanent residence in a *Kebele,* the person's ability to repay loan, his/her reputation as well as the ability to pay the registration fee is the only preconditions for membership in the cooperatives.

Infrastructure: Presence of infrastructure is an important vehicle for the transformation of a rural economy. Roads and communication net works, health and educational infrastructures, and potable water supply, availability and access to input and output markets are some of the infrastructure components that are necessary to improve the production and productivity of the rural poor. With regard to the health service in the study area, there are 2-health stations and 13 health posts under the control of governmental and there are one private rural drug vender and one private health station that provide health service. Regarding the educational infrastructures, there are 70 elementary schools and 4 high schools. There are two major marketing places in the district called *Merawi* and *Pikolo Abay* market places. The *Merawi* market is larger in its volume of transaction than the *Pikolo Abay.* In addition to the above two marketing places, there are others such as *Kudime,* and *Ambomesk* which farmers use to exchange industrial and farm products. Carts and pack animals are the main means of transportation and larger share of farm produce is transported using them. Human labor is another means to transport farm produce to the local market.

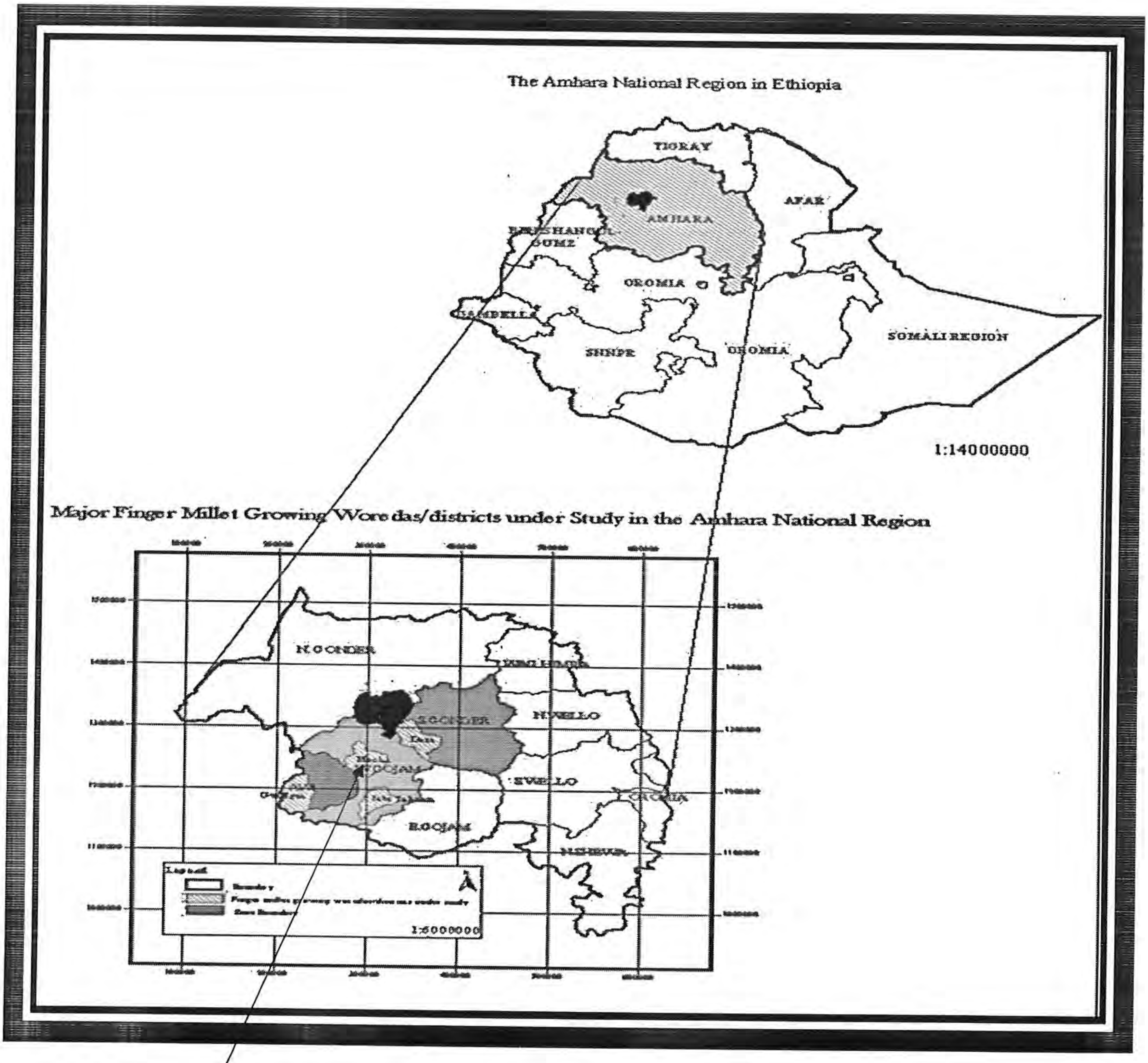


Figure 3.1 Map of Mecha district where the study was conducted/ West Gojam Zone

Source: Alemayehu *et al.*, 2008

3.2 The Research Design

Cross-sectional study design was used for this study because as sample were selected from only some of the population of the categories of the respondents, and was studied at a particular time by aiming the relationships, prevalence of phenomena, situations and problems. It was also useful in obtaining an overall picture. The study was also descriptive, as information about the variables of the study was collected, as they exist as the time of data collection. Hence, analysis was conducted to determine the extent of relationship between the dependent variables and the respective independent variables explained by variations in the attribute of independent variable.

3.3 Sample, Sampling Procedure and Sample Size

The study population comprised of researchers in three public agricultural research organizations, extension personnel in three extension offices and bureaus of agriculture and rural development, and the client system, i.e. finger millet farmers (the end users of technology).

It is evident that appropriate sample size depends on various factors relating to the subject under consideration like the degree of homogeneity of the populations, the number of variables , the degree of confidence or accuracy achieved, time aspect, resource availability, etc. If sample size is too small, we may fail to achieve the objective of the study. Too large sample size will also result in misuse of resources. For this study, the above-mentioned factors were taken into account to determine the sampling size. Accordingly, eighteen (18) researchers, twenty-six (26) extension personnel's and hundred (100) farmers was targeted in the unit of analysis. Thus, the total sample size is 144 in order to allow ample time to conduct the study.

3.3.1 Sampling Procedures of the Study District and Respective Household Farmers

For this part, multi-stage sampling procedure was applied to select the required number of sample respondents. First, Mecha district was purposively selected because the area is representative and has potential for finger millet production in the zone as well as in the region. Moreover, the study area is known as one of the districts with the relative access to extension service. Hence, this district would help us to get useful information on the nature and extent of the research-extension farmers' linkage systems in finger millet technology development and transfer.

At the second stage, since the majority of *Kebele's* (39) in the district have potential for finger millet production with relative access to past extension and research in the promotion of improved finger millet production, five *Kebele's* were selected purposefully based on discussions with key extension experts. Accordingly, two, one, and two *Kebele's* of high, medium, and low volume of finger millet producing were selected, respectively. Consequently, per each *Kebele's*, 20 finger millet cultivating household farmers were selected randomly in collaboration with administrators, key informants and DAs of the respective *Kebele's*. Thus, 100 household farmers were selected for the study in order to allow ample time to conduct the study.

3.3.2 Sampling Procedures of Extension Organizations and Respective Extension Agents

A purposive sampling technique was used to select three extension organizations that were found in the technology system of the study zone. Accordingly, at district level, Mecha Wereda Office of Agricultural and Rural development; at Regional and Zonal levels, Regional and West Gojam Zone Bureau of Agricultural and Rural development were selected, respectively.

Moreover, purposive-sampling technique was used to select extension staff whose work mandate covers finger millet cultivation. Due to their limited number, all the finger millet extension staff (15) in the unit of analysis was included. Furthermore, eleven (11) key extension or transfer agents who has been experienced and involved in linkage activities and act as a manager, coordinator and department heads in the unit of analysis, was selected purposefully.

3.3.3 Sampling Procedures of Research Centers and Respective Researchers

A purposive sampling technique was used to select three out of the existing five research organizations found in the study zone. Accordingly, Amhara Regional Agricultural Research Institute, Adet Agricultural and Bahirdar Mechanization Research Centers were selected, respectively as a sample because their mandates covers crop sector agricultural activities and have been engaged on linkage activities with the extension organizations and farmers for long years. Whereas, the rest two research centers were not included since their mandates covers livestock and fishery sector research activities.

Purposive-sampling techniques was also used to select researchers from the three selected research centers whose work mandate covers finger millet cultivation. Due to their limited number all the finger millet research staffs (11) in the unit of analysis were included. In addition to this, seven (7) researchers who has been experienced and involved in linkage activities and act as a manager, coordinator and department heads in the unit of analysis, were selected purposefully because the respondents have key information about linkage systems from the study population apart from their managerial role. This type of sampling techniques is useful to elicit information regarding challenges of linkage and good for high decision-making. One problem encountered in the study was that initially, 22 questionnaires were distributed to 22 researchers, 18 returned the completed questionnaires while, 4 researchers did not return their questionnaires, as all were on leave to abroad.

3.4 Data Collection Methods

Both primary and secondary data collection methods were used.

3.4.1 Primary Data Collection Methods

Both qualitative and quantitative primary data was collected by using interviews, observations, questionnaires, and focus group discussion.

The qualitative data was collected from researchers, extension staff, and farmers to obtain information about their personal experiences, believes and perspectives on issues of research-extension-farmers linkage in relation to the technology uptake pathways including the various factors influencing linkages and adoption of technologies. Quantitative primary data was also collected from the respondents to elicit and quantify ample information about the variables.

3.4.1.1 Main Techniques of Primary Data Collection

Key Informant Interviews (KII): In depth interview of respondents using checklist, was used in a survey technique. The interview types were both structured and unstructured in order to obtain an overall picture and key information from researchers, extension staffs, and farmers. Accordingly,

Six (6) key researchers who have been experienced, having no managerial roles and whose work mandate does not cover finger millet cultivation had participated in the KII's.

Similarly, eight (8) key extension workers who has been experienced and whose work mandate does not cover finger millet cultivation have participated in the KII's.

Moreover, ten (10) key informant finger millet cultivating farmers (2 from each *kebeles*) comprised of leaders of *kebele* administration, women's, and progressive farmers had participated in the KII's in order to obtain key information about the nature and extent of research-extension-farmers linkage in finger millet technology development and delivery.

B. Questionnaire: Questionnaires were used in order to gather large information from the respondents. Three separate sets of questionnaires was prepared and directed to obtain data from researchers, extensionists and farmers, respectively. Besides, the content of the questionnaires comprised both an open and closed ended questions. Open-ended questions helps to elicit some sensitive information, where as closed ended questions was used to obtain known facts, like demographic characteristics of the respondents. (See appendix for full information of the tools of data collection).

C. Focus Group Discussion (FGDs): In additions to the above techniques, focus group discussions were used to gather information that was not obtained from individual approaches. Accordingly, three FGDs, one with researchers and two with farmers by using checklist was conducted separately to obtain disclosed ideas or issues, which have been considered as vague and closed realities concerning on research-extension-farmers linkage in technology development and delivery. As a result, it generates useful information as it helps to triangulate the information collected through individual approaches. Accordingly, one FGD was conducted with ten (10) research staffs comprised of senior technical assistants and researchers including senior and less experienced.

Similarly, two FGDs were conducted separately in 2 *kebeles* out of the five due to the homogeneity of the population, farming activities, and associated problems.

Hence, thirteen (13) and seventeen (17) farmers, respectively from the 2 *kebeles* comprised of different age categories and farming experiences, being members and non-members of farmers development groups, and women headed households had participated in the FGDs.

Generally, the FGDs participants were familiarized to the discussion points and encouraged to forward their opinion they felt without any reservation. In this process, recording, coding, reorganizing and arrangements, refining expanding of information was conducted.

D. Personal Observation

Personal observations were used to obtain data by watching events, processes, or noting physical characteristics as they occurred in their natural setting and as well as after interactions. Hence, observations data was collected by using recording sheets.

3.4.1.2 Secondary Data Collection Methods

Relevant literature, books, journal articles, and official reports, proceedings, minutes and publications of research and extension agencies in the areas of research-extension linkage was used.

3.5 Pre-Testing and Administration of Instruments

Before the actual data collection, the instruments were subjected to pre-testing. That is, four researchers from Sirinka research center (1), Adet research center(2), and Bahirdar University(1), respectively, and four extension agents from district(1), zonal (1), and regional (2) Bureau of Agriculture and Rural Development were selected to pre-test the questionnaires designed for researchers and extension staff. Comments and suggestions from the pre-test was considered and incorporated in to the final version of the questionnaires. Besides, a one-week diagnostic pre-survey was used for pre-testing and revising the farmers' questionnaire to ensure that the instrument is eliciting information relevant to the study and the clarity and consistency of the questions that was asked.

Once the instruments subjected to pre-testing, then the administration of the instruments on the respondents took place in the offices of researchers, extension agents and houses and farms of farmers'. As well, enumerators all of which (8) are senior researchers were trained to collect data from the farmers and extension staffs. However, since, researchers are supposed to be literate they fill their questionnaire under the monitoring of the researcher and the enumerators.

3.6 Methods of Data Analysis and Econometric model used

This study employed both descriptive statistics and econometric model to study the relationship between the dependent and explanatory variables. The qualitative data generated using FGDs, KIIs, and observation has been analyzed by describing or narrating and interpreting the situation deeply so that the real picture of the issues is clearly understood through triangulation. The quantitative data analysis and presentation involves the use of descriptive statistics such as frequency distribution, measures of central tendency, Chi-square, T-test, and F-test. Tables were also used to illustrate and facilitate the analysis. This helps to assess and analyze the participation of researchers, extension agents, and farmers in linkage mechanisms. Cramer's V and Pearson correlation were used to see the strength and direction of association between variables. Moreover, logit model was used to determine the relative influence of various explanatory variables on the dependent variable. SPSS version 16 software program was used for the analysis.

Research-extension-farmers linkage especially in developing countries is influenced by a complex set of factors (ISNAR, 1987). Hence, modeling effective research-extension-farmers linkages for agricultural innovations has become important both theoretically and empirically.

Logit Model: Conceptually, the econometric models were used to examine the relationships between researchers, extension workers, and farmers' participation in linkage mechanisms and factors influencing linkages involves a mixed set of qualitative and quantitative data. The dependent variable is dichotomous taking two values, 1if the event occurs and 0 if it doesn't. As for instance, in participation decision studies, responses to a question such as whether a researchers, an extension agent, or a farmers are willing to participate in a given linkage activities could be 'yes' or 'no', a typical case of dichotomous variable estimation of this type of relationship requires the use of qualitative response models. In this regard, linear probability, logit and probit model are the possible alternatives. In linear probability model, the dichotomous dependent variable is expressed as a linear function of the explanatory variables. Although one can estimate linear probability model by the standard Ordinary Least Squares methods as a mechanical routine, the result will be beset by several estimation problems (Gujarati, 1995).

Although Ordinary Least Squares (OLS) regression estimates can be computed for binary model, the error terms are likely to be hetroscedastic leading to inefficient parameter estimates. Consequently, hypothesis testing and construction of confidence interval becomes inaccurate and misleading. Likewise, a linear probability model may generate predicted values outside the 0-1 bound, which violate the basic tenets of probability. To alleviate these problems and produce relevant empirical outcomes, the most widely used qualitative response models are logit and probit models (Amemiya, 1981). However, Gujarati (1995) suggested the S-shaped curves satisfying the probability model as those represented by the cumulative logistic function (logit) and cumulative normal distribution function (probit). However, the logistic and cumulative normal functions are very close in the mid-range, but the logistic function has slightly heavier tails than the cumulative normal function. That is, the normal curve approaches the axis more quickly than the logistic curve.

Therefore, logit model, (a binary logistic) based on cumulative logistic probability function was used in this study. Ignoring the minor differences between logit and probit models, Liao (1994) and Gujarati (1995) indicated that the probit and logit models are quite similar, so they usually generate predicted probabilities that are almost identical. The choice between logit and probit models is largely a matter of convenience. However, the logit model is computationally easier to use and leads itself to a meaningful interpretation than the other types (Gujarati, 1995).

Model Specification

Following Gujarati (1995) participation decision model, the logistic distribution function for identification of the participation and non-participation of researchers, extension agents, and farmers can be specified as:

$$P_i = \frac{1}{(1 + e^{-Z_i})} = \frac{e^{Z_i}}{(1 + e^{Z_i})} \quad \dots\dots\dots\dots\dots\dots 1$$

Where p_i - is a probability of participation for the i^{th} respondent and it ranges from 0-1. P is the observed response of the i^{th} respondent (i.e., the binary variable, P = 1 for participators, P = 0 for a non-participator). NB: i^{th} respondent here refers to a researcher, a farmer, and an extension agent and each were treated separately with the model.

e^{Z_i} – Stands for the irrational numbers e to the power of Z_i

Z_i - Is a function of m- explanatory variables (X_i) which is also expressed as:

$$Z_i = \beta_0 + \sum_{i=1}^{m} \beta_i \chi_i + u_i$$

Z is an underlying and unobserved stimulus index for the i^{th} farmer, researcher, or extension agent.

i = 1, 2,… m, are observations on variables for the participation model, m being the number of explanatory variables in this study.

β_0 = is the constant term/ is the intercept and

β_j = Are the unknown/slope parameters to be estimated, and U_t = is the disturbance term

The slope tells how the log-odds ratio in favor of participation in joint research-extension-farmers linkage mechanisms changes as independent variables change. Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds, (Gujarati, 1995). The odds to be used can be defined as the ratio of the probability that a respondent (researcher, extension agent, and farmer) will participate (P_i) to the probability that he/she will not ($1-P_i$).

$$1 - Pi = \frac{1}{(1 + e^{Z_i})} = 1 - \frac{e^{Z_i}}{1 + e^{Z_i}} \quad \dots\dots\dots\dots\dots(2)$$

$$= \frac{e^{-Z_i}}{1 + e^{-Z_i}} = \frac{1}{1 + e^{Z_i}}$$

Therefore, the odds ratio can be written as:

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

Now, $\frac{Pi}{1-Pi}$ is simply the odd ratio in favor of participating in linkage mechanism. Finally, taking the natural logarithm of the odds ratio of equation (3) will result in what is known as the logit model as indicated below:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = \ln\left(e^{B_0 + \sum_{i=1} \beta_i X_i}\right) = Z_i \quad \text{......(4)}$$

If the disturbance term U_i is taken into account, the logit model becomes

$$Z_i = \beta_o + \sum_{i=1}^{m} \beta_i x_i + u_i \quad \text{..5}$$

Where: $L_i =$ is log of the odds ratio in favor of participating in joint linkage mechanism, which is not only linear in x_i but also linear in the parameters.

Hence, the above logit model was used in this part of the study to identify variables influencing linkages between research, extension, and farmers. Moreover, prior to the estimation of the model parameters, the variables that were assumed to influence the joint research-extension-farmers participation were tested for multicollinearity problems among the continuous variables (using VIF). Similarly, the contingency coefficients, which measure the association between various discrete variables based on the Chi-square, were computed in order to check the degree of association among the discrete variables. The parameters (β_i) of the model coefficients were estimated using the iterative maximum likelihood (ML) estimation procedure. The detailed analysis of this section is presented in the result and discussion part.

3.7 Definitions of Variables and Working Hypothesis

Once the analytical procedures and their requirements are known, it is necessary to identify the potential explanatory variables and describe their measurements. Therefore, this part was treated in two divisions. See **Annex** for the dependent and potential explanatory variables that were treated to identify the key factors influencing the performance of research-extension-farmers linkage in the study area.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

Since this chapter is the nucleus of the thesis work, it will consist of the overall findings of the study. It reports the findings of descriptive and econometric analysis in line with the linkage participant groups'. The first section is dedicated in explaining the influence of different demographic, personal, socio-economic, institutional, psychological, organizational, system-contextual, structural, resource related, ,and managerial factors on joint participation of researchers, extension agents, and farmers in linkage activities.

Then, the next sections explaining and characterizing the types of linkage mechanisms of each linkage functions that are regularly used by research and extension organizations; and examining the involvement of researchers, extension agents and farmers in linkage activities of finger millet technology development and delivery during the last two production years (the dependent variable). Finally, the econometric model results of the determinants and the probability of participation of researchers, extension agents, and farmers in linkage activities will be discussed.

In this study, out of the types of linkage mechanisms which were being used by researchers and extension agents to facilitate joint research-extension-farmers linkages or participation, only field day was included for calculating the participation level of researchers, extension agents, and farmers on linkage activities; due to absence of variation among researchers, extension agents, and farmers on the use of the majority of linkage mechanisms mentioned by researchers and extension agents. Moreover, it made too difficult or significantly reduced the participation index of each actors, hence, the remaining linkage mechanisms were excluded from participation level. As for instance, out of the 26 extension agents surveyed none of the extension agents reported being a participant in any joint problem identification, joint technology release committee, joint surveys, and publications at least once in the last two years. Similarly, farmers (N=100) were not involved almost at all in joint-report writing (1%), joint problem identification (3%), joint survey (2%), and publication (1%) in the last 2 years. Moreover, researchers' participation in such joint activities is at least at the level of bare minimum.

Thus, the category as non-participants and participants in linkage mechanisms at least once in the last two years was not identified based on the result of participation index score. Because, the participation index score of the respondents was not normally distributed with a range from 0.00 to 1.00, rather it distributions were fall below half of the index score. As a result, based on the above explanations and reasons the researcher believed and selected only participation in field day for calculating the participation level of researchers, extensionists, and farmers on linkage activities; due to the high and frequent use of field days in the last 2 years as participatory research-extension-farmers linkages mechanisms. In short, the category as non-participant and participant was identified based on the status of participation in linkage mechanism (field day) in such a way that a researcher, a farmer, and an extension worker who had participated in field days at least once in the last 2 production years would be given a value 2, 1 otherwise.

4.2 Influence of Independent Variables on Participations of Researchers, Extension Agents, and Farmers in Linkage Mechanisms of Finger millet Technology Generation and Transfer

Several factors influence linkages. Different researchers group these factors under different major categories depending on the purpose of their study and list of relevant variables to be considered. In this study, the independent variables thought to have relationship with participation in finger millet linkage activities are grouped as 1) household demographic , farm related variables, household's economic, psychological factors and institutional variables; 2) researchers and extension agents personal characteristics, psychological factors, organizational, technology system–contextual, structural, resource issues, and managerial variables. Hence, the relationship of these variables with the dependent variable is discussed under the following sub-topics.

4.2.1 Household Demographic Characteristics of Sampled Farmers

4.2.1.1 Distribution of Sample Household Head by Sex and Marital Status

Sex of the household head was one of the demographic characteristics hypothesized to influence the participation in finger millet linkage mechanisms in such a way that male-headed households were expected to participate more than female headed households. The result shows that majorities of the farmers were males (88 %) indicating most of the households were headed by men (Table 4.1 below).

The proportions of male-headed households were high within the participants (89.2%) than within the non-participants (87.3%). Further, out of the total female respondents the majority (12.7%) were non-participants. The result revealed that the percentage of male-headed participants (89.2%) were higher than that of female-headed (10.8%). This could be attributed to various reasons, which could be the problem of social and economic position of female-headed households, limited access to information and inputs, etc. Regarding its relationship with participation in linkage mechanisms, Pearson chi-square shows sex of the household head between the two groups was found to be insignificant (χ^2 =0.118, DF=1, P=0.732) at 0.1 level with participation in linkage mechanisms. Therefore, the result shows the insignificant difference among male-headed and female-headed households in terms of participation in linkage mechanisms.

With regard to the marital status, from the total sample respondents 88%, 7% and 5% were married, divorced and widowed, respectively. The majority were married which is a reflection of the age category majority of them belong, and provides additional farm labor for the farmers. The marital status of linkage participants were 89.2 % (married), 8.1% (divorced) and 2.7% (widowed) while for the non-participants it is 87.3%, 6.35%, and 6.35%, respectively (Table 4.1) in the same order. Chi-square test of marital status between the groups was found to be insignificant on participation of linkage activities (χ^2 =0.732, DF=2, P=0.693) at 0.1 level. This shows that being married, divorced, or widowed has insignificant relation on participation in finger millet linkage activities.

Table 4.1 Distribution of Sample Household Heads by Sex and Marital Status

	Non-Participants		Participants		Total sample		χ^2 Value
	N	%	N	%	N	%	
Sex							**0.118(NS)**
Female	8	12.7	4	10.8	12	12	
Male	55	87.3	33	89.2	88	88	
Marital status							**0.732(NS)**
Married	55	87.3	33	89.2	88	88	
Divorced	4	6.35	3	8.1	7	7	
Widow	4	6.35	1	2.7	5	5	

$\chi2$ = 0.118, df =1, Cramer's V =0.29, p = 0.732 for sex distribution; $\chi2$ = 0.732, df =2, Cramer's V =0.086, p = 0.693 for marital status, NS, Non Significant.
Source: Own survey result, 2010.

4.2.1.2 Distribution of Sample Households Heads by Age and Farming Experience

Age of the total household head of sample respondents ranged from 24 to 72 years with mean of 41.28 years and standard deviation of 11.78. About 33 %, 24%, 24%, 15%, and 4% were between age categories of 24 to 33; 34 to 43; 44 to 52; 53 to 62 and 63 to 72 years, respectively. The average ages of males and females was found to be 41.07 and 42.83 years with standard deviations of 12.277 and 7.455, respectively. The average ages of linkage participants and non-participants was found to be 42.97 and 40.29 years with the standard deviations of 8.11 and 13.45, respectively.

One-way ANOVA for comparison of average age shows that there is significant mean difference (F=6.16, P=0.000) among the groups at 0.01 significant level. However, results of the bivariate correlation analysis (r = 0.111, p= 0.273) revealed that there is positive but insignificant relation at 0.01 level between age and participation in linkage mechanisms (Table 4.2 below).

Regarding their farming experience, most of the farmers started their own farming during their mid 20s and has an average farming experience of 20.03 years with standard deviation of 11.8. The most experienced farmer in the sample had 45 years while the least had 2 years of farming experience. The average years of farming experience for linkage participants and non-participants is 22.6 and 18.5. One-way ANOVA for comparison of average farming experience shows that there is significant mean difference (F=1.708, p=0.033) among the groups at 0.05 level. In addition, correlation analysis (r = 0.169, p= 0.093) revealed that there is positive and weak relation at 0.1 probability level between farming experience and participation in linkage mechanisms.

Table 4.2 Distribution of Sample Households by Age and Farming Experience

Linkage Participant Category	Age in years					Farming experience in years		F	p value	r
	Mean	SD	F	p	r	Mean	SD			
Non-participant	40.29	13.45				18.5	12.3			
Participant	42.97	8.11				22.6	10.5			
Total	41.28	11.78	6.16***	0.0	0.1	20.03	11.8	1.708	0.033**	0.169

Source: Own Data, 2010; **, Significant at 5% level, ***, Significant at 1% level

4.2.1.3 Distribution of Sample Households Head by Educational Level

The distribution of total sample respondents in terms of literacy level has shown that 42 % were illiterate, 36% could read and write, 15% had attended formal primary education from grade 1 to 8, 4% were exposed to formal secondary education from grade 9 to 10, and the remaining 3% were able to read only. The intervention activities of formal schooling, mass literacy campaigns, adult education programs, and religious institutions accounted for the literacy of the farmers. The total average educational level was 1.37 years of schooling with standard deviation of 0.485.

Linkage participants had better level of educational achievement on average about 2.7 years of schooling with SD of 1.1 compared to non-participants (2.16) with SD of 1.3, implying the significant role of education in participation in research-extension-farmers linkage mechanisms. Mean test showed that there is significant mean difference (t = -2.094, p= 0.039) in level of education among the groups at 5% significance level. Moreover, result of correlation analysis revealed positive and significant relationship of education and participation in linkage mechanisms (r=0.207, p=0.039) at 5% level.

Table 4.3 Distribution of Sample Respondents by Educational Level

	Non-participants		Participants		Total sample		t- value	r-value
Educational level	N	%	N	%	N	%		
Illiterate	32	50.8	10	27	42	42		
Read Only	3	4.8	0	0	3	3		
Read and write	16	25.4	20	54.1	36	36		
From 1 – 8	5	15.9	10	13.5	15	15		
From 9 – 10	2	3.2	2	5.4	4	4		
Mean	2.16		2.70		1.375		-2.094**	0.207**

Source: Own Data, 2010; **, Significant at 5% level

4.2.1.4 Distribution of Sample Households Head by Family Size

Family size of the households ranged from 2 up to 12 persons, with an average family size of 5.63 and a standard deviation of 2.733. About 51 % of the farmers had between 7 and 12 dependants indicating a large farm family. 28 % had between 1 and 3 dependants indicating a small farm family, and 21% had between 4-6 dependants indicating a medium farm family (Table 4.4). The average family size of the linkage participants and non-participants was 5.84 and 5.51, with SD of 2.57 and 2.86, respectively and mean difference of 0.33 that was found to be statistically insignificant (t=-0.596, p > 0.1).

Table 4.4 Distribution of Sample Households Head by Family Size

Family	Non-participants		Participants		Total sample		T-value for mean Difference
	N	%	N	%	N	%	
1- 3	18	29.6	10	27	28	28	
4 – 6	15	23.8	6	16.2	21	21	
>7	30	47.6	21	56.8	51	51	
Mean	5.5		5.84		5.63		-0.581(NS)

Source: Own Data, 2010, NS, Non Significant.

4.2.1.5 Distribution of Sample Households by Participation in Various Social Organizations

Out of the total respondent households, 21 % participated in leadership of formal social organizations at their village or PA level, which ranged from various agriculturally oriented groups to local *kebele* administration. From the sample households who have participated in leaderships of formal social organization, 14% and 7% were linkage participants and non-participants, respectively. Chi-square test showed that the difference in the level of participation in formal social institutions were found to be significant (χ^2=10.482, p=0.05) (Table 4.5). With regard to the participation of the respondents in non-formal social organization such as *Idir* and *Mahber*, all of the sampled farmers took part in various issues that require participation. The difference was statistically tested and it was found to be insignificant (χ^2=1.466, p> 0.1).

Table 4.5 Distribution of Sample Households by Participation in Formal Social Organizations

Parameters	Non participants		Participants		Total sample		
	N	%	N	%	N	%	χ^2
Participation in social organizations							10.482**
Non participant	56	88.9	23	62.2	79	79	
Village Head	0	0	2	5.4	2	2	
Assistant village head	0	0	1	2.7	1	1	
Councilor/cabinet	6	9.5	11	29.7	17	17	
Government development g	1	1.6	0	0	1	1	

Source: Own Data, 2010; **, Significant at 5% level

4.2.2 Farmers' Institutional Characteristics/ Environment

The important institutional services that were required to increase agricultural productivity through the adoption of new technology, among others, were access to extension services, extension contact, market accessibility, availability of input supply, and access to credit. Farmers' institutional environment has important bearing on the preferred status of the farmers with respect to willingness to participate in research- extension-farmers linkages activities. The important institutional concerns, considered in this study, are access to extension services, extension and research contact, distance to farmers training centers and all weather road, market accessibility, and availability of input supply.

4.2.2.1 Distribution of Sample Households by Access and Frequency of Extension Contact

Access to Extension Services:

The survey result (Table 4.6) revealed that 94% of the respondents had contact with extension agents during their farming experiences while 6% all of which are non-participants had no contact at all. Meanwhile, 63% of the linkage participants and 31% non-participants had contact with extension agents in their farming experience. The difference in extension access between the groups in linkage mechanisms were found to be significant at 5% level of significance (χ^2=4.436, p=0.035).

Table 4.6 Access Differentials of Sample Households to Extension Services

Access to extension in their farming experience	Non Participants		Participants		Total sample		χ^2-Value
	N	%	N	%	N	%	
No	6	16.2	0	0	6	6	4.436**
Yes	31	83.8	63	100	94	94	

Source: Own Data, 2010; **, Significant at 5% level

Frequency of Contact with Extension Agents:

With regard to the frequency of extension contact of farmers the minimum and maximum was 0.10 (1 times per 10 years) and 52 times per year respectively, with a mean of 14.03 and a standard deviation of 15.74. It is found that 75% of sample respondents were contacted below 22 times per year, which is less than 2 times per month, indicating that they have a poor access to extension services as illustrated by frequent visit of extension agents.

From among the total respondents 43% contacted 1 to 14 times per year ,19 % below 1 times per year, 14% contacted 28 to 40 times per year, 9 % contacted 15 to 27 times per year and only 9% contacted more than 40 times per year. While 6% had no contact at all. On average, linkage participants had better frequency of extension contact than non-participants i.e. 19 and 9.4 times per year, respectively (Table 4.7). One-way ANOVA revealed that there was significant mean difference (F=2.58, P=0.043) among the groups in the frequency of contact with extension agents at 5% level. Moreover, the bivariate correlation also confirmed positive and significant relationship (r=0.291, P=0.004) in joint linkage mechanisms at 0.05 significance level.

Table 4.7 Distribution of Sample Households' Frequency of Contact with Extension Agents

Frequency of extension contact per year	Non Participants		Participants		Total sample		F value	p value	R
	N	%	N	%	N	%			
No contact	6	9.5	0	0	6	6			
< 1.00 times per year	14	22.2	5	13.5	19	19			
1.00-14 times per year	29	46.0	14	37.8	43	43			
15-27 times per year	4	6.35	5	13.5	9	9			
28-40 times per year	5	7.94	9	24.4	14	14			
41-52 times per year	5	7.94	4	10.8	9	9			
							2.58**	0.043	0.291
Mean	9.4		19.00		14.9				
Standard deviation	11.2		16.00		15.9				

Source: Own survey data, 2010; **, significant at 5%.

Similarly, it was found that 59% of the farmers had no contact with researchers in their farming experiences. While, the frequency of researchers contact of the rest 41% of farmers, the minimum and maximum was 0.10 (1times per 10 years) and 4 times per year, respectively, with a mean of 0.97 and a standard deviation of 0.91. It indicates that they have a loose access to research services.

4.2.2.2 Distribution of Sample Households by Distance to the Nearest Market Centre

Household heads in the study area reported that they sold some of their agricultural products right after harvest to cover costs of farm inputs, social obligation and family expenses by taking to the immediate nearby local market. The survey result indicated that the maximum time required to arrive at the nearest marketing center is 135 minutes (2:15 hours) while the minimum was found to be only 5 minutes with a SD of 25.1. On average, sample households were required to walk for 35.7 minutes.

On average, linkage participant farmers were required to walk for 28.78 minutes whereas non-participants 39.76 minutes to the nearest market. The result also revealed that mean difference of distance to market was significant (t=2.95, p=0.024) at 5% level of significance. Among the total respondents, 63% lived at a distance of 5 to 30 minutes away from the nearest market, of which 30% were participants and 33% were non-participant. This shows that 81.1% of the linkage participants were located near the market that needs only 5 to 30 minutes walk as compared to 52.4% of non-participant' farmers (Table 4.8). The correlation analysis also shows significant and negative relationship between distance to the market and participation in joint linkage activities (r=-0.281, p=0.005). That is, the nearest the farmer to the market, the higher participation in linkages.

Table 4.8 Distribution of Sample Households by Distance to the Nearest Market Center

Distance to market (in minute)	Non participants		Participants		Total sample		F-value	P value	r
	N	%	N	%	N	%			
5-30 minute	33	52.4	30	81.1	63	63			
31-56 minute	7	11.2	4	10.8	11	11			
57-82 minute	19	30.2	2	5.4	21	21			
83-108 minute	2	3.2	0	0	2	2			
≥ 109 minute	2	3.2	1	2.7	3	3			
Mean	39.76		28.78		35.7		2.95**	0.024	-0.281
Standard deviation	25.95		22.25		25.2				

Source: Own survey data, 2010; **, significant at 5%

4.2.2.3 Distribution of Sample Households by Distance to All Weather Roads

Road transport and/or distance to road is a crucial service for farmers, as it helps them to buy farm inputs, sell farm products and strengthens their linkages either with extension or with research. The survey result revealed that the maximum time required to arrive at the nearest weather roads is 150 minutes (2:30 hours) while the minimum time was found to be only 5 minutes with a St.deviation of 25.96 minutes. On average, sample households were required to walk for 38.35 minutes to arrive at all weather roads (Table 4.9).

From among the total respondents, 52% lived at a distance of 5 to 30 minutes walk away from all-weather road, of which 30% were participants and 22% were non-participants. This shows that 81.1% of the participants were located near all-weather road, which needs only 5 to 30 minutes walk. Furthermore, 23% of the respondents lived at a distance of 57 to 82 minutes walk away from all-weather road, of which 2% were participant" farmers. The result was found to be statistically significant at 0.01% level (t=4.143, p=0.00). This indicates that linkage participants' farmers lived near to all weather roads as compared to non-participants'. This could have motivated the farmers to participate in linkage activities than who lived far from the road. The correlation analysis also showed significant and moderately negative relationship at 0.01 level (r=-0.386, P=0.000).

Table 4.9 Distribution of Sample Households by Distance from All Weather Roads

Distance to road (minutes)	Non participants		Participants		Total sample		t-value	p value	r
	N	%	N	%	N	%			
5-30 minute	22	34.9	30	81.1	52	52			
31-56 minute	15	23.8	4	10.8	19	19			
57-82 minute	21	33.3	2	5.4	23	23			
83-108 minute	2	3.2	0	0	2	2			
≥109 minutes	3	4.8	1	2.7	4	4			
Mean (in minute)	43.81		29.05		38.35		4.143***	0.00	-0.38***
Std. deviation	26.67		22.07		25.96				

Source: Own survey data, 2010; ***, significant at 1%

4.2.2.4 Distribution of Sample Households by Distance to Farmers Training Centers /FTC

The minimum and maximum time required to arrive at FTCs was 3 and 120 minutes, respectively. The average time required is about 29.66 minutes with a SD of 25.92. However, mean test shows insignificant difference between linkage participant and non-participant farmers (t=0.439, p=0.661). Moreover, the correlation analysis also shows negative and insignificant relationship at 10% level (r=-0.044, p=0.661). This indicates that other factors than distance from farmers training center may affect participation.

Table 4.10 Distribution of Sample Household Respondents by Distance from FTCs

Distance from FTC (minutes)	Non participants		Participants		Total sample		t-value	P value	r
	N	%	N	%	N	%			
5-27 minute	33	52.4	22	59.5	55	55			
28-50 minute	17	27.0	12	32.4	29	29			
51-73 minute	11	17.4	0	0	11	11			
74-96 minute	1	1.6	0	0	1	1			
≥97 minutes	1	1.6	3	8.1	4	4			
Mean (in minutes)	30.44		28.32		29.66		0.439(NS	0.661	0.044(NS
Std. deviation	23.19		30.322		25.92				

Source: Own survey data, 2010; NS, non-significant at 10%

4.2.2.5 Distribution of Sample Households by Access to Timely Availability of Inputs

Timely availability and supply of quality and quantity input is among the factors influencing farmers' successful linkages with extension and adoption of technologies. Consequently, it was assumed to influence farmers' links with extension positively. Among the total respondents, 66% claimed that, they had no access to timely availability and supply of quality and quantity inputs, mainly, improved seeds and fertilizers. Among which 22% were linkage participants and 44% were non-participants. This shows that the problem of access to input is higher in the non-participants of linkage activities (69.8%) than the participants (59.5%). The chi-square test found that there is a significant and moderately negative relationship at 0.1 probability level between shortage of access to inputs and participation in linkage activities(χ^2=-2.361, P=0.009). That is, the probability of farmers' participation in finger millet linkage activities decreases as an increase in shortage of timely supply of inputs.

Table 4.11 Distribution of Sample Households by Access to Timely Availability of Inputs

Access to timely availability of inputs	Non Participants		Participants		Total sample		χ^2-Value
	N	%	N	%	N	%	
No	44	69.8	22	59.5	66	66	
Yes	19	30.2	15	40.5	34	34	2.361*

Source: Own Data, 2010; *, Significant at 10% level

4.2.3 Socio-Economic Characteristics

4.2.3.1 Distribution of Sample Households Head by Land Holding and Land Use Patterns

Land is the main asset of farmers in the study area. They use both their own land and rent farmland for crop production and grazing land for livestock production. The total size of land operated by sample households varies from 0.063 to 3.25 hectare with an average of 1.14 hectares and St.deviation of 1.71. The result indicated that 98% of the respondents had their own average land size of 0.37 hectare with

St.deviation of 0.62. About 48% of the respondents cultivated, others land through short-term rent or through share cropping arrangements. The average size of total land operated by linkage participants was 1.21 hectare with St.deviation of 1.99, while that of non- participants was 1.06 with St.deviation of 1.43. Statistically, there was no significant difference between participants and non- participants related to size of land holding at 0.1 significance level (Table 4.12).

With regard to land use patterns, from the total land holdings respondents allocated on average 0.085 ,0.17 ,and 0.503 hectares of land for grazing, plantation ,and cultivation, respectively. From the total cultivated land on average, 0.481 hectare of the respondents land was allocated for cultivated annual crops while 0.984 hectare for perennial cropped land. Moreover, there is no great variability within the groups for all types of land uses.

Table 4.12 Distribution of Households by Size of Land Holding and Land Use Pattern

Types of land use	N	Non-participants Mean	Std.Dev	Participants Mean	Std.Dev	t-value	Sig.	Total sample Mean	Std.Dev
Own land holding	98	0.34	0.53	0.41	0.77	-0.52(NS)	0.604	0.37	0.62
Grazing land	19	0.09	0.03	0.08	0.03	0.88(NS)	0.391	0.085	0.31
Cultivated land	100	0.48	0.70	0.53	0.81	-0.32(NS)	0.748	0.503	0.74
plantation land	69	0.15	0.17	0.19	0.38	0.57(NS)	0.573	0.17	0.27
Total size of operated	100	1.06	1.43	1.21	1.99	1.95(NS)	0.604	1.14	1.71

Source: own survey result, 2010, NS, Non Significant.

4.2.3.2 Livestock Holding of the Sample Households

In the study area, mixed farming is practiced with crop and livestock production. Notably, farm animals in the study area are an important source of draught power, food, such as, milk and meat, cash, animal dung for organic fertilizer and fuel, means of transport, and serve as a measure of wealth in the area. The types of livestock found in the study area were poultry, cattle, sheep, goat, chicken, beehives, donkey and horse. As it confirmed in many studies farmers who have better livestock ownership status are likely to adopt improved agricultural technologies, hence it enhances participation in linkages activities. To help the standardization of the analysis, the livestock number was converted to tropical livestock unit (TLU). Conversion factors used were based on Storck, *et al.,* (1991) and indicated in Appendix Table 4.1.

On average, the sample households kept about 5.297 TLU: the minimum and maximum livestock kept being 0.00 and 25.136 TLU, respectively with a St.deviation of 3.619. Fifty-percent of the households own below 4.786 and the remaining 50% above 4.786 TLU. Only one of the household had no TLU.

The mean livestock holding of participants was 6.24 with a St.deviation 4.23 while that of the non-participants was 4.63 with a St.deviation of 2.88. Test of mean difference indicated that there was a significant difference in TLU between participants and non-participants at a 5% significance level (t=-1.74, p=0.029), indicating that the participants are relatively wealthier than the non-participants.

Table 4.13 Distribution of Households by Livestock Ownership

Linkage Participant Category	TLU		t value	p-value
	Mean	Std.Dev		
Non-participants	4.63	2.88		
Participants	6.24	4.23		
Total sample	5.297	3.619	-1.74**	0.029

Source: Own data, 2010, **significant at 5%.

It is also found that 44% of the respondents had adopted improved livestock breeds of cow, sheep and poultry while 46% practiced and used animal fattening technologies. Besides 26% of the respondents had adopted modern beehives (Appendix Table 4.2).

4.2.3.3 Cropping Sub-System of the Sample Households

The principal crops grown in the study areas are finger millet and maize. Depending on the locality, ranges of other minor crops were also grown for crop rotation or other specific purposes. These include barley (by residual moisture or main rainy season), *tef*, grass pea, hot pepper, lupine, mustard and wheat, faba bean, chickpea, groundnut, haricot bean and field pea. The composition of the different crop types grown vary greatly with the locality.

It revealed from the result (Appendix Table 4.2) that 73% of the farmers had adopted improved cereals varieties; maize accounted for the lion share. While 45% had adopted improved fruits and vegetable varieties. Test of mean difference indicated that there was a significant difference in technology use between participants and non-participant groups, implied that linkage participants has a higher tendency to adopt technologies than the non-participant groups. More discussions of this section is presented on the psychological characteristics sub-section later.

4.2.4 Personal Characteristics of Technology Transfer Workers or Extension Agents

Majorities (23) of the extension agents were males (88.5 %). It indicated that there are more male extension agents than females (only 3). The proportions of male extension agents were high within the participants (88.9%) than within the non-participants (87.5%). On the other hand, out of the total female extension agents 12.5% were non-participants. The result revealed (Table 4.14 below) that the percentage of male extension agents of participants (88.9%) was higher than that of female extension agents (11.1%). However, mean test regarding its relationship with participation in finger millet linkage mechanisms, sex has found to be insignificant (t=-0.098, p=0.922) at 10% level. Besides, the Pearson chi-square also confirmed insignificant relationship (χ^2 =0.10, DF=1, P=0.919) at 10% level between sex of the extension agents and participation in linkage mechanisms.

Moreover, age of the sample extension agents ranged from 22 to 55 years with an average age of 38.69 years and st.dev, of 8.49. About 26.9 %, 26.9% 19.2% , 15.4% and 11.5% were between age categories of 42 to 47 ;29 to 34, 35 to 41, 22 to 28, and 48 to 55 years ,respectively. It shows that more than half of the extension agents (57.6%) lie in age categories of 35 to 55 years age. Thus, 42.4 % of the agents were therefore young, energetic who were in their active years of labor (22 to 34 years of age). It would then mean a lot to get them motivated, as people in this age category are always full of aspirations and highly ambitions.

The average ages of linkage participants' extension agents and non-participants was found to be 40.78 and 34 years with the standard deviations of 8.86 and 5.55, respectively. Mean test comparison of average age shows that there is significant mean difference (t=-2.174, P=0.040) among the groups at 0.05 significant level. In addition, correlation analysis (r = 0.406, P= 0.040) revealed that there is positive and moderately significant relation at 0.05 level between age and participation in linkage mechanisms (Table 4.14 below).

Mean while, the maximum working experience of the extension agents is 26 years while the minimum was found to be only 2 years with a St.deviation of 7.26 years (Table 4.15 below). On average, the extension agents had 15.31 years of working experience. About 73.1 % of them had been on the job between 12 and 26 years, indicated their maturity and well equipped experiences in the agricultural system. However, 26.9% had been on the job between 2 and 11 years. The average year of experience for linkage participants and non-participant extension agents is 17.2 and 11.12. Result of mean test comparison of work experience shows that there is significant mean difference (t=-2.552, P=0.033) among the groups at 0.05 level. In addition, bivariate correlation analysis (r = 0.462, P= 0.018) also revealed positive and moderately strong relation at 5% probability level between work experience of extension agents and participation in linkage mechanisms.

Regarding their marital status, about 88.5% of the agents was married indicating that a high level of responsibility would be expected from them, but they may have role conflicting with domestic affairs. The marital status of linkage participants were 88.9 % (married), and 11.1% (single) while for the non-participants it is 87.5%, and 12.5%, respectively (Table 4.14 below). Chi-square test of marital status between the groups was found to be insignificant on participation of linkage activities (χ^2 =0.010, DF=1, P=0.919). This shows that being married or single headed extension agents has insignificant relation on participation in linkage activities.

As indicated in Table 4.15 below, the majorities (12) or 46.2 % of the extension agents were Diploma holders; (7) or 26.9 % had B.Sc, and the rest (7) or 26.9 % had M.Sc degrees. The educational level of linkage participants were 38.9% (diploma), 22.2% (Bsc degree), and 38.9% (Msc degree) while for the non-participants it is 62.5%, 37.5%, and 0%, respectively. It showed that all the Msc degree holders of the extension agents are participants in linkage mechanism. Result of mean test showed that there was significant mean difference (t =-1.809, P = 0.083) in level of education among the groups at 10% level. Moreover, result of correlation analysis revealed positive and significant relationship of education and participation in finger millet linkage mechanisms (r=0.346, p=0.083) at 10% significance level.

Table 4.14 Distribution of Sample Extension Agents by Demographic Characteristics

Variables	Non Participants		Participants		Total sample		r-correlation	χ^2 Value
	N	%	N	%	N	%		
Sex								0.010
Female	1	12.5	2	11.1	3	11.5		
Male	7	87.5	16	88.9	23	88.5		
Marital status								0.010
Single	1	12.5	2	11.1	3	11.5		
Married	7	87.5	16	88.9	23	88.5		
Age							0.406**	
22-28	2	25	2	11.1	4	15.4		
29-34	5	62.5	2	11.1	7	26.9		
35-41	0	0	5	27.8	5	19.2		
42-47	1	12.5	6	33.3	7	26.9		
48+	0	0	3	16.7	3	11.5		
Educational level							0.346*	
Diploma	5	62.5	7	38.9	12	46.2		
Bsc degree	3	37.5	4	22.2	7	26.9		
Msc degree	0	0	7	38.9	7	26.9		
Work Experience							0.462**	
2-6	2	25	2	11.1	4	15.4		
7-11	3	37.5	0	0	3	11.5		
12-15	2	25	7	38.9	9	34.6		
16-20	1	12.5	1	5.5	2	7.7		
21+	0	0	8	44.4	8	30.8		

4.15 Relationship between Demographic Characteristics of Extension Agents and Participation in Linkage Mechanisms

Variables	Non Participants		Participants		Total sample		T value	P value	r
	Mean	SD	Mean	SD	N	%			
Age	34	5.55	40.78	8.86	38.69	8.494	-2.174	0.040**	0.406**
Year of experience	11.12	4.7	17.2	7.517	15.31	7.26	-2.552	0.033**	0.462**

Source: own survey result, 2010; *Significant at 10%, ** Significant at 5%.

4.2.5 Personal Characteristics of Researchers

It is found that all (18) of the researchers were males (100 %), suggesting probably the presence of high gender disparity in the research organizations in one reason or males offer more agricultural courses/training than women do ,and possibly could be the presence of few and young women researchers in the organizations (Table 4.16 and 17 below). Hence, test statics cannot be performed. The result revealed that, the proportions of male researchers were high within the participants in finger millet linkage mechanisms (61.1%) than within the non-participants (38.9%).

Age of the sample researchers ranged from 27 to 48 years with an average age of 36.28 years with St.deviation of 6.49. Of which ,the average ages of linkage participant researchers and non-participants was found to be 38.64 and 32.57 years with the St.deviation of 6.562 and 4.650, respectively. About 27.8%, 27.8%, 11.1%, 22.2%, and 22.2% were between age categories of 40 to 43; 35 to 39, 44 to 48, 31 to 34 years, and 27 to 30 years, respectively (Table 4.16 below). It showed that more than half of the researchers (55.5%) lie in age categories of 35 to 48 years age, of which the majority, 72.8% of the researchers are participants in linkage activities. About 45.5 % of the researchers were therefore young, energetic who were in their active years of labor (27 to 34 years of age). It would then mean a lot to get them motivated, as people in this age category are always full of aspirations and highly ambitions. Despite this, out of the total non-participant researchers, 42.8% were under age categories of 27 to 31 implied that they are not favored in participation in joint linkage activities. Mean test comparison of average age shows that there is significant mean difference (t=-2.120, P=0.050) among the groups at 0.05 significant level. In addition, correlation analysis (r = 0.538, P= 0.021) revealed positive and moderately strong relation at 0.05 level between age and participation in linkage mechanisms.

Moreover, the sample researchers had a maximum working experience of 24 years while the minimum was found to be only 5 years with a St.deviation of 6.47 years. On average, the researchers had 13.17 years of working experience, of which the average experience of linkage participants (15.36) is higher than the non-participants (9.29). The result showed that the majority of linkage participant researchers (72.8%) had been on the job between 13 and 24 years, showing their maturity and well equipped experiences in the research system. However, about 27.2 % of them had been on the job between 5 and 12 years. About, 11.11 % of the total researchers, had spent at least 20 years in service, of which all are participants, suggesting that necessary experience on the job would have been developed participation in linkage activities, and could be passed down to younger scientist as they learn on the job. Long year of service and educational level may however account for managerial practices in administrative procedures by older and senior scientists in the study area.

Result of mean test comparison of average work experience shows that there is significant mean difference ($t=-2.046$, $P=0.058$) among the groups at 0.1 level. In addition, bivariate correlation analysis ($r = 0.457$, $P= 0.057$) revealed that there is positive and moderately strong relation at 10% probability level between researchers professional experience and participation in finger millet linkage mechanisms (Table 4.16 and 17 below).

Regarding their marital status, the result showed that 72.2 % of the researchers were married while 27.8% were single. The majorities (81.8%) of the linkage participants are married as compared to the non-participants, and as well, the proportion of single is higher among the non-participant as compared to the participant researchers. Chi-square test of marital status between the groups was found to be insignificant at 10% probability level on participation of linkage activities ($\chi^2=1.298$, DF=1, $p=0.255$). This implied that being married, or single headed researcher has insignificant relationship on participation in linkage activities.

Mean while the majorities (38.9 %) of the researchers had M.Sc holders, 33.3 % had B.Sc and the rest 27.8 % had PhD degrees. The educational level of linkage participant researchers were 18.2 % (Bsc degree), 54.5% (Msc degree), and 27.3% (PhD degree) while for the non-participants it is 57.1%, 14.2%, and 28.6%, respectively. Moreover, the majority 66.7% of the researchers had high educational level above first degree, showing their high research ability and analytical skills and thus a good performance. However, the result of mean test showed that there is insignificant mean difference ($t = -0.969$, $p = 0.347$) in level of education among the groups at 10% significance level. Moreover, result of correlation analysis confirmed insignificant relationship of education and participation in joint linkage mechanisms ($r=0.235$, $p=0.347$) at 10% significance level. It implied the educational status of the researchers has insignificant role towards participation in finger millet research-extension-farmers linkage mechanisms (Table 4.16 and 17 below).

4.16 The Relationship between Personal Characteristics of Researchers and Participation in Linkage Mechanisms

Variables	Non Participants		Participants		Total sample		T value	p value	r
	Mean	SD	Mean	SD	Mean	SD			
Age	32.57	4.650	38.64	6.562	36.28	6.497	-2.120	0.050**	0.538**
Year of experience	9.29	5.964	15.36	6.249	13.00	6.695	-2.046	0.058*	0.457*

Source: Own survey result, 2010; *Significant at 10%, ** Significant at 5%.

4.17 Distribution of Sample Researchers by Demographic Characteristics

	Non Participants		Participants		Total sample		r-correlation	χ^2 Value
	N	%	N	%	N	%		
Sex								
Female	0	0	0	0	0	0		-
Male	7	100	11	100	18	18		
Marital status								1.298
Single	3	42.9	2	18.2	5	27.8		
Married	4	57.1	9	81.8	13	72.2		
Age							0.538**	
27-30	3	42.8	1	9.1	4	22.2		
31-34	2	28.6	2	18.2	4	22.2		
35-39	2	28.6	3	27.3	5	27.8		
40-43	0	0	3	27.3	3	16.7		
44-48	0	0	2	18.2	2	11.1		
Educational level							0.235	
Bsc degree	4	57.1	2	18.2	6	33.3		
Msc degree	1	14.2	6	54.5	7	38.9		
PhD degree	2	28.6	3	27.3	5	27.8		
Work Experience							0.457*	
5-8	4	57.1	2	18.2	6	33.33		
9-12	1	14.2	1	9.1	2	11.11		
13-15	1	14.2	3	27.3	4	22.22		
16-19	1	14.2	3	27.3	4	22.22		
20-24	0	0	2	18.2	2	11.11		

4.2.6 Psychological Related Characteristics

4.2.6.1 Finger Millet Varieties Grown and Farmers' Perceptions of Finger Millet Varieties Attributes

Through reconnaissance survey and discussions with farmers, and extension experts working in the study area 11 different variety traits, which farmers use for technology evaluation of finger millet variety, were identified. Accordingly, the farmers claimed grain yield, early maturity, grain color, good quality for consumption, and easy of threshing are the five most important traits required to adopt a given finger millet variety in the study area. The responses are depicted in Table 4.18 & 4.20 below. Generally, four local finger millet varieties are grown in the study area. In *kebeles* of similar agro-ecology, more or less the same types of varieties are grown (Table 4.18).

It was found that 86%, 55%, 42%, and 39% of the farmers have been cultivating finger millet local varieties of' names, *Deqe, Necho, Angedie ,and Tikur dagussa*, respectively.

The best preferred variety, however, is the one namely *Deke/tikur deqe dagusa.* It yields higher than the rest black varieties. It yields on average 20.88 quintal per hectare, which exceeds 18.6, 16.28, 14.68 quintal per hectare of *Tikur dagussa, Necho,* and *Angedie* respectively. All of the households claimed that 'Deqe' is extra early compared with the whole range of other varieties. It overcomes blast disease (88.2%), weed tolerant (91.4%), possess black color seeds that is preferred in the market (96.8%), good 'injera' quality for consumption (96.8%) and best for local drinks, *areki and tella* (97.8%). Its water holding capacity is excellent. Threshing is very easy (96.7%). However, 69.9 % of the households claimed that its straw for animals is insignificant or very low as compared to all the other finger millet varieties. This is its major drawback (Table 4.18 below).

The second variety, the white seeded namely, *Necho* gives good yield, 16.28 quintal per hectare (85.1%) fetches better price, relatively early maturing (68.6%), disease resistant (73.1%), weed tolerant (62.7%). Preferred grain color (98.5%), good *injera* quality (95.5%), however 65.6% of the farmers claimed that it is bad for local drinks, '*areki* and *tella.* Similarly, the straw yield is low; the stem is rough, and made threshing very difficult, relatively less palatable to livestock, hence unacceptable by some farmers (52.2%).

The third local variety, '*Angede'* or the red variety is also more or less the same in physical features to the white one except color, which made it unprofitable in the market (64.9%). It is a very late maturing variety (89.5%) with excellent plant stand, densely tillering, good yield (14.68qt/ha) and high water holding capacity, with good straw for animals (89.4%). However, 82.4% of farmers claimed that threshing is very difficult and it is susceptible to drought and head blast due to slow maturity; it requires fertile soil. 64.9% of the households not preferred it for *injera* quality for consumption, but good for local drinks, 'areki and tella' (64.9%).

The fourth local variety, the black' *tikur dagusa'* has been the traditional variety of choice, deeply rooted to the culture of the people for generations. They call it the father of all varieties or the founder variety. It grows nicely but when it starts grain setting it severely suffers head blast damage (34.8%). It is *graceful*, i.e., much injera can be made from a unit weight of grain, Its water holding capacity is excellent, good *injera* quality (87.5%) and best for local 'drinks, *areki* and *tella*' (91.6%). It is good in market but is not as marketable as the black seeded variety. It overcomes weed (91.4%), possess good black color (93.7%), high yielding next to '*deqe*' (18.6 qt/ha), good straw yield (91.6%). However, 41.7 % of the households claimed its threshing is difficult.

Table 4.18 the Importance of Local Finger Millet Characteristics Based On Rank Order Assessments by Households

Characteristic traits	Types of local finger millet varieties and respondents rating			
	Deqe	*Necho*	*Angedie*	*Tikur dagussa'*
Good average grain yield in qt/ha	20.88 (100%)	16.28 (85.1%)	14.68 (89.4%)	18.6 (95.5%)
Good Straw yield	31.9%	69.7%	89.4%	91.6%
Good straw quality	96.8%	31.3%	55%	74%
Good Grain color	96.8%	98.5%	91.8%	93.7%
Early maturity	100%	68.6%	11.5%	97.8%
Good for local drinks	97.8%	34.4%	64.9%	91.6%
Good injera quality	96.8%	95.5%	35.1%	87.5%
Good Disease resistance	88.2%	73.1%	45%	65.2%
Good Weed tolerant	91.4%	62.7%	50%	91.4%
Easy of threshing	96.7%	47.8%	17.6%	58.3%
Easy of Marketability	96.8%	85.1%	35.1%	86.5%

The percentages indicated the frequency of the households claiming each characteristics trait of the varieties.

4.2.6.2 Farmers Perceptions/ Awareness of Improved Finger Millet Technologies and Comparisons with Local Attributes

Table 4.19 below revealed that, 43% of the farmers claimed to be aware of improved finger millet varieties. However, only 15% of them had been cultivating at least one improved varieties of finger millet, namely '*Degu*' (13%), '*Tadesse*' (2%), and '*Padet*' (0%) in their farming experience. When asked whether they had been cultivating at least one of the improved finger millet varieties in 2008 and 2009 cropping season, only 7 and 6 farmers claimed the cultivation of only '*Degu*' variety in the respective years. Hence, the 15 farmers evaluated the performance of the improved finger millet variety as compared to their local varieties, and claimed that the improved variety namely, '*Degu*' was better than the local landraces. Moreover, the remaining 28% (out of the 43%) cited that although they were not cultivating any improved finger millet variety, they aware that they evaluated the performance of '*Degu*' variety, during demonstration trials conducted at their fellow farmers fields. Added that the improved finger millet variety has good performances, especially in its tillering capacity, but they were uncertain whether the variety is superior or inferior to their local landraces, as they did not cultivate and evaluate in their own farm fields.

On the contrary, majorities (57%) of the households had no awareness or understanding information that new finger millet varieties were exist in the technology system of the study area. This implied the poor performance of research-extension-farmers linkages, hence weakening timely awareness and transfer of technologies, there by affecting farmers' adoption of improved finger millet varieties. However, chi-square test indicated insignificant relationship in awareness level of improved finger millet variety between participants and non-participants of finger millet linkage mechanisms at 0.1 level ($\chi2 = 0.090$, p=0.764).

Table 4.19 Distributions of Sample Households by Awareness of Improved Finger Millet Varieties and Participation in Finger millet Linkage Mechanisms

Farmers Awareness	Non-Participants		Participants				
	N	%	N	%	Total (%)	$\chi2$	p
No	37	58.7	20	54.1	57		
Yes	26	41.3	17	45.9	43		
Total	63	100	37	100	100	0.09(NS)	0.764

Source: Survey result, 2010; $\chi2 = 0.090$, df=1, Cramer's V =0.30, p = 0.764; NS=Non-significant

Evaluations of the Characteristics of Improved Versus Local Finger Millet Varieties

To compare and evaluate technological options, it is necessary to assess the importance of each of finger millet traits relative to each other and with the farmers' local variety. Comparison of finger millet varieties was conducted through preference rating (based on scale: 1 =poor, 2 =good and 3 =very good) with the 15 farmers who cultivated improved finger millet varieties. Non-adopters were not able to rate traits of improved finger millet since most of them did not know their important traits. According to official bullets, key informant farmers, researchers and extension agents, the improved varieties that were developed, demonstrated and transferred to the study area in the last ten years were, 1) '*Degu*' variety in 2005, 2) '*Padet*' variety in 2002, and 3) '*Taddesse*' variety in 2003 cropping seasons. However, except 'Padet' the two varieties have been cultivating by the sample households of 15 farmers. Unfortunately, the farmers do not use specific names for the improved varieties; they call them collectively as "improved" meaning not local. Hence, the two improved varieties were handled as one variety and preference rating was conducted with the two major local varieties, '*Deqe and Necho*'.

The result of ratings below shows that the improved finger millet varieties were superior to the local in terms of straw yield, and disease resistant. Whereas the local finger millet varieties, especially the best-preferred variety (*Deqe*) were superior to the improved varieties almost in all traits, with respect to grain yield, straw quality, grain color, early maturity, quality for local consumptions, weed tolerance, easy of threshing, preference in market.

Table 4.20 Comparisons of Local and Improved Finger Millet Characteristics Based On Rank Order Assessments by Respondents

No	*Characteristics*	*Total weight of Improved Varieties (N=15)*	*Rank*	*Total weight of Deqe (N=86)*	*Rank*	*Total weight of Necho (N=55)*	*Rank*	*Average weight*	*Rank position*
1	Grain yield	250	2	275*	3	224	4	249.67	1st
2	Straw yield	250*	2	167	11	199	6	205.33	
3	straw quality	202	6	261*	5	131	11	198	
4	Grain color	210	5	260	6	262*	1	244	3rd
5	Early maturity	260	1	282*	1	202	5	248	2nd
6	Good for local drinks	250	2	256*	8	141	10	215.67	
7	Good injera quality	220	4	258*	7	236	3	238	4th
8	Good disease resistance	240*	3	230	9	191	7	220.33	
9	Good weed tolerant	150	8	184*	10	172	8	168.67	
10	Easy of threshing	240	3	276*	2	164	9	226.67	5th
11	Easy of marketability	150	7	258*	4	236	2	214.67	

Source: Survey Result, 2010: The total weight score is the sum of rank order frequencies multiplied respectively by 3 for very good trait, 2 for good trait and 1 for poor trait of the varieties.

A closer look at Table 4.20 above shows that farmers have different selection criteria's for adopting finger millet varieties. Even though, high yielding and disease resistant varieties are the most important trait in technology evaluation, most farmers indicated that grain color, early maturity, digestibility, local beverage making quality and market preference, ease of threshing, straw yield and palatability for livestock's are also the most important traits considered while evaluating finger millet varieties. This shows that a variety, which is required by farmers, should possess such traits. The group discussion held with the farmers revealed that the reasons for adopting improved finger millet varieties, especially 'Degu' is that it can yield better when planted in fertile soils(on average 15qt/ha), and have good straw yield , which is needed for livestock feeding and thatch roofing. However, except '*Degu*', '*Tadesse*' variety was rejected by farmers due to its stiff straw, which is not suitable for animal feed, and has shorter and fewer fingers than the local and even lower straw yield (half the yield of the local varieties). Moreover, according to farmers, the black seeded varieties (like *Degu* and *Deqe*) are more preferable than the red seeded improved variety (*Tadesse*) in digestibility, local beverage making quality and market preference.

In a nutshell, the result clearly showed that the local varieties were superior to the improved, and it is questionable whether the technologies were generated based on researchers' interests by undervaluing the indigenous knowledge or not. Thus, it depicted the existing gap between researchers, extension workers, and farmers in finger millet technology development and delivery.

4.2.6.3 Researchers Perceptions/ Awareness of Farmers Best Local Finger Millet Varieties and Practices

To determine whether researchers were really knowledgeable about farmers' local finger millet varieties and practices, they were asked to respond to questions related to farmers' practices or varieties that were perceived to be interesting and better than some of the recommendations from the research organizations, and to cite the best local finger millet varieties that were rated highly by farmers.

As indicated in Table 4.21 below, only six or about 33 % of the researchers claimed to be aware of local finger millet farming practices that were superior to some of the practices recommended by their research organization. When asked to name at least one local finger millet varieties that farmers rated highly, five out of the six (83.3%) of the researchers correctly mentioned any such varieties *(Deqe* (2 of them), *Tiukur dagusa* (2), *Necho* (1 of them). This indicated that only 5 (27.8%) of the researchers had correct understanding of farmers indigenous knowledge system of local finger millet practices; hence, blending this with scientific knowledge could yield a basket of sustainable finger millet technological options that satisfies the felt needs of finger millet cultivating farmers. On the contrary, twelve (about 67%) of the researchers claimed that they were not aware of best local finger millet varieties or practices that outstands the improved finger millet practices. Five of these researchers (41.7%) reasoned that the available improved finger millet varieties were released by the research system after comparisons with best farmers' local varieties. As a result, they outstand or beat the best local finger millet varieties in most traits during the technology verification phases, and hence these researchers claimed that there were no local finger millet varieties that were better than the improved system.

While the remaining seven researchers (58.3%) claimed that they had no correct knowledge and awareness whether the local finger millet practices were superior or inferior than the improved finger mille varieties and vice versa. However, as shown in Table 4.21 below, chi-square test confirmed insignificant relationship between participation in finger millet linkage activities and researchers awareness of local finger millet varieties at 0.1 level ($\chi2 = 0.468$, $p=0.494$).

Table 4.21 Distribution of Sample Researchers by Awareness of Best Local Finger Millet Varieties and Participation in Linkage Activities

Researchers Awareness	Non-Participants		Participants		Total N	%	χ2	p
	N	%	N	%				
No	4	57.1	8	73	12	66.7		
Yes	3	42.9	3	27	6	33.3		
Total	7	100	11	100	18	100	0.468(NS)	0.494

Source: Survey result, 2010: $\chi2 = 0.468$, df =1, Cramer's V =0.161, p = 0.494; NS=Non-significant.

4.2.6.4 Extension Agents Perceptions/ Awareness of Farmers Best Local Finger Millet Varieties

As with researchers, extension agents were also asked about their awareness of best local finger millet varieties. Eighteen or the majority of the extension agents (69.2%) claimed that they were aware of local finger millet farming practices that were better than the recommendations from the research organizations. Moreover, fourteen out of the eighteen (77.8%) of the agents correctly mentioned any such varieties (*Deqe,* 8 of them), *Tiukur dagusa* (4), *Angede* (2). This indicated that over half of the extension agents (53.8%) out of the total sample had correct knowledge of at least one of the best local finger millet varieties that farmers rated highly (Table 4.22). This showed that the extension agents being grass-root agents, they possessed a correct knowledge of farmers' indigenous finger millet practices as compared to researchers in the technology system of the study area. However, chi-square confirmed insignificant relationship at 0.1 level ($\chi2$ = 0.022, p=0.883) between extension agents awareness of local finger millet varieties and participation in linkage mechanisms.

Table 4.22 Distribution of Sample Extension Agents by Awareness of Best Local Finger Millet Varieties and Participation in Linkage Activities

Awareness	Non-Participants		Participants		Total N	%	χ2	p
	N	%	N	%				
No	3	37.5	5	27.8	8	30.8		
Yes	5	62.5	13	72.2	18	69.2		
Total	8	100	18	100	26	100	0.022	0.883

Source: Survey result, $\chi2 = 0.022$, df=1, Cramer's V =0.029, p = 0.883; NS=Non-significant.

4.2.6.5 Perceptions of Researchers, Extension Agents, and Farmers on the Factors Limiting Farmers' Adoption of Improved Finger Millet Varieties

Researchers and extension agents are unanimous inciting these as the five major factors limiting farmers' adoption of improved finger millet technologies in the study area. 1) Absence of sound seed production and delivery system; 2) Lack of awareness of improved finger millet varieties; 3) Lack of consistent demonstration and popularizations of the technologies; 4) Poor research- extension linkage and chronically weak extension services; and 5) lack of completeness of the technology package (see Appendix Table 4.3 for all the mentioned factors by researchers and extension agents).

Similarly, the farmers for their part indicated these as the five most limiting factors; 1) lack of awareness of improved finger millet varieties, 2) Limited promotion or lack of consistent demonstration and popularization; 3) quality seed shortage, 4) Poor performance of generated improved finger millet technologies, 5) Weak research and extension linkage.

The common factors limiting improved finger millet technology adoption mentioned by the three actors are summarized as follows.

Lack of Awareness

Lack of awareness was one of the major factors that are commonly shared by researchers, extension workers, and farmers. It is evident that generation of technology is not an end by itself. It must be utilized by end users. This can be achieved through the presence of strong linkages between the major actors involved in the agricultural knowledge and information system. As mentioned earlier in this study that, only 43% of the sample household farmers have an awareness of improved finger millet varieties. Despite, only 13% of them have been cultivating only one (namely, *Degu* variety) out of the three improved finger millet varieties in the last two production years, implying that the technologies remain on the shelf, simply because extension and farmers were unaware of their existence ('*Degu*'), or could not use them (*Taddese* and *Padet* varieties). Both research and extension might not have mechanisms that frequently enhance the exchange information on one hand or the available linkage mechanisms are ineffective and idle, or financial, physical, and human resources caused the non-use of technologies. Moreover, as described earlier one improved finger millet variety, namely *'Taddese'* was rejected by farmers due to its poor performance as compared to local varieties in most finger millet technology evaluation and selection criteria of farmers. It implied that, research outputs for finger millet were minimal and lagged behind the farmers' need for the crop. Hence, limited efforts were made by both research and extension in constantly changing and developing baskets of finger millet technological options that satisfies the needs and constraints of farmers.

Absence of Sound Seed Production and Delivery System

Absence of sound seed production and delivery system were frequently stated by the actors, as one of the causes of non-adoption of improved finger millet varieties. Both researchers and extension agents were unanimous in citing absence of responsible body, which played effective role in quality seed production, multiplication and transfer of improved finger millet varieties. Hence, the role of input multiplying and distributing agencies in finger millet technology development and transfer activities was non-existent.

Remarkably, the researchers claimed, small-scale multiplication of the variety in their own seed multiplication farms for research and transfer purposes, and even they demonstrated, popularized and disseminated the available finger millet technologies jointly with extension agents in some progressive farmers' fields of the study area. Yet, they reported the poor extension service provisions in the study area as one of a responsible factor limiting farmers' adoption of the technologies. Contrary with these facts, the extension agents claimed that multiple factors, including financial, human, and physical resources accompanied by diverse mandate areas, poor linkages with research, and high overburden in different tasks were the major factors influenced sound finger millet technology adoption. Moreover, those farmers who are cultivating improved finger millet variety claimed that shortage of quality seeds hampered their continual use of the available improved variety. They stressed, the very mixing of the improved variety with their local landraces during threshing time reduced the actual performance and volume of yield year after year, apart from aggravating diseases infestations. Thus, lack of quality seed made them discouraged for further use of the currently produced improved finger millet variety.

Lack of Completeness of the technology package

Researchers and extension agents also mentioned lack of completeness of the technology package as a factor limiting farmers' finger millet technology adoption. They questioned the recommended seed and fertilizer rates by research were obsolete and lower than what the farmers continued to use for their local seed and fertilizer rates. Their perception was supported by this study. In the study area, farmers claimed that on average 60.76 kg seed is needed for a hectare of land with a Std. Deviation of 24.4, depending on the fertility of the soil and land preparation. As for instance, when the land preparation and the soil is fertile the rates can be as low as 36.2 kg/ha on average. Similarly, they use up to 84 kg/ha seed on infertile and less prepared soils. Contrary to this fact, research recommendations claimed 25-30 kg seed is needed for a hectare of land by broadcasting method and 15 kg/ha for row planting (none of the surveyed farmers practiced row planting). Similarly, research recommended that on average 100 kg DAP and 50 kg UREA is needed for a hectare of land. However, the sample farmers on average use 122.3 kg DAP per hectare with a Std. Deviation of 64 and 44 kg UREA per hectare with a Std. Deviation of 5, depending on the nature of the soil.

Hence, as mentioned by researchers, extension agents, and the finding, lack of completeness of the finger millet technology package could limit the intensity use of the improved finger millet varieties. Thus, constantly upgrading and improving the existing finger millet research recommendations consistent with the indigenous practices is a missing link in the study area. This is also a reflection of weak research-extension-farmers linkages.

4.2.7 Organizational Related Factors

In order to understand and describe the prevailing linkage mechanisms, which fosters research-extension-farmers linkage for sound technology development and delivery, researchers and extension agents were asked to indicate the sources they often use for ideas to set their work priorities. Similarly, farmers were asked to indicate their sources of agricultural information in general and improved finger millet varieties in particular.

4.2.7.1 Researchers' Sources of Idea for Setting Research Agenda

Researchers reported that 77.8 % of their research ideas come from the problems identified by the Regional Bureau of Agriculture and Rural Development, whereas 72.2% of the researchers claimed based on research objectives determined by their research institute thematic area. Moreover, the researchers surveyed were more balanced in their use of stakeholders meeting (38.9%) and research community itself, including fellow research staffs (38.9%) as sources of their research agenda. However, only five (27.8%) of the researchers perceived farmers as a source of ideas for setting their research agendas. Similarly, only four (22.2%) of the researchers claimed personal observation as a source of ideas for setting their research agendas (See Appendix Table 4.4).

Pearson chi-square confirmed that there is a strong and significant relationship between participation in finger millet linkage mechanisms and researchers sources of research agenda setting using stakeholders meeting ($\chi2$ =2.918, P=0.088), problems identified by regional BoARD ($\chi2$ = 2.822, P=0.093), and personal observations ($\chi2$ = 2.822, P=0.093), at 10% significant levels, respectively. However, insignificant relationship was found on the rest sources of research agenda setting and participation in linkage activities at 10% level (See Appendix Table 4.4).

4.2.7.2 Extension Agents Sources of Idea for Setting Extension Agenda or Work Priorities

The extension agents reported that 61.5 % of their work ideas come from the problems identified by the Regional Bureau of Agriculture and Rural Development, whereas 57.7% claimed extension objectives determined by their extension institute thematic area as sources of their work priorities. Similarly, stakeholders meeting (34.6%), top-down planning procedures (26.9%), extension community itself (19.2%), were claimed as sources of extension agenda setting. Moreover, eight (30.8%) of the extension agents surveyed also perceived farmers as a source of ideas for setting their work priorities. However, only one of the extension agents (3.8%) reported personal observation as a source of ideas for setting extension agenda (See Appendix Table 4.5).

Pearson chi-square, confirmed that there is insignificant relationship between extension agents participation in joint linkage mechanisms and sources of their extension agenda setting using all the mentioned sources at 10% level. Thus, it implied that others factors other than extension workers sources of work priorities affect the participation of extension agents and performance of joint research-extension-farmers linkage activities.

4.2.7.3 Farmers Sources of Obtaining Agricultural Information and Improved Finger Millet Varieties

As indicated in Appendix Table 4.6 the four most common sources of obtaining agricultural information by farmers in the study area were extension staffs (77%), neighbors (77%), religious organizations (76%), and parents/relatives (64%). The percentage record of linkage participant farmers were higher than the non-participants in terms of their information sources of extension staffs (97.3%), neighbors (81.1%), and religious organizations (83.3%), as compared to 65.1%, 74.6%, and 71.4%, respectively of non-participants. However, the non-participants have more information sources from their relatives and parents (68.3%) than the participants (56.8%) do. In short, linkage participants have higher information accesses almost in all sources of information, except that of relatives and NGO's (Appendix Table 4.6).

Moreover, Pearson chi-square, confirmed a strong and significant relationship between participation in joint linkage mechanisms and farmers sources of obtaining agricultural information using extension staffs ($\chi2=13.62$, P=0.00), demonstrations ($\chi2=4.292$, P=0.036), marketing place ($\chi2= 7.784$, P=0.005), and attendant at seminars/trainings ($\chi2=8.278$, P=0.004), at less than 5% significant levels, respectively.

Hence, linkage participant have more access to information from extension agents, marketing place, and from participation in demonstration trials, and trainings/workshops as compared to non-participant farmers. However, insignificant relationship is found on the rest sources of agricultural information.

Furthermore, the common sources of improved finger millet seeds and technical information, mentioned by the fifteen farmers, were research staffs (8), extension staffs (3), relatives (3), and neighbors (1), respectively. The bivariate correlation analysis shows a significant and moderately weak relationship at 0.1 level between farmers participation in linkage activities and improved finger millet seeds and information sources (r=0.126, p=0.099).

4.2.7.4 Researchers Perceived Factors Limiting the Performance of Linkages between Research, Extension and Farmers

Cognizant of the fact that every research and extension system functions within unique contextual factors to address the technological needs of farmers several factors could limit the performance of research-extension-farmers linkages for sound technology development and delivery.

Researchers mentioned these as the six most limiting factors affecting research-extension-farmers linkages: 1) Lack of transparent, accountable, and responsible linkage strategies; 2) Idle, ineffective and non-functional linkage mechanisms; 3) Extension agents failure to perceive linkages as their responsibility; 4) Lack of adequate and sustainable financial, and physical resources for the linkage requirements of a system; 5) Lack of adequate and quality human resources; and 6) The diversity of the farming systems served by technology systems.

Other limiting factors mentioned by researchers included; lack of sound reward system; donor dependence of linkage activities; lack of mutual respect and recognition among research and extension; lack of sound leadership from policy makers; limited participation of other stakeholder; high involvement of extension agents in non-agricultural activities, etc. (See Appendix Table 4.7 for all the limiting factors mentioned by researchers).

Researchers also indicated other factors limiting their close working relationship specifically with farmers. 67 percents claimed, the loose participation of farmers in the entire technology system was mainly due to their high involvement in diverse livelihood activities, and hence limited their contacts with farmers. Similarly, 33% of the researchers claimed, the poorly established farmers training centers with scarce human and physical resources limited their linkages, thus posed limited awareness and timely transfer of agricultural technologies. Yet, only three (16.7%) of the researchers claimed farmers low level of understanding and their suspicions to accept technologies limited their linkages with farmers. Thus, they stressed that their entire focus or contact was on model or progressive farmers, who understands and tends to accept and implement technologies based on research recommendations, by neglecting the so-called laggards, or conservatives. Besides, these same researchers blamed poor communication or facilitation skills and poor respect to indigenous knowledge by researchers limited researchers contact with farmers (See Appendix Table 4.7).

4.2.7.5 Extension Workers Perceived Factors Limiting Linkages between Research, Extension, and Farmers

The extension workers for their part indicated these as the six most limiting factors: 1) Lack of sound incentives; 2) Lack of adequate and quality human, physical and financial resources; 3) Wide domain area and diversity of farming system; 4) Absence of transparent and accountable linkage mechanisms; 5) Limited emphasis is give to linkages by research and extension including, lack of proper planning and time management for linkages by optimizing the financial resources needed; 6) Differences in the status of research and extension agents.

Other limiting factors mentioned by extension workers included, lack of essential skills of extension managers in managing linkages; lack of mutual respect and recognition among research and extension; idle and ineffective linkage mechanisms; lack of domain consensus between research and extension; high work overload of extension agents; lack of sound leadership from policy makers; and etc (See Appendix Table 4.8 for all the limiting factors mentioned by extension workers).

In addition to this, technology transfer workers indicated other factors limiting their close working relationship, specifically with farmers. Three (12%) of the extension workers cited their dissatisfactions on the reactions of the majority of farmers towards extension experts. They stated farmers have been giving high respect and loyalty to political leader farmers of their respective *kebeles* than extension experts thereby limited the scope of farmers-extension contact. Moreover, 35 percents claimed, farmers' shortage of time to seek extension advice due to their high involvement in diverse livelihood activities, constrained their entire working relationship. Similarly, about 12% of the extension workers claimed that poor working environment of their localities, explained by lack of full facilities of the existing farmers training centers, accompanied by shortage of housing, offices, staff turn-over, human and material resources, limited the motivation to work and there by affected extension linkages with farmers. In addition to these facts, 35% of the extension workers indicated that farmers' low level of understanding and consciousness limited their linkages. Adding, they explained that their efforts were inclined towards farmers development groups (about 12 groups) which each group consists of about 25-30 model household farmers in each respective *kebele's*, with the aim to catalyze the adoptions of technologies. The model farmers were supposed to be conscious, literate, and who tends to accept and implement technologies at the earliest, thereby fostering spillover effects on the rest of farmers. Moreover, the model farmers are the ones that have been a participant in various developmental related issues, including seminars, trainings, exchange tours, etc, with either extension or other bodies often on behalf of farmers of the respective localities. On the contrary to this fact, these same extension workers blamed poor communication or facilitation skills of extension workers to persuade laggard farmers was also a responsible factor for weak extension linkage with farmers (See Appendix Table 4.8).

4.2.7.6 Farmers Perceptions of the Factors Affecting the Performance of Linkages between Research, Extension and Farmers

Farmers based on their farming experience, perceived these six as the most critical factors limiting their close relationships with research and extension: 1) Limited involvement or participation of farmers in linkage activities; 2) Biasness' of development agents/grass-root extension workers; 3) Lack of commitment of extension; 4) Farmers shortage of time due to high overburden in diverse livelihood activities; 5) Weak research-extension linkage; 6) Lack of timely supply of adequate and quality seeds and fertilizers from extension.

Other limiting factors mentioned by farmers included: high focus of research in road side trials; lack of commitment of research; limited motivation of farmers to seek advice; lack of sound and basket of technological options either from research or extension; limited number of development agents; farmers expectations of allowance or per diem during linkage activities organized either by extension or research, etc (See Appendix Table 4.9 for all the factors mentioned by farmers).

As it stated above, most of the farmers (59%) blamed that one of the critical factor limiting their close contact specifically with extension is the biasness' of development agents. Especially they are frustrated by lack of timely supply of adequate and quality seeds and fertilizers from the agents. They added the available agricultural inputs, trainings, workshops, etc, have been provided to the same influential and politically motivated farmers year after year. As a result, they are less motivated in seeking any advice and production inputs from the agents, and the farmers did not perceive the agents as real developmental workers. Besides, they have been dissatisfied by the extension methods which focused more on progressive farmers and which neglected the so-called laggards.

Besides, 15% of the sample farmers claimed that absence of sound and basket of technological options either from research or extension are the major contributory factor which limit linkages. The most common expression of these farmers was that 'whether research, or extension, or farmers, or others, they were ready to travel to anywhere to secure seed without mattering distances whenever they heard or aware that best technologies exist in the destination. Remarked, the available technologies being transferred by extension agents were few and even scarce to the majority of farmers, being dominated by improved maize technologies. They stressed they would frequently contact both extension and research if there were baskets of sound technologies (See Appendix Table 4.9).

4.2.8 Context of Technology System/ Task Environment Related Factors

The reasons for the degree of the poor status of linkage explained in the previous section slightly vary from the respondents of research, extension, and farmers. Nevertheless, both researchers and extension workers share several factors contributing to the poor performance of linkage between them unanimously. Thus, three key elements of the 'task environment' influenced research-extension-farmers linkage. Namely, policy, the structure of farming systems, and donor involvement.

4.2.8.1 Issues at the System and Policy Levels

One of the basic causes of poor linkages between research, extension and farmers in the study area is the absence of system perspectives. Evidence from the data showed that, policy makers, research and extension personnel fail to recognize that research and extension are part of a single system and that the mission of this system is to make relevant technologies available to farmers. As shown in Appendix Table 4.7 and 4.8, 67.7% and 50% of the sample researchers and extension agents, respectively indicated that policy makers fail to recognize research and extension as two components of the same system and that they fail to deal with from a systems perspectives. They fail to assume sound leadership by promoting domain consensus and complementarities between research, extension and others of the system; by enforcing accountability; and sound incentives.

Despite their being, components of the same system, research and transfer differ in their respective roles, specific goals, priorities, and methodologies. Further, their incentive systems and status are not the same. These differences could be the sources of potential tensions and conflict and could override the complementarities of two components, making them overly competitive. Hence, lack of a system perspective with a transparent, agreed upon and responsible linkage mechanisms based on the consent of stakeholders, might have potential implications for policy makers' handling of linkages. Similar finding was reported by (e.g. ISNAR, 1987; Kaimowitz *et al.*, 1989; Eponou 1990).

4.2.8.2 The Structure `of Farming Systems

The majority, 72% and 92% of researchers and extension workers, respectively cited the wide domain area served by the technology systems as one of the primary problems affecting linkages. The farming systems are diverse and agro-ecologically and socio-economically complex. Thus, it posed incompatibility to the quantity, and quality of human, physical and financial resources required. Unfortunately, the agricultural technology systems of the area lack the required resources (Appendix Table 4.7 and 4.8). The finding agrees with (ISNAR, 1987; Ekpere *et al.*, 1990; Kaimowitz *et al.*, 1989). Despite these, 72% of the researchers and 69% of the extension workers frustrated by the involvement of extension workers in non-agricultural activities. In that, extension agents had many tasks to perform other than transfer of technology and information, which typically included agricultural administration, credit administration and input supply. Hence, farmers seldom saw their role as real developmental agents. The finding agrees with Belay (2003).

4.2.8.3 Dependency of Linkages in Donor-Funded Projects

In the study area, although donor projects had played a positive role in improving linkages and achieving a high degree of effectiveness for a short period, often the duration of the project, they had also posed negative effects when donor fund ceases. One was the disappearance of leadership and accountability at all levels. Added 77.8% and 46.2% of the researchers and extension agents (Appendix Table 4.7 and 4.8) apart from KIIs and FGDs indicated that dependency of linkages in donor-funded projects lead to fluctuations in the performances of linkages between research and extension in the study area. As soon as the project ceases, performance dropped sharply. Linkage initiatives were thus lost and, in many cases, the level of integration achieved was not sustainable. It improved only when donor resources again became available. Empirical example for the past few years in the technology system of the area as information obtained from KIIs and FGDs showed that,

> Breakthrough had been achieved in creating strong linkages among the major actors in the study area by donor-projects, specifically by IFAD, USAID and SIDA; where by ordinary costs such as transportation, per diems, publications, joint trials, technology transfer, trainings, and seminars and workshops related to linkages were paid by these projects. More strikingly, these projects were gradually phased, as the projects

near their scheduled completion in the past four to two years. As a result, linkage initiatives were thus lost and the level of integration achieved was not sustainable. It improved only when donor resources again became available. As for instance, currently, donor-funded project namely, RCBP (rural capacity building project) has been launched in the technology system of the area and has shown that whenever a resource is available, the performance of linkages of this technology system is being enhanced.

Thus, fluctuations in linkages were due to the fact that most linkage mechanisms were related to donor funded projects; they were not maintained by resources from the national budget because of either limited funding or because the relevant actors underestimate the usefulness of linkage. Previous linkage studies have also revealed that many research-extension linkage problems could be traced to problems of donor involvement (e.g. Palmieri, 1990; ISNAR, 1987; FAO, 1997).

4.2.9. Structural Related Factors

The common factors explaining the present situations of research-extension-farmers linkages in the study are on the context of structural and/or organizational related factors are three, namely; idle and ineffective linkage mechanisms, limited participation of farmers, and relevant stakeholders.

KIIs and FGDs indicated that one of the basic linkage problems prevailing in the region in general and the study area in particular are the existence of idle and ineffective linkage mechanisms. This is confirmed by evidence of the data that 72.2% and 61.5% of the sample researchers and extension agents, respectively claimed that the available linkage mechanisms are idle and ineffective.

4.2.9.1 Idle and Ineffective Linkage Mechanisms

Formal mechanisms for cooperation are existent, but they were ineffective or not are used or are used so poorly that the intended objectives could not be achieved (Appendix Table 4.7 and 4.8). This could be due to lack of accountable linkage mechanisms, or to their method of operation, or to managerial practices or to the nature of the resource base. The finding agrees with (ISNAR, 1993).

An important phenomenon as noticed from the finding, KIIs and FGDs with researchers and extension agents, is a fluctuating situation in assuming responsibility for linkages. That is, no institutional system is specifically charged of establishing and managing linkages with a transparent and responsible linkage policy based on the consent of all stakeholders. In fact, both the researchers and extension workers claimed that they acknowledge the importance of linkages but do not always perceive them as their responsibility. To put across,

Even if almost all the major stakeholders of the Research-Extension-Farmers Linkages Advisory Council are under the umbrella of Bureau of Agriculture and Rural Development, there is no a responsible and accountable body of managing linkages. As a result, most of the linkage mechanisms are being undertaken on the goodwill of participants, specifically one side initiation from researchers. To explain this, although the linkage council has been serving all the stakeholders in the technology system of the study area, the research wing shares the lions share or have been the only responsible body of organizing and facilitating the council's activities. The others actors on the contrary, were passive participants in the entire activities of the council, or they come to the scene only during review, and field days. For example, managers of Zonal office of Agriculture and Rural Development have been chairmen' of the linkage council for more than eight years, but their role was not more than chairing the meeting. Hence, there would be a planning and review committee that meets, but its decisions were ignored and rarely implemented and/or the committee rarely or never meets. Mechanisms for program formulation and priority setting activities during the Linkage Advisory council meeting of relevant stakeholders were typical examples in the study area. Research and extension were supposed to meet and formulate the research program together. However, during these meetings, only the researchers would present their current results and their plan of activities for the following year. In other cases, research or extension never even organizes the meetings.

To put it briefly, properly defined, well-formulated and institutionalized research-extension-farmers linkage strategies have been non-existent, despite few attempts are currently being made.

4.2.9.2 Limited Participation of Farmers in Linkage Mechanisms

It was evident from the finding (Appendix Table 4.9) and the analysis of farmers' participation in linkage mechanisms (section 4.3 later), farmers input in setting both research and extension agenda has been limited or is at least at the level of bare minimum. This is despite the fact that farmers' participation can be one of the key factors ensuring the success of agricultural technology systems. Farmers' involvement (section 4.3 later) in the study area was often limited to field day (37%), training (37%), and joint demonstration trial (36%). However, only involving farmers in such linkage activities does not allow them to become part of the decision making process. This is because; for e.g., the majority, 97% and 90% of the sample households had not been participated in the last two production years jointly with researchers and extension workers in joint problem identification, and joint priority planning and setting activities, respectively.

4.2.9.3 Limited Participation of Other Relevant Stakeholders

KIIs, FGDs and both researchers (72%) and transfer agents (38%) claimed the low participation of the relevant actors of the agricultural knowledge and information system, in linkage planning and implementation efforts at all levels hampered the effectiveness of research-extension-farmers linkages of the study area. Specifically, NGOs, and input multiplying and distributing agencies, respectively were among the major actors in playing an effective role by supporting via adequate funding at all levels, and timely multiplication, dissemination and transfer of technologies. However, the involvement of such organizations in linkage mechanisms in general and technology development and transfer activities in particular had not been active and well coordinated. In the situations, where there exist diverse agro-ecologies linkage among the actors involved in technology generation, multiplication and transfer schemes covering wider agro-ecologies ensure the relevance and adaptability of technologies. However, such coordination is poor in the study area. The finding agrees with Teklu (2001).

4.2.10 Resource Factors

In the technology system of the study area, various aspects of human, financial and physical resources influenced the level of integration between research, extension and farmers.

4.2.10.1 Human Resources

4.2.10.1.1 Motivation and Rewards/Incentives

Striking phenomena in the technology systems of the study area were the incompatibility between professional reward systems and organizational goals. While the goals of the studied publicly-funded research organizations is to generate relevant technologies which are socio-economically, agro ecologically and technically sound to farmers, their employees reward systems did not reflect this.

KIIs , FGDs and evidence from the survey result indicated the majority of researchers (72.2%) and extension workers (65.4%) claimed that the reward systems currently in use are not compatible with the missions and goals of technology systems (Appendix Table 4.7 and 4.8). They stated the low salaries or the monthly pay envelope was so insufficient to cover basic needs that, their morale were low and were less motivated to devote their entire efforts to sound technology development and delivery system in general or establishing effective linkages with the components of the system in particular. The finding agrees with (ISNAR, 1993).

Moreover, promotion and peer recognition were perceived by researchers as the most important professional awards, based on the number of scientific articles published. Researchers gained little or no peer recognition from working effectively with extension and hence practical bulletins and pamphlets aimed at technology transfer agents and farmers were given little attention by researchers and managers. The linkage activities that they were most likely to engage in were those that advance their personal aims. Participation in scientific seminars, conferences, workshops and training of extension workers, as for instance, were preferred because they could help to give researchers a scientific profile. Moreover, 57.7% of technology transfer agents claimed that promotion, training, and peer recognition was not based on the relevance and effective use of technologies rather than on individuals' political commitment. Hence, in such case, extension workers who devote their efforts to transfer activities might even be penalized (Appendix Table 4.8).

4.2.10.1.2 Human Resource Mix

Technology generation and transfer are social processes involving mix of human resources with different personal attributes, attitudes, behaviors, motivations, interests, and goals. Individuals have different professions and positions with varying levels of prestige and incentives. They also belong to groups or organizations that do not necessarily have the same status, authority and resources. KIIs , FGDs and sample researchers (88.9%) and extension workers (61.5%) as factors contributing to poor linkages between research and extension have identified personal attributes, as well as professional and organizational differences. Hence, since the mixes of human resources in the technology system of the study area are not right, personnel's might unable to cooperate to the required amount. It is remarked that group competence, in particular, is an important factor in carrying out linkage activities. Basic tasks such as gathering information on farmers' problems or providing feedback to research on transferred technologies could not be properly performed because technology transfer agents were not sufficiently well educated to do so; or were poorly trained in identifying clearly farmers' production problems, or serve as partners in joint trials or surveys. Researchers on the other hand could not be able to make information understandable to extension agents because they might be poorly trained or lack good communication and facilitation skills to pass scientific results to transfer agents and farmers.

KIIs and FGDs with researchers stressed that serious staff turnover of experienced research staffs have been limiting the performance of the entire technology development activities in general and net working with relevant stakeholders in particular. Apparently, the research systems of the study area had a limited number of qualified scientists that it was usually the best of these who were assigned coordination and other linkage tasks. This tends to overload them and may interfere with technology generation work.

4.2.10.1.3 Status Differences

Sample researchers (38.9%) and majorities of extension agents (76.9%) mentioned differences in social status, e.g., differences in educational level between them as source of linkage problems (Appendix Table 4.7 and 4.8). They stated that the educational gaps between them are so wide that effective cooperation was severely handicapped. Tensions thus arose or intergroup conflicts exist. This result supports the findings of earlier researches on linkages (e.g. FAO, 1997, Seegers *et al.*, 1989, Eponou, 1990). In the same way with what Eponou (1990) expressed,

> Majorities of the surveyed extension agents (76.9%) stressed that ''in the technology system of the study area, researchers had more status than extension workers, and hence there were often a 'pecking order' of occupations, reinforced by the general perception that researchers were the 'white collar' workers who alone are capable of identifying, analyzing and solving farmers problems. Technology transfer agents were perceived as the 'blue collar' workers who mechanically deliver the product of research to farmers''. This frustrated technology transfer agents. The most common expression of their dissatisfaction was to question the competence and motivation of researchers and the relevance of their results.

Briefly, mutual respect, recognition of the partner's competence, and domain consensus seem to be prerequisites for using linkage mechanisms to integrate research and technology transfer. Unfortunately, these conditions were rarely present in the technology system of the study area.

4.2.10.2 Financial Resource Factors for Linkages

4.2.10.2.1 Availability and Management of Funds

Access to resources is one of the critical factors determining organizational strength. National governments in general and donors were the major sources of funding. Contributions from the public sector, the most convenient way of financing technology development and transfer in the study area, were determined by the level of economic development of, and support given to, the agricultural sector within the overall national economy. Donor contributions, by contrast, were a function of linkages between donors, the public sector, and the organizations of the technology system. In general, a high level of financial resources has a positive effect on linkage mechanisms because it allows for more than one mechanism to perform the same function and as well for achieving correspondence. Unfortunately, it is found from KIIs and FGDs that these conditions were rarely present in the technology system of the study area. As a result, in some cases, trials and transfer activities were not always finished and joint linkage activities would have been suspended. Moreover, 77.8 % and 76.9% of the sample researchers and extension agents respectively confirmed, lack of adequate and sustainable financial resources for the linkage requirements of a system as one of the major factors contributing to poor research-extension-farmers linkage (Appendix Table 4.7 and 4.8). Likewise, linkage mechanisms were not budgeted as separate items; the costs related to linkages were the first to be cut when financial resources became scarce. Very often, the mechanisms were established with donor resources. When these were no longer available, linkages cease to function properly. This result supports the findings of earlier researches on linkages (e.g. FAO, 1997, ISNAR, 1993).

4.2.10.3 Physical Resource Factors

Both sample researchers (94.1%) and technology transfer agents (84.6%) apart from results of KIIs and FGDs claimed that scarcity of physical resource as one of the factors contributing to poor linkage between research, extension and farmers. The researchers cited lack of adequate vehicles and high aged trucks with little maintenance costs, accompanied by scarce financial resources were the main factors influenced the overall performance of their organizations. The most common expression of their dissatisfaction was to question 'how could the research covers a wide domain area of diverse agro ecology, (specifically mandated for more than 48 districts per single research center in the unit of analysis), given that such physical facilities were rarely present and financial resources at the same time were insufficient. Hence, it made too difficult for them to contact frequently with extension and farmers as well to test technologies at the farm level of their diverse mandate areas (Appendix Table 4.7).

Similarly, the extension workers claimed the scarcity or absence of such resources. Remarkably, KIIs with extension supervisors indicated that without any vehicles, motor cycle, or bicycle they were forced to advice famers located in at least three or four different rural *kebeles* 52 times per year; given that the *kebeles* are placed distantly with each other. This frustrated their individual motivation to work in particular and the overall performance of the technology transfer and feedback activities in general mentioned before that sound incentive and promotion mechanisms were rarely present.

4.2.11 Managerial Factors

In the agricultural technology system of the study area, managerial problems also influenced the performance of linkage between research, extension and farmers.

4.2.11.1 Managerial Capacities of Research and Extension Managers

Empirical evidences indicated that, the managers of the research systems were forced to be senior research scientists who accumulated long years of experience in research; however, they might not have little or no managerial experience. Sixty-seven percent of the researchers claimed, either because of poor management training programs or personality problems, the research managers of the study area lack the essential skills for running the research organizations, including those for managing linkages both inside and externally with other relevant stakeholders, and lack to provide leadership, to build a team, and to communicate effectively. This result supports the findings of, e.g., ISNAR (1993).

To this end, matching the interests of researchers with those of the organization and reconciling divergent scientific views were a challenge for the managers. Individual personality problems might have been a source of poor linkages. Personality clashes were not addressed in the study, but in some case, difficulties might arise because of the authoritarian management style of certain individuals. Despite this, the remaining 33.3% of the researchers cited, the capacity of the mangers to perform the various organizational tasks, managing linkages, building a favorable climate for mutual interaction is good; however, different factors including lack of accountable and responsible linkage strategies, inadequate financial, physical and human resources and wide domain area and coverage affected the efficiency of the research managers (Appendix Table 4.7).

Similarly, KIIs and 73.1% of the surveyed extension agents have claimed that the managers of their extension organizations lack the essential skills for running the organizations and creating a favorable climate for integration. They claimed that the managers were simply politically appointed to fill management posts unlike the nomination and selection procedures of research managers based on individual talent and achievement. Consequently, difficulties might arise because of the authoritarian management style of certain posted individuals. Moreover, they stressed that the managers of their extension organizations have been devoting almost their entire time to often-unplanned activities, conferences and meetings, concerned on both agricultural and non-agricultural issues. Added, they spent a bare minimum time on real technology delivery mechanisms and linkages, which would have a significant effect on the livelihoods of farmers in general and for sound technology development and delivery particular. To this end, the managers could unable to identify the systems linkage needs, are unable to provide effective leadership in the extension system and unable to choose appropriate mechanisms which would work better than others, depending on the functions to be performed and the specific conditions such as the quality, quantity of resources and the system climate.

On the contrary, the remaining 26.9% of the transfer agents claimed that the managers did not lack essential skills for undertaking and implementing the goals of the organization, including managing linkages, however they overburdened with different planned and unplanned activities. Moreover, they claimed the managers faced with, scarcity of financial, physical, and human resources, which in turn posed unfavorable climate for integration and affected a two-way flow of information and knowledge.

Generally, Appendix Tables 4.10 and 4.11, summarizes all the discussions of section 4.2 based on distributions of linkage participant and non-participant researchers and extension agents, respectively.

4.3 Types of Linkage Mechanisms and Their Functions Used By the Research and Extension Organizations

According to ISNAR (1993), a linkage mechanism is defined as any structural or managerial devices or procedure used to enhance the complementarities of research and extension. In view of that, 6 basic linkage functions/purposes comprising 25 linkage mechanisms were identified from the research and extension organizations of the study area. These are:

Planning and review functions: the specific linkage mechanisms used for this function were a) Joint problem identification, b) Joint priority planning and setting committees or meetings, c) Joint programming and review committees or meetings, d) Joint technology release committee or meetings.

Collaborative activities: the specific linkage mechanisms used for this function were a) Joint adaptive trials, b) Joint field visits, c) joint demonstration trials, and d) Joint surveys.

Exchange of resources: the specific linkage mechanisms used for this function were a) Financial agreement, b) Contract for services, c) Exchange of personnel, and d) Staff rotation.

Dissemination of knowledge and information; the specific linkage mechanisms used for this function were a) Publications, b) Seminar/ Workshop, c) Technical Reports; d) Farmers exchange tour, e) Demonstration trials, f) field days, g) Audio-visual material, and h) Trainings.

Evaluation and feedback: the specific linkage mechanisms used for this function were a) Evaluation surveys, b) Evaluation meetings, c) Evaluation field visits, d) Publication of reports by monitoring and evaluation team.

Coordination: The specific linkage mechanisms used for this function were a) Coordinator positions, and/ or Research extension liaison positions.

Based on these 6 linkage functions, specific linkage mechanisms for each purpose is described below from the technology system of the study area, specifically linkage mechanisms of research, extension, and farmers.

4.3.1 Linkage Mechanisms of Extension Agents/Extension organizations

Based on the aforementioned premises, extension workers indicated 25 structural or managerial devices, which are being used by their organizations to enhance the complementarities of research and transfer processes. As shown in Appendix. Table 4.12, there is too great reliance of the extension workers on two practices. These are joint priority setting and planning (80.8%), and field days (76.9%). Moreover, high frequency was scored on extension links with research through, joint technology release meetings, and joint field visits.

On the contrary, there were low extension link with researchers, specifically links on; farmers exchange tour (11.5%), joint surveys (19.2%), evaluation surveys (19.2%), coordinators positions (19.2%), publication of reports (26.9%), joint demonstration trials (26.9%), trainings (26.9%), joint problem identification(30.8%), joint programming and review (30.8%) - which are key tasks for ensuring the relevance of technologies and particularly important in systems serving resource-poor farmers. Their low record undermines the technology systems performance by preventing extension workers and researchers from carrying out subsequent tasks.

4.3.2 Linkage Mechanisms of Researchers /Research organizations

Similarly, researchers were also indicated about twenty-five linkage activities or structural or managerial devices that are used by their organizations to enhance the complementarities of research and extension. As indicated in Appendix Table 4.13, of all about five linkage activities or mechanisms was very prominent in practice.

Researchers' dissemination of knowledge and information to extension workers through demonstration trials (100%) and field days (83.3 %) have been widely used and have been moderately successful in strengthening the links. Moreover, evaluation meetings (72.2 %), evaluation field visits (72.2 %) and seminar/ workshop (72.2 %) were also popular linkage mechanisms. However, these mechanisms alone are inadequate to sustain the integration of research and extension. They can be effective only if there is already some degree of integration fostered through other mechanisms. Evidently the data showed that (Appendix Table 4.13), researchers found it difficult to use staff rotation (11.1%), coordinator positions (11.1 %), joint programming and review (16.7 %), joint problem identification (16.7 %), exchange of personnel (16.7 %), contract for services (16.7 %), financial agreement (22.2 %), publication of reports (16.7 %), and joint priority setting and planning (27.8 %).

4.3.3 Relationship of Research and Extension on Linkage Mechanisms

Table 4.23 below shows the linkage mechanisms that are jointly used as a link between researchers and extension workers. It is found that there is a relationship between researchers and extension agents in terms of their use towards; joint priority setting and planning (59 %), joint technology release committee (54.5%), joint field visits (66 %), exchange of personnel (41%), publications (41%), seminar (61 %), joint technical reporting (48%), demonstration trials (61%), field days (80%), audio-visual materials (57 %), trainings (39 %), evaluation meetings (55 %), and evaluation field visits (52 %).

Table 4.23 Breakdown of Research and Extension Organizations Linkage Mechanisms

Linkage Mechanisms	Researchers and Extension Agents		
	N-yes responses	%	Total Sample
Joint Problem Identification	11	25	44
Joint Priority Setting and Planning	26	59	44
Joint Programming and Review	11	25	44
Joint Technology Release Committee	24	54.5	44
Joint Adaptive Trials	15	34	44
Joint Field Visits	29	66	44
Joint Demonstration Trials	14	32	44
Joint Surveys/Diagnostic Survey	12	27	44
Financial Agreement	15	34	44
Contract For Services	14	32	44
Exchange of Personnel	18	41	44
Staff Rotation	14	32	44
Publications	18	41	44
Seminar/ Workshop	27	61	44
Technical Reports	21	48	44
Farmers Exchange Tour	10	23	44
Demonstration Trials	27	61	44
Field Days	35	80	44
Audio-Visual Material	25	57	44
Trainings	17	39	44
Evaluation Surveys	16	36	44
Evaluation Meetings	24	55	44
Evaluation Field Visits	23	52	44
Publication of Reports	10	23	44
Coordinator Positions	13	30	44

4.3.3.1 Planning and Review Linkage Functions of Research and Extension Organizations

Planning and review was one of the most important purposes for linkages between research and extension in the technology system of the study area. As indicated in Table 4.23 above, there is a relationship between researchers and extension agents in terms of their use towards mechanisms of joint priority setting and planning meetings (59 %), and joint technology release committee or meetings (54.5 %), for purposes of joint planning and review.

Joint planning and review functions; which is the interactions of input from both research and extension to problem identification, program formulation and evaluation, agreement on the priority domains and consensus on responsibility sharing, and joint release of sound technologies; could play a role to meet the technological needs of farmers, a goal which neither party can achieve on its own. However, mechanisms of joint problem identification (25%) and program formulation (25 %) were the least effectively used linkage mechanisms.

In the region in general, it was witnessed from FGDs, KIIs, and official bulletins of research and extension that, problem diagnosis and meeting for program planning and review was currently vested under the responsibility of Regional Bureau of Agricultural and Rural development, where by substantial authority was given to the regional technology transfer experts of the department titled 'Community Need and Problem Assessment. The department encompasses community need and problem assessment experts who supposed to knew or are aware of the real needs and problems of farmers, and diagnosis the problems at grass-root levels. After diagnosing the problems, which have practical technological constraints on farmers, a two-stage meeting would be made. Technology transfer agents alone attend the first meeting. Problems noted at the field level are listed, discussed, and synthesized. Top-level technology transfer agents, presented, and submitted to research at a planning meeting, then reformulate them as research problems.

Even when a community need and problem assessment experts were vested with substantial authority, its operating rules gave too much control to one party-extension-allowing it to pursue its own interests. This situation was common in the study area where meeting where used as planning mechanisms. From personal observation and KIIs, it was witnessed during the survey that,

> Technology transfer agents organized a meeting on joint research agenda setting and plan so as to inform researchers about the prior problems which need solutions by research, thus ordering research to incorporate as a new research proposals on those problems identified by the community need and problem assessment experts of the regional BoARD. More strikingly, the meeting was organized only one day before what the research organizations have already planned for undertaking their own research annual planning or proposal review meeting of researchers. Consequently, one day was extended for the start of research annual planning in favor of the meeting organized by the need assessment experts. However, researchers came to the meeting with proposals already written and difficult to incorporate changes provided that the researchers were informed only one day before their annual planning meetings. It is often unclear whether the assessment groups or the meeting have a decision making body. Even the meeting agendas were not clearly defined; many topics were broached but few were discussed comprehensively. As a result, the meetings did not produce explicit recommendations. This possibly due to; the participants in the system were insufficiently prepared for

linkage tasks, or to the financial and human resources needed for the selected linkage mechanisms or events were not available, or to the mechanisms chosen could not be perceived as appropriate by others. However, full participation would have been more likely if all partners agree, in advance, on the mechanisms to be used as well as the timing of events.

The second planning strategies being applied in the region in general and the study area in particular are regional and zonal levels stakeholders/development bi-annual meetings, and research-extension-farmers linkage advisory council. As for instance, West *Gojam* Zonal research-extension-farmers linkage advisory council meeting are being used as a planning mechanism by joint operational teams and deal with technical matters. Each Zonal heads of extension in collaboration with directors of research organized the workshops every six months, at the end and before the beginning of the agricultural session. Research staffs, district, and zonal extension agents, including relevant stakeholders, subject matter specialists and selected farmers from the zone, attend the workshops. The participants would discuss, proposed production recommendations for major agricultural technologies in light of research findings and farm trial results; research priorities and proposals; plans for, and results of, farm trials and applied research activities. However, in practice it was observed that this linkage mechanism is operational but ineffective. The linkage mechanisms work only if there is an effective exchange of information between research and extension.

It is therefore important for managers of both research and extension to identify the conditions needed for an intensive and fruitful exchange of information before they begin joint planning. More specifically, the technology system of the study area lack some of the basic requirements of horizontal cooperation between research and extension, namely; identification of objectives, understanding of tasks to be carried out, awareness of one's role and that of the other participants, and adoption by consensus of compatible approaches.

The various information sources indicated that in general, planning of linkage activities was common. However, the need to improvise and lack of continuity still plague the systems of the study area. Consequently, times were wasted because the mechanisms could not be properly used or were inappropriate, and hence integration between research and extension were not enhanced as needed.

4.3.3.2 Collaborative Activities as Linkage Functions of Research and Extension Organizations

Table 4.23 above shows that there is a close relationship between researchers and extension agents (66 %) in terms of their use towards mechanisms of joint field visits for purposes of joint collaborative activities. The participation of both agents in field visits is crucial to the effectiveness of the technology system. It is used to identify problems, assess the performance of technologies in farmers' fields, increases researchers knowledge of local production conditions, combine expertise of both research and transfer for specific tasks in order to enhance efficiency and effectiveness for a smooth transition between sequential tasks, etc. However, visits can be highly effective if they are used along with other mechanisms to achieve specific objectives. As for instance, joint adaptive trials (34%), joint surveys (27 %), and joint demonstration trials (32 %), are among the least effectively used linkage mechanisms. The low usage of such collaborative activities may result in duplication of efforts.

The most striking example of lack of collaboration between research and extension was found during the survey in the study area. KIIs with extension and FGDs with farmers claimed that,

> Technology transfer workers carried out a trial of cultivating finger millet varieties in 2009 by liming soils of some farmers' fields without collaboration with researchers. Consequently the trial was failed in most farmers fields due to methodological problems arise because of the absence of qualified professionals in technology transfer organizations as one reason and the methods were poorly designed without a proper analysis of the characteristics of the soils, and post trial failure arrangement, etc. As a result, the farmers requested compensation for the loss of production from their particular fields; but the extension workers refused to pay any compensation. Hence, serious disagreements was created between them and the victim farmers distrust extension workers and developed bad attitude towards the role the agents played in particular and bad picture for the overall technology development and delivery system in general.

To put it concisely, at the present stage of development of the technology systems of the study area, collaborative activities are essential. It is crucial for research and extension to have a common understanding of the purposes, and both should use them more frequently and avoid unnecessary duplication of tasks by realizing their critical importance for overall systems performance.

4.3.3.3 Exchange of Resources as Linkage Functions of Research and Extension Organizations

Resource exchange between research and extension, including exchange of financial, physical, and human resources is vital to enhance the capacity of one or both parties ; to undertake a technology task, or an activity related to a specific task or to establish a" contractor-client" relationship in order to obtain a set of precise products. However, it is the least link between research and extension in the study area except the use of exchange of personnel's.

As indicated in Table 4.23 above, there is a relatively moderate link between researchers and extension agents (41 %) in terms of their use towards mechanisms of exchange of personnel's for purposes of joint exchange of resources. However, KIIs and FGDs with researchers and extension workers claimed, "The exchange of personnel's were used or better adapted to immediately solvable problems rather than ones that are chronic and fundamental". They stated, this mechanism was commonly used to overcome short-term difficulties such as disease or pest infestations occurring at suddenly.

On the contrary, financial agreements (34%), contract for services (32 %), and staff rotation (32 %) are among the least effectively used mechanisms of exchange of resources between research and extension.

Even if financial agreements are one of the most important resource allocation linkage mechanisms, specifically, contractor-client relationships seems to be the best way to make research responsive to client needs, it has been used rarely for high-value commodities but almost never for subsistence crops. Thus, all farmers, specifically, resource-poor farmers have not benefited from this useful mechanism. The KIIS and FGDs claimed that the limited impact of research on developing and delivering sound technological options of high value and marketable products, and lack of a transparent and agreed up on linkage policy among the major stakeholders hindered with a formal contract with research almost for all commodities. Similarly, staff rotation was rarely practiced jointly by research and extension. For one reason, differences in the administrative mandate of research and extension to perform a set of activities, or the manner in which the mechanisms are arranged and the quality of the individuals involved could matter the non-existence of staff rotation in the technology system of the study area.

4.3.3.4 Dissemination of Knowledge and Information as Linkage Functions of Research and Extension Organizations

Disseminations of knowledge and information between research and extension could play a role to tackle communication difficulties between them and timely delay of relevant outputs that satisfies the needs of beneficiaries. Evidence of the study shows (Table 4.23 above), use of field days (80 %), demonstration trials (61%), seminars (61%), and audio-visual materials (57 %) were the most frequently used mechanisms where by research and technology transfer fosters a two-way flow of information and knowledge in the technology system of the area.

As it shown, field days are the most effective mechanisms of dissemination of knowledge and information by the parties. By doing so, they could enhance feedback and awareness to relevant actors and farmers on the performance of baskets of technologies. Similarly, use of audio-visual materials especially broadcasting programs via radio and television were used in the region for passing of information by research and extension regarding on various achievements and challenges obtained from a given best practices in the technology development and delivery. Despite this, the source of information (namely research) could not able to put the message in to the form easily accessible by users. It was obtained from KIIs with extension workers that the main complaint from extension agents about training events conducted by research is that the materials were too jargon words and complex for direct use, and researchers could not adjusted the complexities of the training materials to the level of their audience, specifically transfer agents and farmers.

In sum, dissemination of knowledge and information is the most effectively used purposes for linkage between research and extension in the study area, as compared to the rest functions of linkage mechanisms. However, these mechanisms (field days, demonstration trials, seminars, and audio-visual material) used alone was not sufficient to ensure integration; their effectiveness could be enhanced by using other mechanisms in the system. Namely, use of publications (41 %), joint technical reporting 48 %), farmers exchange tour (23 %), and trainings (39 %), are among the least effectively used linkage mechanisms of disseminating knowledge and information.

For example, information could be presented on a range of publications from leaflets, brochures, handouts, bulletins; which are formats preferred by extension workers to highly specialized journal articles for scientists, however it was a weak link between researchers and extensionists.

In short, researchers should need to recognize extension agents as the major immediate beneficiary of their scientific results and in turn, extension agents should communicate feedback from farmers to researchers. This is because the range of publications could cover every aspect of improved production practices, including adaptation, production techniques to post harvest handling and the like.

Similarly, formal training of technology transfer workers by researchers, were not a wide spread practice in the study area, regardless of the role it could play by bridging the educational level between researchers and technology transfer agents and as well as for successful results. Deficiencies in several areas like planning, level of resources could often undermine the effectiveness of training programs.

4.3.3.5 Evaluation and Feedback as Linkage Functions of Research and Extension Organizations

Researchers needs feedback or get information on performance of transferred agricultural technologies they develop so that they can adjust their research programs. Similarly, extension workers also need feedback. Without it, future performance of the technology system will be weak. Evidence from the survey result (Table 4.23 above), and FGDs, shows that getting the necessary feedback and evaluation were one of the prominent links between research and extension in the study area though the process starts with end users- farmers. Significantly, evaluation meetings (55 %), and evaluation field visits (52 %), are supposed to be moderately used linkage mechanisms between research and extension.

Nevertheless, researchers and extension workers found it difficult to use evaluation surveys and publication of reports by monitoring and evaluation team. Hence, these two mechanisms are the least effective linkage mechanisms of feedback functions. Therefore, it is important to stress that both research and technology transfer sustains their needs, to share feedback from one another and from farmers to ensure the effectiveness of the system as a whole. Establishing formal feedback mechanisms are therefore essential for both research and extension to strengthen their linkages for the long run.

4.3.3.6 Coordination as Linkage Functions of Research and Extension Organizations

Coordination mechanisms could enable to facilitate a smooth transition between tasks or among activities of the same task performed by research and technology transfer. However, there is a weak link between researchers and extension agents in terms of their use towards mechanisms of coordinator or research-extension-liaison positions (30 %) for purposes of coordination.

Results of FGDs and KIIs with researchers and extension staffs claimed that the presence of coordinators and/or liaison officers in the respective organizations have played a vital role by coordinating the activities between research and extension and by ensuring all exchange or a two-way flow of information between the two parties. Thus, centralization of information flow might reduce the time needed for managing linkages and allows for more coherence in the activities of the two parties. Despite their crucial importance for improving linkages, the research-extension liaison positions are currently disbanded or dismissed from the research organizations of the region in general and the study area in particular following the current business processing and reengineering (BPR). The story of the missing link in brief based on KIIs and FGDs is that,

> In 1985 the Ethiopian Institute of Agricultural Research established a Research-Extension Division on each research center of the country in general and the technology system of the study area in particular, with the aim to strengthen research-extension-farmers linkage. Since its establishment, the division played a vital role in disseminating research findings to development agents, farmers, and relevant stakeholders working in the mandate areas of each research center; facilitating and ensuring the efficient transfer, utilization and adoptions of research recommendations; monitor impact and adoption of technologies and direct research agenda by devising a system for assessing relevant feedback from users. Its job was therefore to ensure the maximum flow of appropriate research information from the research organizations to farmers and technology transfer agents, and to inform research organization of production problems facing farmers. The activities of the research system of the study area, especially, Amhara Regional Agricultural Research Institute (ARARI) and AARC were also largely

brought to public awareness through mass media, exhibitions and workshops. The division also organized stakeholders' linkage council meetings, trainings, field days and prepared production guidelines for technology transfer workers and farmers besides conducting a series of pre-extension demonstrations, popularizations of released technologies that all together had significantly contributed in bringing together researchers, extension workers and farmers. It is not the bravado to say, it is by far due to the Research-Extension Divisions that ARARIs and AARCs importance has been brought to awareness of the public and different stakeholders including farmers. Conspicuously, the division has functioned reasonably well for more than fifteen years. However, in 2008/09 the division was totally dismissed from the research systems of the area by respective researchers of the organizations itself who performed the BPR during 2007/8 years. Even if, massive efforts were made to diagnose the cause of the ruling out of the division from the research system, most of them who performed the BPR denied the fact and blamed one another for the dismissal of the research-extension division.

4.3.4 Linkage Mechanisms of Researchers, Extension Agents, and Farmers: Their Involvement in Selected Linkage Activities of Finger Millet Technologies

In order to understand whether the stated linkage mechanisms of research and extension (section 4.2 and 4.3) were really functional to foster joint research-extension-farmers linkages in finger millet technology development and delivery; and to address the technological needs of farmers through their active participation; researchers, extension agents and farmers were requested whether they had been involved or participated at least once in the last two cropping seasons (2008/9 and 2009/10) in selected linkage mechanisms. Accordingly, the variables was measured in such a way that a researcher, a farmer, and an extension worker who had participated in a particular linkage mechanism at least once in the last 2 production years would be given a value 2, 1 otherwise. Similar procedure was followed for all linkage mechanisms. Accordingly, a continuous participation index of each respondent researchers, extension workers, and farmers was grouped and developed as a sum of status of participation on each linkage mechanisms divided by the number of linkage activities (14 in this case).

As indicated in Table 4.24 below, joint participation of researchers, extension workers, and farmers were very prominent in finger millet linkage mechanisms of field days, joint demonstration trials, and trainings, with participation indexes of 0.033, 0.026, and 0.023, respectively. Moreover, evaluation field visits (0.016), and joint priority setting, planning and programming (0.015) were also prominent. On the contrary, joint participation of the three actors were the least in linkage mechanisms of joint surveys, joint problem identification, joint technology release meetings, joint technical reporting, publications, and farmers exchange tour.

Among others, disseminations of knowledge and information is the most effective linkage mechanisms where by researchers, extension workers, and farmers were jointly participated in the last two years, given the dominant role of field days in general and trainings in particular.

Researchers, Extension Agents, and Farmers Participation in Field Days

Table 4.24 below shows, 69.2% of the extension agents claimed that they had participated field days regarding finger millet technologies with researchers and farmers at least once in the last two years, whereas over half of the researchers (61.1%), and 37% of the farmers indicated that they had attended field days at least once in the last two years. Moreover, 46.2 % of the extension agents cited that they have been involved in evaluation of field visits in different trial sites with farmers or research staff. However, only quarter of the researchers (25%) and only 15% of the farmers surveyed reported being a participant on evaluation of field visits in 2008-2009.

Table 4.24 Distributions of Researchers, Extension Workers and Farmers Participation in Finger Millet Linkage Mechanisms

Selected Linkage Mechanisms of Finger millet Technologies	NO- responses			YES-responses			Mean Score	Partici-pation index
	Researchers	Extension agents	Farmers	Researchers	Extension agents	farmers		
Joint Problem Identification	16(88.9%)	26 (100%)	97 (97%)	2 (11.1%)	0 (0%)	3(3%)	0.035	0.0025
Joint priority planning, setting, programming and review	4 (22.2%)	18 (69.2%)	90 (90%)	14 (77.8%)	8 (30.8%)	10 (10%)	0.222	0.015
Joint technology release meetings	17 (94.4%)	26 (100%)	95 (95%)	1 (5.6%)	0 (0%)	5 (5%)	0.042	0.003
Joint Adaptive Trials	13 (72.2%)	23 (88.5%)	83 (83%)	5 (27.8%)	3 (11.5%)	17 (17%)	0.174	0.012
Joint Demonstration Trials	9 (50%)	19 (73.1%)	64 (64%)	9 (50%)	7 (26.9%)	36 (36%)	0.361	0.026
Joint Surveys/Diagnostic Survey	17 (94.4%)	26 (100%)	98 (98%)	1 (5.6%)	0 (0%)	2 (2%)	0.021	0.002
Publications	16 (88.9%)	26 (100%)	99 (99%)	2 (11.1%)	0 (0%)	1 (1%)	0.021	0.002
Seminar/ Workshop	11 (61.1%)	15 (57.7%)	91 (91%)	7 (38.9%)	11 (42.3%)	9 (9%)	0.188	0.010
Technical Reports	16 (88.9%)	23 (88.5%)	99 (99%)	2 (11.1%)	3 (11.5%)	1 (1%)	0.042	0.003
Farmers Exchange Tour	16 (88.9%)	22 (84.6%)	96 (96%)	2 (11.1%)	4 (15.4%)	4 (4%)	0.069	0.005
Field Days	7 (38.9%)	8 (30.8%)	63 (63%)	11(61.1%)	18 (69.2%)	37 (37%)	0.458	0.033
Trainings	12 (75%)	22 (84.6%)	63 (63%)	6 (25%)	4 (15.4%)	37 (37%)	0.326	0.023
Evaluation Meetings	14 (77.8%)	17 (65.4%)	95 (95%)	4 (22.2%)	9 (34.6%)	5 (5%)	0.125	0.009
Evaluation Field Visits	12 (75%)	14 (53.8%)	85 (85%)	6 (25%)	12 (46.2%)	15 (15%)	0.229	0.016
Participation index				0.286	0.217	0.13		0.211

Source: Own computational result, 2010

Researchers, Extension Agents, and Farmers Participation in Trainings

37 percent of the farmers claimed to have been involved in farmers training programs with an extension or research staff at least once in 2008 and 2009 cropping seasons, whereas only quarter of the researchers (25%) had participated in such programs. However, only four (15.4%) of the extension agents surveyed reported being a participant on farmers training programs in 2008-2009.

Researchers, Extension Agents, and Farmers Participation in Joint Demonstration Trials

Joint demonstration trials were also one of the most prominent linkage activities where by researchers, extension workers and farmers were participated collaboratively regarding finger millet technologies. As indicated in Table 4.24 above, half of the researchers (50%) had attended joint demonstration trials with farmers and extension workers at least once in 2008 and 2009 cropping seasons, whereas 26.9% and 36 % of extension agents and farmers, respectively indicated that they had attended such activities.

Participation in Joint Priority Planning, Setting, Programming and Review

Planning and review functions of linkage mechanisms were also the prominent activities where by high participation index of researchers, extension workers, and farmers were recorded during the last two production years. Majorities (77.8 %) of the researchers claimed to have been involved in such activities regarding finger millet technologies, however only 30.8% and 10 % of the extension agents and farmers had participated in such planning and review mechanism, respectively.

Generally, the results of the comparative analysis (Table 4.24 above) of the mechanisms, which were used to link researchers, extension agents and farmers regarding finger millet technologies, are summarized as follows.

Researchers' participation was low in most linkage activities, specifically rare in joint technology release meetings (5.6%), joint surveys (5.6%), joint problem identification (11.1%), publications (11.1%), joint-technical report writing (11.1%), and farmers exchange tour (11.1%). On the contrary, researchers had high participation in joint priority planning and review (77.8 %), field days (61.1 %), and joint demonstration trials (50 %).

Similarly, extension workers participation was low in most linkage activities, specifically rare in, joint adaptive trials (11.5%), joint-technical report writing (11.5%), trainings (15.4%), and farmers exchange tour (15.4%). However, none of the extension agents surveyed reported being a participant in joint problem identification, joint technology release committee, joint surveys, and publications in 2008-

2009 cropping seasons. Their low or non-involvement in such activities underscores the existing gap between researchers, extension agents and farmers in finger millet technology generation and delivery. On the contrary, extension agents had high participation only in field days (69.2 %).

Regarding farmers participation, three types of linkage activities are prominent. Namely, field days (37%), trainings (37%), and joint demonstration trial (36%). The acquisition of knowledge associated with these activities and their frequent usage by research and extension could be responsible for their prominence. However, farmers were less involved in priority planning and setting (10%), joint technology release (5%), evaluation meeting (5%), farmers exchange tour (4%), workshop (9%), and joint adaptive trial (17%). Nevertheless, they were not involved almost at all in joint-report writing (1%), joint problem identification (3%), joint survey (2%), and publication (1%). It showed that farmers participation in setting both research and extension agenda has been limited.

In general, there is a difference in the participation of researchers, extension agents and farmers in finger millet linkage mechanisms. The mean participation indexes showed that researchers (0.286) are mostly participated followed by extension agents (0.217) and then farmers (0.13). The participation is thus represented as Researchers > Extension agents > Farmers (Table 4.24 above). The implications of this is that the gap for developing and delivering a basket of sustainable finger millet technological options that is, products that are technically, socio-economically and environmentally solutions to the needs and problems of farmers will continue to remain; since researchers, extension agents and farmers were not collaborate as equals, emphasising linkages through an exchange of knowledge, different contributions and a sharing of decision-making power during the innovation process.

4.4. Econometric Results of the Binary Logistic Regression Model

Descriptions of the sample respondents and test of the existence of association between the dependent and explanatory variables to identify factors affecting joint participation of researchers, extension agents and farmers in joint linkage mechanisms, have been discussed thoroughly in the previous section. Identification of these factors alone is however not enough to stimulate policy actions unless the relative influence of each factor is known for priority-based intervention. In this section, the econometric (logit) model was used to see the relative influence of the different variables on joint participation and successful research-extension-farmers linkage.

Before running the model, it was necessary to see the problem of muticollinearity or association among the variables. In this case, the VIF (Variance inflation Factor) for continuous variables and contingency coefficients' for discrete variables was applied. According to Gujarati (1995), VIF can be computed using the formula:

$$VIF\ (X_i) = \frac{1}{(1 - R_i^2)}$$

, where: Ri^2 is the multiple correlation coefficients between X_i and other explanatory variables.

For each selected continuous explanatory variable, (X_i) was regressed on all other continuous explanatory variables, the coefficient of determination (R_i^2) constructed for each case. The larger the value of R_i^2 the higher the value of VIF (Xi) causing higher collinearity in the variables (X_i). As a rule of thumb, if the VIF of continuous variables is 10 and exceeds 10 (this will happen if R_i^2 exceeds 0.95), that variable is said to be highly collinear (Gujarati, 1995). If the value of R^2 is 1, it would result in higher VIF and causes perfect multicollinearity between the variables. Similarly, the contingency coefficients, which measure the association between various discrete variables based on the Chi-square, were computed in order to check the degree of association among the discrete variables using the formula:

$$C.C = \sqrt{\frac{\chi^2}{n + \chi^2}}$$

, Where: C.C = Contingency coefficient, n = sample size, and $\chi2$=Chi square value.

As a rule of thumb, if the value of contingency coefficient is greater than 0.75, the variable is said to be collinear (Gujarati, 1995). As it has indicated in many literatures, if there is a serious multicollinearity or high degrees of association problem among independent variables, these situations can create difficulties to differentiate the separate effects of independent variables on dependent variables and seriously affect the parameter estimate because of strong relationship among them. Hence, should not be included in the model analysis.

As a result, from those independent continuous variables included in the logit analysis only age and professional experience of the extension agents and age of the farmers were dropped from logit model analysis based on practical and actual situations, researcher's observation (Appendix Table 4.16). Similarly, the data of the three actors have no serious problem of multicollinearity among the dummy variables, except farmers' access to extension service and timely availability of inputs. The C.C results are displayed in Appendix Table 4.17, 4.18, and 4.19 for farmers, researchers, and extension agents, respectively. At last, the remaining screened and verified hypothesized independent variables were included in logit model analysis.

4.4.1 Analysis of Determinants Influencing Farmers Participation in Linkage Mechanisms with Researchers and Extension Agents

The factors among hypothesized independent variables that significantly influencing the probability of farmers' participation in joint linkage mechanisms with research and extension in the study area, *Mecha*, were analyzed (Table 4.25 below). Eventually, a set of 9 explanatory variables (6 continuous and 3 discrete) were included in the model and used in the logistic analysis. To determine the best subset of explanatory variables that are good predictors of the dependent variable, the logistic regression were estimated using enter method of Maximum Likelihood. In this method, all the above mentioned variables were entered in a single step

The various goodness of fit measures validate that the model fits the data well. The value of Pearson Chi-square test shows the overall goodness of fit of the model at less than 1% probability level. Other summary statistics for the goodness of fit, which are not based directly on the distance between the observed and fitted values, are the various measures of classification accuracy. An intuitively appealing way to summarize the results of a fitted logistic model is via a classification Table.

Table 4.25 Results of Maximum Likelihood Estimates of Factors Affecting Farmers Participation in Linkage Mechanisms of Participatory Finger millet Technology Generation and Transfer

Variables	B	S.E	Wald	Df	Sign.	Exp (B)
EDUHHH-education	0.032	0.752	0.002	1	0.966	0.969
FAREXPS-farming experience	0.067	0.032	4.273	1	0.039**	1.069
DISTROD-distance to weather road	-3.288	3.071	15.307	1	0.029**	385.004
DISMARK-distance to market	-0.091	0.040	5.160	1	0.023**	1.095
FRQCONEXT–frequency of contact	0.694	0.326	4.532	1	0.033**	2.021
TLU-livestock ownership	-0.019	0.119	0.026	1	0.872	0.981
LDRFSOC-leadership position	3.125	1.231	6.448	1	0.011**	22.766
DEMONST-demonstration, as source	-0.371	0.948	0.153	1	0.696	0.690
TRWORKINFO –training & workshop	2.338	1.226	3.634	1	0.057*	10.357
Constant	-22.456	7.065	10.103	1	0.001	0.000

Notes: Exp (B) represents the ratio-change in the odds of the event of interest for a one-unit change in the predictor (Gujarati, 1995).

-2 log Likelihood Ratio	70.056
Chi-Square (X^2)	53.938
[a] Correctly predicted (count R^2)	82.6%
[b] Over all prediction of non-participants	85.5%
[c] Over all prediction of participants	78.4%

Source: Results of Binary Logit Analysis. ,*, **, represent significance at 10, and 5 % levels, respectively.

The model results show that the logistic regression model correctly predicted 82.6% of the total sample farmers: 78.4% participants and 85.5% non-participants in joint linkage mechanisms.

Among the nine explanatory variables included in the analysis, five variables were found to have a significant impact on determining farmers' participation in joint linkage mechanisms' with less than 5% probability level. These variables include farming experience of head of the household (FAREXPS), distance to all weather road (DISTROD), distance to market (DISMARK), frequency of extension contact (FRQCONEXT), and participation in leadership position in formal social organizations (LDRFSOC). Besides, attending training and workshop (TRWORKINFO) of the head of the household affects the participation at less than 10% probability level. The other three variables were not significant at less than 10% probability level.

Farming Experience: The variable, farming experience influenced linkages of farmers. Farmers who have longer years of experience in farming have more chances to participate in joint linkage mechanisms regarding finger millet technology development and delivery system with research or extension than those who have lower years of experience. As shown in Table 4.25 above, the Exp (B) of 1.069 indicate that keeping the effects of other factors constant, the changes and improvement of farmers' farming experience by one year can increase their participation on linkage activities by the factor of 1.069. This showed that the farmers with longer years of farming experience knows the benefits of linking with research and extension by realizing the advantages obtained from agricultural innovations. They may also develop a habit of participating in various field days, demonstrations trials, trainings, etc.

Distance to All Weather Road: Distance from farmers' residence to all weather road centers was assumed to influence farmer participation in linkage mechanisms negatively and significantly. The negative association suggests that the likelihood of participating or linking with extension or research declines as the distance from the roads increases. The Exp (B) of 385.004 for all weather roads implies that, other things being constant, the odds of farmers participation in linkage mechanisms decreases by a factor of 385.004 when farmers are farther to all weather roads of one hour-walk.

Distance to Market: In this study, it was hypothesized and revealed that market access has a negative relationship with farmers' linkages with either research or extension. When farmers are farther to market access by one hour-walk, there is a decrease of probability of their linkages by a factor of 1.095.

Frequency of Extension Contact: The Exp (B) of 2.021 indicate that keeping the effects of other factors constant, the odds of participation in linkage mechanisms increases by a factor of 2.021, as a unit increase in frequency of farmers contact by extension agent. The result is consistent with the idea in the hypothesis, which means those farmers who have more contact hours with their development workers, can get easy access to extension support and agricultural information arising from their frequent linkages with extension. On the contrary, extension agents (Table 4.25) less frequently contact the non-participant farmers.

Participation in Leadership Positions of Formal Social Organizations: The variable leadership position significantly affects farmers' participation in finger millet linkage mechanisms or their linkages with extension or research in the study area. The Exp (B) of 22.766 implies that, other things being constant, the odds of participation in linkage mechanism increases by a factor of 22.766, as there is a change of farmer's position from non-leadership to leadership (Table 4.25 above).

It shows that farmers who have a leadership position in the society could get a better opportunity to access resources and inputs, to contact with DAs for better information, because of their leadership position. Moreover, as stated earlier in the finding that the leaders are the only one who reaps out all the benefits that obtained from any external bodies, including, attending trainings, seminars, etc. This has a serious implications for policy makers which handle linkages as witnessed that majorities of the farmers seldom seen the role of developmental agents as real extension workers. In short, this influenced farmers to seek advice or production inputs from the agents, thereby affecting the overall system performance in general and effective linkages with research and extension in particular.

Training and Workshop as Farmers Sources of Information: Farmers that obtain various agricultural information's from training and seminar forums are more likely to participate in linkages activities as hypothesized. As farmers' frequency of obtaining information by trainings and seminars increases by one unit, the odds of participation in linkage mechanisms increase by a factor of 10.357.

4.4.2 Analysis of Determinants Influencing Extension Agents Participation in Linkage Mechanisms with Researchers and Farmers

The results in Table 4.26 below show that the logistic regression model correctly predicted 92.3% of the total sample extension agents: 87.5% non-participants and 94.4% participants in joint finger millet linkage mechanisms.

In the model, one potential continuous and 14 discrete variables were entered. Out of the fifteen explanatory variables, only 5 variables of which 1 continuous and 4 dummies were found to have a significant impact on determining extension agents participation in linkage mechanisms of participatory finger millet technology development and delivery with researchers and farmers. Variables found to be significant at 5% levels are; extension agents overburden in various activities (WORKOVREXT), and physical resource constraints of extension organizations (PHYSPROB). Besides, educational level of the agents (EDLEOEXT), structural problems on linkages (STRCPROB), and motivational and incentive problems (INCENTPRO), was found to be significant at 10% probability level.

Although the remaining 10 variables were found to be insignificant in the model, it was revealed from various secondary sources, KIIS, FGDs and the test statistic that they are among the major factors influencing the performance of linkages between researchers, extension agents, and farmers in the technology system of the study area. With the above brief background, the effect of the significant predictor variables on the performance of linkage system was discussed below.

Table 4.26 Results of Maximum Likelihood Estimates of Factors Affecting Extension Agents Participation in Linkage Mechanisms of Participatory Finger millet Technology Generation and Transfer

Variables	B	S.E	Wald	df	Sign.	Exp (B)
EDLEOEXT-educational level	0.200	0.788	0.064	1	0.098*	1.221
POENVPR-policy environment problems	-0.657	0.777	0.714	1	0.398	1.928
STRCPROB-structural problems	-0.156	0.536	0.094	1	0.072*	0.856
WORKOVREXT-extensionists diverse tasks	-2.217	0.756	8.610	1	0.003**	9.181
LMTPRTST-limited actors involvement	0.942	0.901	1.092	1	0.296	2.565
DVFRMSYS-diversity of the farming system	-1.490	0.910	2.683	1	0.131	4.436
DONDEP-donor dependency	-0.688	0.945	0.531	1	0.466	0.502
HUMNPRO-scarcity of human resources	-0.361	0.301	1.435	1	0.231	1.435
PHYSPROB-scarcity of physical resources	-1.636	0.819	0.3.993	1	0.046**	2467.236
FINPRO-scarcity of financial resources	-0.110	1.228	0.008	1	0.928	1.117
INCENTPRO-poor incentive/rewards	-0.475	0.113	17.690	1	0.069*	1.108
STATSPRO-status difference	-7.811	23.647	0.109	1	0.741	0.195
MANGPRO-managerial problems	-0.024	0.135	0.030	1	0.862	1.024
PLTIMGTPRO-planning and timing problems	0.023	0.021	1.194	1	0.274	0.977
LACKLNKPO-lack of linkage policies	-0.103	0.278	0.137	1	0.712	1.608
Constant	-4.053	1.744	5.399	1	0.020	0.017

Notes: Exp (B) represents the ratio-change in the odds of the event of interest for a one-unit change in the predictor (Gujarati, 1995).

-2 log likelihood	21.555
Model chi-square (X^2)	34.505 ***
Over all, model prediction of total sample extension agents	92.3%
Over all prediction of participants	94.4%
Over all prediction of non-participants	87.5%

*, **, *** represent significance at 10, 5 and 1 % levels, respectively.

Source: Results of Binary Logit Analysis

Educational Level of Extension Agents: As indicated above, the probability of being a participant in linkage mechanisms increases by a factor of 1.221 as the educational levels of the extension agents increases by one unit or status (e.g. change from B.Sc. to M.Sc. degrees). It indicates that long years of formal schooling enhanced extension agent ability to perceive process, interpret and respond to new events, which ultimately increase their participation in joint linkage mechanisms that dealt with various issues that require analytical skills about finger millet technology generation and delivery.

Structural Problems on Linkages: Availability of conducive structural arrangement with responsible linkage mechanisms that fosters research-extension-farmers linkages is a prerequisite for sound technology development and delivery. However, linkage problems were traced to structural conditions at 10% significant, and negatively influenced participation. This result agreed with (e.g FAO, 1997; Eponou, 1993; Kaimowitz *et al.*, 1989), which showed the responsibility of managing linkage activities, conducting adaptive research, communication of research results, or, feedback from users to researchers is not generally assigned to individuals, or institute that manages in accountable manner. The negative relationship implies, other things being constant, the probability of extension agents being a participant in linkage mechanisms decreases by a factor of 0.856, or 85.6% as an increase in structural problems. To express it conversely, the extension agents' participation in linkage mechanisms increases by 85.6% as the prevailing structural problems of linkages solved by one unit.

Extension Agents Overburden in Various Activities: Devotion of transfer agents on real agricultural activities is a prerequisite for sound technology development and delivery in general and effective research-extension-farmers linkages in particular. However, linkage problems were affected by high work overload of extension workers at 5% significant, and negatively influenced participation. The negative relationship indicates that, other things being constant, the probability of being a participant in linkage mechanisms decreases by a factor of 9.181 as a unit increase in work overburden of extension workers. Thus, high involvement of transfer agents specifically on non-agricultural activities has negative implications on the overall performance of the technology system.

Physical Resource Constraints of Extension Organizations: Resources issues for linkages including financial, physical, and human resources are a prerequisite for the level of integration between research, extension, and farmers for sound generation and transfer of technologies. However, extension agents' linkage problems were affected by scarcity of physical resources at 5% significant level, and negatively influenced participation. The negative relationship indicates that the probability of extension agents' participation in linkage mechanisms decreases by a factor of 2467.236 as a unit increase in scarcity of physical resources like (transportation facilities, trucks, and vehicles). The result supports earlier linkage studies (e.g FAO, 1997; ISNAR, 1993; Eponou, 1993; Kaimowitz *et al.*, 1989).

Motivational and Incentive Problems: As expected, the reward and incentive system currently in use in the extension organizations are negatively influencing extension agents' participation in linkage mechanisms in general and their individual motivations to enhance effective linkages with either research or farmers in particular at 10% significance level. The model result revealed that other things kept constant, the probability of extension agents' linkages with either farmers or researchers decreases by a factor of 1.108 as a unit increase in shortage of the current incentive mechanisms like (salaries, promotions, trainings) The finding agree with previous research results (e.g. McDermott, 1987; ISNAR,1993) which indicated that individuals might have little incentive (due to low salaries and rewards) to perform linkage activities, made obvious where researchers and extension agents avoid linkage activities such as adaptive field trials and preparation of written materials.

4.4.3. Analysis of Determinants Influencing Researchers Participation in Linkage Mechanisms with Extension Agents and Farmers

A set of 19 explanatory variables (2 continuous and 17 discrete) were included in the model and used in the logistic analysis (Table 4.27 below). Among the nineteen, 4 variables (1continoues and 3 dummies) were found to have a significant impact on determining researchers' participation in joint linkage mechanisms' with less than 5% and 10% probability level. The variables significant at 5% probability level are financial constraints of the research organizations (FINPRO) and extension agents work involvement in diverse tasks (WORKOVREXT). Besides, professional work experience of researchers (WORKEXP), and use of stakeholders meeting as sources of research agenda setting (STKMETNG) are significant at 10% probability level. Although, the other 15 variables were insignificant at less than 10% probability level, discussions with key informants and relevant official reports of research depicted that these variables have been influencing the performance of research organizations in general and research-extension-farmers linkage system in particular.

Table 4.27 Results of Maximum Likelihood Estimates of Factors Affecting Researchers Participation in Linkage Mechanisms of Participatory Finger millet Technology Generation and Transfer

Variables	(B)	(S.E)	Wald	Sig. Level	Exp (B)
AGE-age of the researchers	1.224	0.734	2.776	0.106	3.399
WORKEXP-work experience	0.048	0.028	2.938	0.087*	1.050
LACKLNKPO- lack of linkage policies	-0.201	0.152	1.736	0.188	1.222
DVFRMSYS-diversity of the farming system	-0.427	0.222	3.706	0.104	1.532
INCENTPRO-poor incentive/rewards	-0.577	0.243	5.639	0.108	0.561
STRCPROB-structural problems	-0.759	1.390	0.298	0.585	2.135
HUMNPRO- scarcity of human resources	-0.149	0.063	5.581	0.118	1.160
FINPRO-scarcity of financial resources	-2.130	0.676	9.938	0.002**	8.419
POENVR-policy environment problems	-0.799	0.598	1.788	0.181	0.450
STKMETNG-stakeholders meeting	1.813	0.673	7.247	0.007*	6.129
DONDEP-donor dependency	-0.002	0.001	9.908	0.102	0.998
PHYSPROB-scarcity of physical resources	-0.233	0.091	6.476	0.111	0.793
STATSPRO-status difference	-0.088	0.0682	0.017	0.898	1.092
MANGPRO-managerial problems	-0.023	0.029	0.657	0.418	0.977
PLTIMGTPR-planning and timing problems	-0.297	0.731	0.165	0.685	0.743
WORKOVREXT-extensionists diverse tasks	-1.758	0.708	6.170	0.013**	0.172
LMTPRTST-limited actors involvement	-0.005	0.111	0.002	0.966	1.005
PRBOARD-problems identified by BoARD	1.072	1.121	0.915	0.339	2.921
PERSOBS-personal observation	0.181	0.934	0.037	0.847	0.835
Constant	3.637	2.398	2.299	0.129	0.095

Notes: **Notes**: Exp (B) represents the ratio-change in the odds of the event of interest for a one-unit change in the predictor (Gujarati, 1995).

-2 log likelihood	9.561
Model chi-square (X^2)	15.170***
Over all, model prediction	88.9%
Over all prediction of participants	90.0%
Over all prediction of non participants	87.5%

*, **, *** represent significance at 10, 5 and 1% levels, respectively.

Source: Results of Binary Logit Analysis

The results show that the logistic regression model correctly predicted 88.9% of the total sample researchers: 87.5% non-participants and 90.0% participants in linkage mechanisms.

With the above brief background, the effect of the significant explanatory variables on the performance of linkage system is discussed below.

Professional Work Experience of Researchers: As expected, the model results show that professional work experience of researchers positively influencing the probability of researchers' involvement in research-extension-farmers linkages activities at 10% s probability level. It indicates that long years of experience would have offered varied experiences, knowledge, which would be necessary for researchers to generate sound technologies that meet the needs and constraints of farmers. Moreover, it would enable them to easily identify farmers' problem, understand and find solutions to them by adapting, adjusting and align situation as they occur on the field. Thus, they have better competence in assessing the characteristics and potential benefits of technologies together with extension agents and farmers in various linkage activities than the less experienced researchers, e.g., joint planning and review, feedback mechanisms, etc. Table 4.27 above indicated that, other things being normal, the probability of researchers' linkages or participation with farmers and extension agents increases by a factor of 1.050, as a one-year increase in work experience.

Financial Constraints of the Research Organizations: Availability of adequate financial resources is among the prerequisite for achieving any organizational goals in general and for good level of integration between research, extension, and farmers for generation and transfer of technologies in particular. However, scarcity of financial resources negatively influenced researchers' organizational goals and linkage problems at 5% significant level. The negative relationship indicates that the probability of researchers' participation in linkage mechanisms decreases by a factor of 8.419 as a unit increase in scarcity of financial resources. Conversely, the researchers' linkage with either farmers or extension agents increases by a factor of 8.419 as the prevailing scarcity of financial resources solved by one unit. The finding agrees with FAO (1997), ISNAR (1987), and Kaimowitz *et al.* (1989), claimed that sufficient financial resources for linkage functions such as publications, testing of research results and training of extension workers are often lacking, while there may be sufficient human resources in the organization but they may not be available for linkage activities. Adequate resources are lacking to achieve the stated goals. In a resource-limited situation, linkage activities suffer most.

Use of Stakeholders Meeting As Sources of Research Agenda Setting: Researchers sources of research agenda setting based on the consent of stakeholders including, extension agents and farmers is a prerequisite for sound technology development and delivery. As expected, the model results show that researchers' sources of agenda setting based on stakeholders meeting positively influencing the probability of researchers' involvement in linkage activities at 10% significance level. It indicates that use of stakeholders meeting enhances feedback from farmers and extension agents to researchers on the various production problems that needs research solutions; thereby facilitating baskets of sound technology generation and transfer that satisfies the felt needs of farmers. The Exp (B) of 6.129 shows that the probability of researchers being a participant in linkage mechanisms increases by a factor of 6.129, as a unitary increase of the use of stakeholders meeting as a research agenda setting.

Extension Agents Work Involvement in Diverse Tasks: As expected, the model results show that high work overload of extension workers in various activities negatively influencing the probability of researchers' linkages with extension and farmers at 0.05 levels. It showed in Table 4.27 that the probability of researchers being a participant in joint linkage mechanisms decreases by a factor of 0.172, or 17.2% as a unit increase in work overburden of extension workers. Explaining the concept conversely, researchers' linkages with farmers and extension agents improve by 17.2% as the prevailing diverse tasks of extension workers solved by one unit. This has serious implications for policy makers, which handle linkages as witnessed that the three actors namely researchers, farmers, and even extension agents themselves were unanimous in citing the role played by the extension agents in non-professional activities. Hence, it is possible to conclude that the overall technology system performance was seriously handicapped by extension agents work involvement in diverse tasks including non-agricultural, as it widens the communication gap for technology generation, transfer, and further adjustments of agricultural technologies.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This study attempts to assess the institutional linkage mechanisms and partcipation of researchers, extension agents and farmers in linkage activities of finger millet technology development and delivery in Mech Wereda, North West Ethiopia. Moreover, attempts were also made to identify and to quantify the potentail factors that influence successful research-extension-farmers linkage.

First, the study was initiated purposively in one of the largest area and volume of finger millet growing district of ANRS, Mecha district, West Gojam Zone. Samples were randomly and purposively drawn from the study area that have farmers (100), researchers (18) and extension agents (26).

As mentioned by sample respondents, the reasons for the deviation of linkages were found to be demographic characteristics, socio-economic, institutional, psychological, organizational, system-contextual, structural, resource related, and managerial factors.

According to the results of descriptive statistics of household demographic characteristics, age, farming experience, and education level of the household head were significantly related to participation in finger millet linkage mechanisms with research and extension, indicating that relatively being older, having longer years of farming experience, and better educated is positively correlated with linkages with extension and research. With regard to the household's socio-economic variables, partcipants had more livestock holding in terms of TLU and more number of oxen holding than the non- partcipants. This implies that linkage partcipant groups are relatively wealthier than non-partcipant groups.

Concerning institutional variables, access to extension service and input supply,frequency of contact with extension agent, participation in extension events (demonstration fields, trainings and seminars), and leaderships of formal social organization were found to have a significant and positive relationship with farmers participation in finger millet linkages activities. This shows that partcipant farmers had relatively better access to such variables. Moreover, it was mirrored that partcipant groups live nearer (relatively in shorter distance) to all weather road and market center than the non- partcipant groups.

Similarily, the descripitive statistics with regared to the personal characteristics of extension agents revealed that the linkage partcipant groups were relatively older, having longer years of work experience, and have better educational status than non-participant groups. Concerning resource factors, various aspects of human, physical, and financial resource constraints, motivational and incentive problems, and status difference between researchers and extension agents' negatively and significantly influenced the participation of extension agents in linkage activities.

Concerning technological system-contextual variables, problems of policy environment, donor dependency of linkages, and high work overload and involvement of extension agents in non-agricultural activities negatively and significantly influenced the participation of extension agents in linkage activities. Regarding, structural factors, lack of a transparent, responsible, and accountable linkage mechanisms based on the consent of stakeholders negatively and significantly influenced the linkages of extension agents with researchers and farmers.

Similarily, the descripitive statistics with regared to the personal characteristics of researchers revealed that the linkage partcipants were relatively older and having longer years of work experience than non-participants. Hence, it positively correlated with participation in joint research-extension-farmers finger millet linkage activities. Concerning resource related variables; scarcity of financial resources negatively and significantly influenced the performance of the research organizations in general and the participation of researchers in linkage activities in particular. Moreover, motivational and incentive problems, accompanied by lack of mutual respect or status difference between researchers and extension agents weakness the research-extension-farmers linkage system. Likewise, the organizational related factors, namely researchers' sources of research agenda setting based on stakeholders meeting, problems identified by BoARD, and personal observations positively correlated with researchers' participation in research-extension-farmers linkage activities.

Concerning technological system-contextual variables, the diversity of the structure of farming system, donor dependency of linkages, and high work overload and involvement of extension agents in non-agricultural activities negatively and significantly influenced the participation of researchers in finger millet joint linkage activities with extension agents and farmers. Regarding, structural related factors, lack of a transparent, responsible, and accountable linkage mechanisms based on the consent of all stakeholders, and limited participation of relevant stakeholders like NGOs, input multiplying agencies negatively and significantly influenced research-extension-farmers linkage in general and the participation of researchers in joint linkage activities in particular.

The logistic regression model was estimated using maximum likelihood estimation procedure to identify factors influencing linkages of researchers, extension agents, and farmers for participatory finger millet technology development and delivery. Accordingily, the model has correctly predicted the partcipants and non-partcipants by 82.6%, 92.3%, and 88.9% of the overall observations of farmers, extension agents, and researchers, respectivily. Correctly predicted partcipants and correctly predicted non-partcipants value of the logit model were 78.4% and 85.5%, of farmers, 94.4% and 87.5%, of extension agents, and 90.0% and 87.5%, of researchers respectively.

Furthermore, among the nine explanatory variables included in the model, six variables were found to have a significant impact on determining farmers' participation in joint linkage mechanisms' regarding participatory finger millet technology generation and delivery with less than 10% probability level. These variables include farming experience of head of the household, distance to all weather roads, distance to market, frequency of extension contact, leadership position in formal social organizations, and attending training and workshops.

Similarily, among the 15 explanatory variables included in the model, 5 variables were found to have a significant impact on determining extension agents participation in linkage mechanisms' regarding participatory finger millet technology generation and delivery with researchers and farmers with less than 10% probability level. These are, extension agents overburden in various activities, physical resource constraints, educational level of the agents, structural problems of linkages, and motivational and incentive problems.

Regarding researchers, among the 19 explanatory variables included in the the model, 4 were found to have a significant impact on determining researchers' participation in joint linkage mechanisms' regarding participatory finger millet technology generation and delivery with less than 10% probability level. These variables are financial constraints; extension agents work involvement in diverse tasks, work experience of researchers, and use of stakeholders meeting as sources of research agenda setting.

In this study, the effects of various factors that influenced the performance of research-extension-farmers linkage in general and partcipatory finger millet technology development and delivery mechanisms in partcular were examined. To this end , based on the above descripitive statistics and economertic results the following conclusion and policy implications are forwarded.

5.2. Conclusions

The linkage between research, extension, and farmers are extremely important areas, which are currently underemphasized by the actors of the technology systems of the study area. How well researchers, transfer agents, and farmers communicate and cooperate has a strong influence on whether agricultural science succeeds or fails as a catalyst of national development and as a tool for eliminating poverty. The study revealed research-extension-farmers linkages in relation to efforts to increase finger millet technology development and delivery. From the results of the study the following inferences could be drawn:

Farmers' awareness of improved finger millet technologies and researchers' awareness of best farmers' finger millet varities were low. Thus, further work is required to create awarness and improve thier perceptions through joint partcipation in linkage actvities for sound generation, transfer, and adoptions of new technologies.

Moreover, distance to all weather road and market centers are negatively and significantly releated to farmers linkages with extension and research. Therefore, the consruction of all weather roads and improving the existing market centers in the locality should be given proper attention.

The influence and participation of farmers, researchers, and extension agents in the generation and transfer of finger millet technologies have been minimal. Their participation in setting both research and extension agenda; in execution of collaborative activities such as joint adaptive trials, and surveys, has been limited. Moreover, their mechanisms of evaluation, exchange of resources, and coordinating the overall activities and systems performance were found to be weak. The infrequent contacts among researchers, extension agents and farmers do not provide adequate opportunity for feedback of information from farmers to researchers there by hindering the flow of generated finger millet technology (one variety) in one hand, and the rejection of two improved finger millet varieties by farmers, on the other hand. Thus, suggest the need to modify the current top-down research approach that exists in North West Ethiopia to encourage more active participation by farmers and extension agents in the process of developing sound finger millet technologies in line with the needs of farmers.

Despite, researchers, extension agents, and farmers were more involved in mechanisms of disseminating knowledge and information through field days and demonstration of technologies, which are their prime linkage activities while researchers did not frequently produce written materials, and training of extension workers.

Moreover, it was found that various aspects of human, financial, and physical resource constraints accompanied by diverse farming system, and poor reward and incentive mechanisms influenced the level of linkage between research, extension, and farmers there by affected the overall technology system performance. Likewise, high dependency of linkages in donor sources lead to fluctuations in the performance of linkage between the major stakeholders of the technology system of the study area.

A responsible institute or body, which manages linkages in a system perspective with a transparent and accountable linkage policies based on the consent of stakeholders, is a missing link in the study area. Besides, policy makers, relevant stakeholders, and managers at all levels of the system lack equal awareness that research and extension organizations are two components of one mission, making relevant technologies available to farmers. In addition, extension agents' involvement in diverse tasks including non-agricultural activities and dependency of extension methods on targeting influential, progressive farmers', and leaders influenced effective research–extension- farmers' linkages.

It is unambiguous that neither research nor extension can fulfill its responsibilities without the other: hence good communication, strong interaction and effective collaboration are primary requisites. However, there are differences between researchers and extension workers, which very often have prevented collaboration and linkage between them. Researchers are considered professionals, and consequently enjoy higher status and benefits. In contrast, extension staffs are in contact with low-status farmers. The perceived differences in status have led or severely handicapped cooperation between the groups, there by affected mutual respect and recognitions of the partners' competence, and domain consensus.

To put it in nutshell, all the issues discussed above arise simply because of weaknesses in the links between research and extension. Hence, technology development and transfer functions are treated in isolation. The implications of this is that the gap for developing and delivering a basket of sustainable technological options that is, products that are technically, socio-economically and environmentally solutions to the needs and problems of farmers will continue to remain.

5.3 Recommendations and Policy Implications

As has been stated in several sections of this study, there are demographic, socio-economic, psychological, organizational, institutional, system-contextual, structural, managerial, and resource factors that influenced effective research-extension-farmers linkage for sound technology generation and transfer. The role of each factors needs to be taken in to account to provide useful recommendations on how existing problems in the technology systems of the study area can be addressed. Hence, the researcher would like to forward the following recommendation points based on the synthesis of the results, and suggestions by the respondents on the ground including key informants and focus group participants.

5.3.1 Issues at the Policy Making Levels

There should be a Responsible and Accountable Body, Which Manages Linkages with a System Perspective

One of the basic causes of poor linkage between research, extension, and farmers in the study area is the absence of systems perceptivities. Research and extension are not always perceived as two components sharing a common goal, that of making relevant technologies available to farmers. It should be noted that policy makers, managers, and research and extension personnel should recognize that research and extension are part of a single system and that the technology system is important for a country's overall agricultural development strategy. Therefore, the broad strategies, policies to ensure linkages between all stakeholders in general and research and extension in particular must be defined and managed at the policy-making level. This should result in the following:

-leadership by policy makers in coordinating the whole technology system. Policy makers must provide mechanisms to ensure accountability as well as to ease tensions and conflicts. Integration is made easier if policy makers perceive and treat research and extension as two components of a single system. Policy makers must know that linkages cannot be administratively imposed; they should be established by consensus among the participants through managerial action. Moreover, creating an enabling environment by exploiting the complementarities of research, extension, and other stakeholders of the system is also needed.

-Provisions of resources to research and extension organizations in line with the mandate and mission. Strong research-extension-farmers linkage should be enhanced through provisions of quality and quantity of human, physical, and financial resources. Likewise, continuous human resource development targeted both research and extension staffs are needed to cope up with the complex and dynamic system of the agricultural context. Therefore, linkages must be explicitly budgeted for, and resources must be made available, in a balanced fashion.

-Criteria for rewarding personnel in accordance with the mandate and mission assigned to the technology system. For example, scientific publications cannot be the basic criterion for promotion if technology generation and transfer is the foremost mission of the technology system. The case to illustrate this is that out of the three finger millet technologies that were generated by research two were totally rejected by farmers while the one was weakly promoted and had remained on the research shelf. Therefore, efforts that place more emphasis on the practical value of research related to farmers' real concerns and needs rather than one that emphasizes mere research publications is needed.

-Policy decisions, with regard to the professional status of extension agents, incentives for staffs, as well as the attitude and behavior of individual staff members, adherence to systems principles are needed and should be a prerequisite to successful research-extension-farmers linkage. It was found in this study that the involvement of extension agents in non-professional activities and the perceived differences in status between research and extension have severely handicapped cooperation. Similarly, farmers seldom have seen extension agents' as real transfer agents. Thus, extension should improve its position by becoming more professional, taking a general role in information integration, making recommendations, and participating in linkage mechanisms and real agricultural activities, even to avoid unacceptability enhancing factors as noted by the farmers. Researchers could respond by building closer links with extension agents. Over time, there might be a change in the attitude of both researchers and extension staff. Therefore, technology generation and transfer should become central to both groups, and their operations are becoming increasingly more dependent on each other. In fact, problems resulting from differences in status cannot be totally overcome because they are normally part and parcel of the institutional structure and personal attributes. They could be minimized, however by changing the reward and incentive systems. To this end mutual respect, recognitions of the partners' competence, and domain consensus should be prerequisites for using linkage mechanisms to integrate research and extension. Hence, the need to improve the working conditions and rewarding system of researchers and extension agents in order to elicit higher job performance should be strengthened.

-Major linkage mechanisms should be independent of donor-funded projects. Although donor projects in the study area had played a positive role in improving linkages, they were also having negative effective once they ceases to function. Thus, performance droops sharply and lacks accountability and sustainability of thus initiated activities. Hence, if relevant technologies are to reach poor farmers, donors should make greater commitments to increasing knowledge of their diverse production systems and creating a greater technology span of them on one hand. Likewise, donor projects should be designed with a prior assessment of the national technology system's capacity to ensure post-project continuity. On the other hand, it is better the technology systems of the study area to use their own managerial, financial, physical, and human resources to establish and operate the kind of linkages needed to induce beneficial change in production and productivity, although it is a challenging task.

5.3.2 Issues at Managerial Levels

Linkage activities of farmers demand the need for generating more awareness among farmers with respect to finger millet technologies linkage mechanisms other than field days and demonstration trials. It should be noted that involving farmers in setting both research and extension agendas would strengthen links. Resources for organizing e.g planning and review forums, collaborative activities, field days, trainings and joint demonstration trials should be provided to enhance farmers' voices. Moreover, research organizations may have to establish policies that require its researchers to assume limited extension duties, and to cultivate a work ethos that places more emphasis on the practical value of research related to farmers' real concerns and needs rather than one that emphasizes mere research publications. Therefore, appropriate linkage mechanisms and management, participation of relevant stakeholders, and treating linkages as an integral part in the technology process should be emphasized and managed at the managerial level to ensure linkages between all stakeholders for participatory technology development and transfer in general and finger millet technology in particular. This should result in the following:

There Should Be Appropriate Linkage Mechanisms and Management

The linkage mechanisms followed by the technology system of the study area are not effective in fostering successful research-extension-farmers linkage and similarly are not better adapted to the diverse and complex farming systems. To express, the linear model, which regards finger millet technology generation, transfer, and adoption as sequential and stresses a clear division of labor between research and extension services is used. The interface between research and extension is reduced to field days and demonstration trials. Therefore:

-Both research and extension managers must identify the systems linkage needs and choose appropriate mechanisms. They should be aware that some mechanisms would work better than others, depending on the functions to be performed and the specific conditions such as, the resource base, system climate, and managerial capacity. That is, there is no one recipe for solving linkage problems. Hence, linkage needs must be assessed and go through several steps. That is, potential gaps need to be identified, alternative solutions need to be evaluated and designed, and selecting and implementing the best appropriate mechanisms and constant evaluation is needed. To this end,

-Both research and extension must participate in planning and review of their work agendas together with farmers; executions of collaborative tasks; exchange of resources including exchange of personnel to improve the balance of skills required to deal with specific linkage situations. Moreover, they should enhance a two-way flow of knowledge and information, and joint evaluation and feedback of agricultural innovations. Thus, these comprehensive cooperative links should be strengthened between researchers and extension agents as it would encourage the harmonization of research and extension programmes and for effective links with farmers.

-Moreover, both research and extension should enhance or create special units, such as research-extension liaison positions, which specifically in charge of linkages, to ensure appropriate level of integration and effective operation of the technology systems.

All Relevant Actors of the Agricultural Knowledge and Information System Should Participate In Linkage Activities

-In this study, it was also found that the participation of relevant stakeholders, e.g., NGOs and input supplying agencies in linkage activities is a bare minimum. Therefore, for effective research and transfer functions, all relevant actors should participate in linkage activities. Because in one hand the linkage mechanisms can be effective only if they are agreed upon by collaborates whom, in addition, have the capacity and the resources to fulfill their linkage responsibilities. Moreover, it was witnessed in the finding that representatives chosen from farmers are often not suitable because they are selected purely on an administrative basis, rather than by using the criteria of effectiveness. Very often, the farmers' representatives tend to be the richer farmers or political leaders of formal social organizations in the respective *kebeles*. Thus, efforts should be made to address the majority of resource poor farmers.

-All the actors in the system, from policy makers to grassroots-level agents, need to be made aware that linkages are important and that their participation in linkage activities is crucial to the effectiveness of the system. To this end, awareness creation and sensitization measures should be taken. As for instance, through seminars and workshops, provide effective information on the importance of linkages. Furthermore, including linkage activities as explicit components of the job descriptions of researchers and transfer agents; ensuring that incentives, rewards, and promotions explicitly take into account the performance of linkage tasks; training both researchers and extension agents in linkage work, both on the job- training and short-term training sessions should be emphasized.

Linkage should be treated as an Integral Part of the Technology Generation and Transfer Process

It revealed from the finding that linkages are considered supplementary to the normal research workload by some researchers who think that it is up to the extension agent to come to research, get the technology, transfer it to farmers, and provide any feedback they may have. Similarly, some extension agents do not perceive linkages as their responsibilities. Due to the divergent ideas and conflicts, information on farmers perspectives tend to be collected in uncoordinated way by various components of both research and extension, and that information was not always reflected in research activities. This is simply because the technology system of the study area lacks transparent and accountable linkage mechanisms that monitors and evaluates the action of research and extension. In some cases the most motivating element in being involved in linkages (e.g in planning forums, participation in trainings, and field days), for both researchers and extension agents, is the extra income it provides.

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APPENDIXES

Appendix Table 2.1 Area and Volume of Production of the Three Major Finger Millet Production Zones in the Amhara Region in 2004/05

Crop type	West Gojam		South Gondar		Awi	
	Area (million ha)	Production (million tons)	Area (million ha)	Production (million tons)	Area (million ha)	Production (million tons)
Cereals	0.50	0.57	0.33	0.25	0.16	0.16
Finger millet	0.06	0.05	0.02	0.02	0.05	0.04

Source: The Amhara National Regional State Bureau of Finance and Economic Development 2004/05 Budget Year Annual Statistical Bulletin.

Appendix Table 3.1 Percentage Land Cover/Land Use Pattern in West Gojam Zone

Land use type	Afro alpine	Cultivated land	Grass land	Natural forest	Plantation forest	Wood land	Shrub land	Wet land	Others
West Gojam	0.0	11.3	8.2	3.4	16.5	8.5	2.6	33.2	2.1

Source: The Amhara National Regional State Bureau of Finance and Economic Development 2004/05 Budget Year Annual Statistical Bulletin.

Appendix Table 4.1. Conversion Factors Used To Estimate Tropical Livestock Unit

Animal category	TLU	Animal category	TLU
Calf	0.25	Donkey (young)	0.35
Weaned Calf	0.34	Camel	1.25
Heifer	0.75	Sheep & Goats (adult)	0.13
Cow and Ox	1.00	Sheep & Goats (young)	0.06
Horse	1.10	Chicken	0.013
Donkey (adult)	0.70		

Source: Storck, *et al.*, (1991)

Appendix Table 4.2 Relationship between Technologies Adopted By Household Head and Participation in Linkage Mechanisms

Types of Technologie	Participants		Non-Participants			Total Sample	
	Mean	Std.Dev	Mean	Std.Dev	t-value	Non adopte	Adopted
Crop(cereals) technol	0.41	1.37	0.49	1.81	1.20*	27	73
Modern beehives	1.83	0.38	1.61	0.49	-2.6**	74	26
Livestock breeds	1.75	0.44	1.29	0.48	-4.39**	66	44
Improved fruits &vegetable	1.69	0.46	1.34	0.48	-3.69***	55	45
water harvesting technologies	1.75	0.44	1.51	0.51	-2.45**	65	35
animal fattening technologies	1.69	0.46	1.32	0.47	-3.48***	54	46

Source: own survey result, 2010; * Significant at 10%, ** Significant at 5%, *** Significant at 1%

Appendix Table 4.3 Researchers and Extension Agents Perceptions of the Factors Limiting Farmers Adoption of Finger Millet Technologies

Researchers and extension workers perceptions of the causes limiting farmers adoption of finger millet techno	Researchers Yes-responses			Extension staffs Yes-responses			X2 Value	Sig.
	N	%	Total N	N	%	Total N		
Lack of completeness of technology package	9	50.0%	18	9	34.6%	26	0.234	0.629
Poor research- extension linkage and weak extension serv	10	55.6%	18	11	42.3%	26	0.748	0.387
Lack of consistent demonstration & popularization	12	66.7%	18	18	69.2%	26	2.922*	0.087
Having a good quality local landraces	6	33.4%	18	6	23.1%	26	0.076	0.783
Lack of awareness	12	66.7%	18	23	88.5%	26	0.468	0.494
Absence of sound seed production & delivery system	13	72.2%	18	7	26.9%	26	1.298	0.255
Little attention is given to finger millet as compared to other	-	-	-	3	11.5%	26	1.432	0.231
High labor requirement of the crop	-	-	-	5	19.2%	26	1.432	0.231

Appendix Table 4.4 Relationships of Linkage Participant and Non-Participant Researchers on Their Sources of Research Agenda

Researchers Sources of Idea	Non- Participants		Participants				
	N	N	N	N	N	X2	Sig.
	Yes	No	Yes	No			
Research community itself, including fellow research staff members	3(16.7%)	4(22.2%)	4(22.2%)	7(38.9%)	18	0.076	0.783
Research objectives determined by the research institute thematic area	6(33.3%)	1(5.6%)	7(38.9%)	4(22.2%)	18	1.039	0.308
Farmers as a source of ideas	1(5.6%)	6(33.3%)	4(22.2%)	7(38.9%)	18	1.039	0.308
Stakeholders meeting/REFAC	1(5.6%)	6(33.3%)	6(33.3%)	5(27.8%)	18	2.918	0.088*
Based on problems identified by regional BoARD	4(22.2%)	3(16.7%)	10(55.6%)	1(5.6%)	18	2.822	0.093*
Based on personal observation	3(16.6%)	4(22.2%)	1(5.6%)	10(90.9%)	18	2.822	0.093*

Appendix Table 4.5 Relationships of Linkage Participant and Non-Participant Extensionists & Their Sources of Extension Agenda

Extension Workers Sources of Ideas	Non- Participants		Participants				
	N	N	N	N	Tot:	χ2value	Sig.
	Yes	No	Yes	No			
Extension community itself, including fellow extension staff members	2(7.7%)	6(23.1%)	3(11.5%)	15(57.7%)	26	0.248(NS)	0.619
Extension objectives determined by the Extension organization thematic area	6(23.1%)	2(7.7%)	9(34.6%)	9(34.6%)	26	1.418(NS)	0.234
Farmers as a source of ideas	4(15.4%)	4(15.4%)	4(15.4%)	14(53.8%)	26	2.006(NS)	0.157
Stakeholders meeting/REFAC	1(3.8%)	7(26.2%)	8(30.8%)	10(38.5%)	26	2.497(NS)	0.114
Based on problems identified by regional BoARD	5(19.2%)	3(11.5%)	11(42.3%)	7(26.2%)	26	0.005(NS)	0.946
Based on personal observation	1(3.8%)	7(26.2%)	0(%)	18(69.2%)	26	2.340(NS)	0.126
Based on top-down planning procedure	1(3.8%)	7(26.2%)	6(23.1%)	12(46.2%)	26	1.222(NS)	0.269

Source: Own computational result, 2010. Correlation is Non-significant at 10% levels

Appendix Table 4.6 Relationships of Joint Linkage Participant and Non-Participant Households on Their Sources of Obtaining Agricultural Information

Farmers Sources of Agricultural Informatioı	Non- Participants		Participants				
	N	N	N	N	Total	X^2 valuɛ	Sig.
	Yes	No	Yes	No			
Neighbors	47	16	30	7	100	0.552	0.457
Parents/children/relatives	43	20	21	16	100	1.337	0.248
Farmers own experience	34	29	22	15	100	0.285	0.593
Extension Staffs	41	22	36	1	100	13.62	0.00***
Research Staffs	9	54	8	29	100	0.889	0.346
NGO Staffs	1	62	0	37	100	0.593	0.441
Cooperatives	22	41	16	21	100	0.685	0.408
Churches	45	18	31	6	100	1.951	0.162
Demonstrations	8	55	11	26	100	4.293	0.036**
Farmers exchange visit	4	59	4	33	100	0.630	0.427
Community leaders	21	42	14	23	100	0.208	0.648
Market place	18	45	21	16	100	7.784	0.005**
Trainings/workshops/seminars	4	59	10	27	100	8.278	0.004**
Farmers Seed sources of fing technologies						**r**	**Sig.**
Extension Agents	0(0%)		3(30%)		100		
Research Staffs	2(40%)		6(60%)		100		
Neighbors	1(20%)		0(0%)		100		
Relatives	2(40%)		1(10%)		100		
						0.126	**0.099***

Appendix Table 4.7 Researchers Perceptions of the Major Limiting Factors affecting R-E-F linkages

Limiting Factors	Responses (YES)		Responses (NO)	
	N	%	N	%
High involvement of extension agents in non agricultural activities	13	72.2%	5	27.8%
Extension workers undervalue researchers work and unwilling to accept technologies genuinely	8	44.4%	10	55.6%
Frequent structural reorganization in the extension	9	50.0%	9	50.0%
Lack of transparent and accountable linkage mechanism	15	83.3%	3	16.7%
Lack of mutual respect, recognition and genuine cooperation among parties	13	72.2%	5	27.8%
Lack of research extension liaison positions from both research and extension sides	4	22.2%	14	77.8%
Lack of check and balance system over the role and responsibilities of the three actors	17	94.4%	1	5.6%
Limited participation of other stakeholder ,NGO, input multiplying agencies	13	72.2%	5	27.8%
Lack of a responsible body for managing linkages	18	100.0%	0	07%
Policy makers didn't recognize research and technology transfer as two components of the same system and that they fail to deal with from a systems perspectives	12	66.7%	6	33.3%
The farming systems are diverse and agro ecologically, and socio-economically complex	13	72.2%	5	27.8%
Donor dependence leads to fluctuations in the performances of linkages	14	77.8%	4	22.2%
Non -functional linkage mechanism	17	94.4%	1	5.6%
Idle and ineffective linkage mechanisms/ Structural problems	13	72.2%	5	27.8%
Reward systems currently in use are not compatible with the missions and goals of technology	13	72.2%	5	27.8%
Researchers acknowledge the importance of linkages but do not always perceive as their responsibility	10	55.6%	8	44.4%
Extension Agents acknowledge the importance of linkages but do not always perceive as their responsibility	17	94.4%	1	5.6%
The mix of human resources in the organizations is not enough to able to carry out linkage activities	16	88.9%	2	11.1%
Differences in the status of research and extension agents affected cooperation between the two groups	7	38.9%	11	61.1%
Financial resources are often inadequate and not sustainable for the linkage requirements of a system	14	77.8	4	22.2
Physical resource are scarce or inadequate	17	94.4%	1	5.6%
Research managers lack essential skills for managing linkages and team work	12	66.7%	6	33.3%
Linkage activities are not carefully planned by optimizing financial resources	13	72.2	5	27.8
Farmers high involvement in diverse livelihood activities,	12	66.7%	6	33.3%
Absence or Lack of well established farmers training centers	6	33.3%	12	66.7%
Farmers low level of understanding and their suspicions to accept technologies	3	16.7%	15	83.3%
Researchers poor communication ,facilitation skills and poor respect to local practices	3	16.7%	15	83.3%

Appendix Table 4.8 Extension Agents Perceptions of the Major Limiting Factors affecting R-E-F linkages

Limiting Factors	Responses (YES)		Responses (NO)	
	N	%	**N**	%
Absence of transparent and accountable linkage mechanism	19	73.1%	7	26.9%
Poor attitude and motivations of the research staffs to work with extension agents	13	50.0%	13	50.0%
Failure to recognize of having and doing for a common goal	14	53.8%	12	46.2%
The technology generated by research is not based on farmers needs and not effective at farm level	4	15.4%	22	84.6%
Frequent structural reorganization in the extension	7	26.9%	19	73.1%
Lack of mutual respect, recognition and genuine cooperation among parties	18	69.2%	8	30.8%
High workload of extension workers	18	69.2%	8	30.8%
Limited participation of other stakeholder ,NGO, input multiplying agencies	10	38.5%	16	61.5%
Policy makers did not recognize research and technology transfer as two components of the same system and that they fail to deal with from a systems perspectives	13	50.0%	13	50.0%
The farming systems are diverse and agro ecologically, and socio-economically complex	24	92.3%	2	7.7%
Donor dependence leads to fluctuations in the performances of linkages	12	46.2%	14	53.8%
Non -functional linkage mechanism	11	42.3%	15	57.7%
Idle and ineffective linkage mechanisms/ structural problems	16	61.5%	10	38.5%
Reward systems currently in use are not compatible with the missions and goals of technology	17	65.4%	9	34.6%
Promotion, training ,and peer recognition isnot based on the relevance and effective use of technologies rather than on individuals political commitment	15	57.7%	11	42.3%
Researchers acknowledge the importance of linkages but do not always perceive them as their responsibility	20	76.9%	6	23.1%
Extension workers acknowledge the importance of linkages but do not always perceive them as their responsibility	20	76.9%	6	23.1%
Differences in the status of research and extension agents ,e.g. educational difference between them can sometimes be so wide that cooperation between the two groups is severely handicapped	20	76.9%	6	23.1%
The mix of human resources in the organizations is not enough to able to carry out linkage activities	16	61.5%	10	38.5%
Financial resources are often inadequate for the linkage requirements of a system	20	76.9	6	23.1
Physical resource scarcity	22	84.6%	4	15.4%

Extension managers lack essential skills for managing linkages and team work	19	73.1%	7	26.9%
Planning and Time Management for linkages is not carefully planned via optimize the financial resources needed	19	73.1%	7	26.9%
Farmers give high attention to political leader farmers	3	12%	23	88%
Lack of full facilities of the existing farmers training centers	9	35.5%	17	65.5%
Farmers' low level of understanding and consciousness and involvement in complex activities	9	35.5%	17	65.5%
Extension agents poor communication ,facilitation skills and poor respect to local practices	9	35.5%	17	65.5%

Appendix Table 4.9 Farmers Perceptions of the Major Limiting Factors affecting R-E-F linkages

Limiting Factors	Responses (YES)		Responses (NO)	
	N	%	N	%
Lack of timely supply of adequate and quality seeds and fertilizers from extension	34	34%	66	66.0%
Lack of sound and basket of technological options either from research or extension	15	15%	85	85.0%
Limited technical qualifications of developmental agents	5	5%	95	95.0%
Presence of limited number of developmental agents	12	12%	88	88.0%
Farmers shortage of time due to high overburden in diverse livelihood activities	42	42%	58	58%
High focus of research in road side trials	28	28%	72	72.0%
Poor linkage between research and extension affects the performance of linkages	41	41%	59	59.0%
Lack of commitment of research affects the performance of linkages	26	26%	74	74.0%
Lack of commitment of extension affects the performance of linkages	46	46%	54	54.0%
Limited invitation or participation of farmers affects the performance of linkages	72	72%	28	28.0%
Biasness' and non gene unity of Developmental agents affects the performance of linkages	59	59%	41	41.0%
high distance of farmers resident place and farm affects the performance of linkages	6	6%	94	94.0%
Limited motivation of farmers to seek advice affects the performance of linkages	21	21%	79	79.0%
Distant of research organizations affects the performance of linkages	8	8%	92	92.0%
Selection of Weak and accessible farmers for an experiment or trial limit contact with research	16	16%	84	84.0%
Farmers needs of allowance or per diem affects the performance of linkages	10	10%	90	90.0%
Limited focus on women farmers affects the performance of linkages	16	16%	84	84.0%

Appendix Table 4.10 Relationships of Linkage Participant and Non-Participant Researchers on Perceived common Linkages Problems

Linkage problems	**Researchers Responses**							
	Non-participants			Participants			$\chi 2$- value	Sig.
	Yes	No	Total	Yes	No	Total		
Policy environment problems	5	2	7	7	4	11	0.117	0.732
Diversity of the structure of farming system	6	1	7	2	9	11	4.406**	0.036
Problems of donor dependency of linkages	7	0	7	7	4	11	3.273*	0.070
Human resource constraints	7	0	7	9	2	11	1.432	0.231
Financial resource constraints	3	4	7	11	0	11	8.082**	0.004
Physical resource constraints	6	1	7	11	0	11	1.644	0.197
Motivational and incentive problems	3	4	7	10	1	11	4.923**	0.026
Status differences	5	2	7	2	11	11	5.103**	0.024
Structural problems	7	0	7	6	5	11	4.406**	0.036
Managerial problems	6	1	7	6	5	11	1.870	0.171
Planning and time management problems	5	2	7	8	3	11	0.04	0.952
High work overload and involvement of extension agents in non agricultural activities	2	5	7	11	0	11	10.879***	0.001
Lack of transparent & accountable linkage mechanism	4	3	7	11	0	11	5.657**	0.017
Lack of genuine cooperation	5	2	7	8	3	11	0.004	0.952
Limited participation of NGOs, input multiplying agencies	7	0	7	6	5	11	4.406**	0.036

Appendix Table 4.11 Relationships of Linkage Participant and Non-Participant Extension Agents on Perceived common Linkages Problems

Linkage Problems	Extension agents responses							
	Non-participants			Participants			χ2- value	Sig.
	Yes	No	Total	Yes	No	Total		
Policy environment problems	2	6	8	11	7	18	2.889*	0.089
Diversity of the structure of farming system	7	1	8	17	1	18	0.376	0.540
Problems of donor dependency of linkages	1	7	8	11	7	18	5.266**	0.022
Human resource constraints	3	5	8	13	5	18	2.821*	0.093
Financial resource constraints	8	0	8	12	6	18	3.467*	0.063
Physical resource constraints	7	1	8	15	3	18	0.074***	0.001
Motivational and incentive problems	2	6	8	15	3	18	8.327**	0.004
Status differences	8	0	8	12	6	18	3.467*	0.063
Structural problems	3	5	8	13	5	18	2.821*	0.093
Managerial problems	7	1	8	12	3	18	1.222	0.269
Planning and time management problems	7	1	8	12	6	18	1.222	0.269
High work overload and involvement of extension agents in non agricultural activities	2	6	8	16	2	18	10.613***	0.001
Lack of transparent & accountable linkage mechanism	8	0	8	11	7	18	4.257**	0.039
Lack of genuine cooperation	4	4	8	14	4	18	2.06	0.157
limited participation of other stakeholder ,NGO, input multiplying agencies	2	6	8	8	10	18	0.885	0.347

Source: Own computational result, 2010. *Correlation is significant at 10% levels, ** at 5% level, * **at 0.1% level.

Table 4.12 Distributions of Extension Workers on the Use of Linkage Mechanisms

Linkage Mechanisms	NO-Responses		YES-Responses		Mean	St.deviation
	Count	N %	Count	N %		
Joint Problem Identification	18	69.2%	8	30.8%	1.31	0.471
Joint Priority Setting and Planning Meetings	5	19.2%	21	80.8%	1.81	0.402
Joint Programming and Review Meetings	18	69.2%	8	30.8%	1.31	0.471
Joint Technology Release Meetings	9	34.6%	17	65.4%	1.65	0.485
Joint Adaptive Trials	15	57.7%	11	42.3%	1.42	0.504
Joint Field Visits	9	34.6%	17	65.4%	1.65	0.485
Joint Demonstration Trials	19	73.1%	7	26.9%	1.27	0.452
Joint Surveys/Diagnostic Survey	21	80.8%	5	19.2%	1.19	0.402
Financial Agreement	15	57.7%	11	42.3%	1.42	0.504
Contract for Services	15	57.7%	11	42.3%	1.42	0.504
Exchange of Personnel	11	42.3%	15	57.7%	1.58	0.504
Staff Rotation	14	53.8%	12	46.2%	1.46	0.508
Publications	19	73.1%	7	26.9%	1.27	0.452
Seminar/ Workshop	12	46.2%	14	53.8%	1.54	0.508
Technical Reports	15	57.7%	11	42.3%	1.42	0.504
Farmers Exchange Tour	23	88.5%	3	11.5%	1.12	0.326
Demonstration Trials	17	65.4%	9	34.6%	1.35	0.485
Field Days	6	23.1%	20	76.9%	1.77	0.430
Audio-Visual Material	9	34.6%	17	65.4%	1.65	0.485
Trainings	19	73.1%	7	26.9%	1.27	0.452
Evaluation Surveys	21	80.8%	5	19.2%	1.19	0.402
Evaluation Meetings	15	57.7%	11	42.3%	1.42	0.504
Evaluation Field Visits	16	61.5%	10	38.5%	1.38	0.496
Publication of Reports	19	73.1%	7	26.9%	1.27	0.452
Coordinators Positions	21	80.8%	5	19.2%	1.19	0.402

Source: Own computational result, 2010.

Appendix Table 4.13 Distributions of Researchers on the Use of Linkage Mechanisms

Linkage Mechanisms	NO-Responses		YES-Responses		Mean	St.deviation
	Count	N %	Count	N %		
Joint Problem Identification	15	83.3%	3	16.7%	1.17	0.383
Joint Priority Setting and Planning Meetings	13	72.2%	5	27.8%	1.28	0.461
Joint Programming and Review Meetings	15	83.3%	3	16.7%	1.17	0.383
Joint Technology Release Meetings	11	61.1%	7	38.9%	1.39	0.502
Joint Adaptive Trials	14	77.7%	4	22.3%	1.22	0.428
Joint Field Visits	6	33.3%	12	66.7%	1.67	0.485
Joint Demonstration Trials	11	61.1%	7	38.9%	1.39	0.502
Joint Surveys/Diagnostic Survey	11	61.1%	7	38.9%	1.39	0.502
Financial Agreement	14	77.8%	4	22.2%	1.22	0.428
Contract For Services	15	83.3%	3	16.7%	1.17	0.383
Exchange of Personnel	15	83.3%	3	16.7%	1.17	0.383
Staff Rotation	16	88.9%	2	11.1%	1.11	0.323
Publications	7	38.9%	11	61.1%	1.61	0.502
Seminar/ Workshop	5	27.8%	13	72.2%	1.72	0.461
Technical Reports	8	44.4%	10	55.6%	1.56	0.511
Farmers Exchange Tour	11	61.1%	7	38.9%	1.39	0.502
Demonstration Trials	0	0.0%	18	100.0%	2.00	0.00
Field Days	3	16.7%	15	83.3%	1.83	0.383
Audio-Visual Material	10	55.6%	8	44.4%	1.44	0.511
Trainings	8	44.4%	10	55.6%	1.56	0.511
Evaluation Surveys	7	38.9%	11	61.1%	1.61	0.502
Evaluation Meetings	5	27.8%	13	72.2%	1.722	0.460
Evaluation Field Visits	5	27.8%	13	72.2%	1.722	0.461
Publication of Reports	15	83.3%	3	16.7%	1.17	0.383
Coordinators Positions	10	55.6%	8	44.4%	1.44	0.511

Source: Own computational result, 2010.

Appendix Table 4.14 Definitions and Units of Measurement and Summary of Results Continuous Explanatory Variables Used In the Logistic Regression

Explaining variables	Description	Mean	SD	F
	Household farmers			
EDUHHH	Level grade attained	1.375	0.79	2.094**
AGEHHH	Age of the household	41.28	11.78	6.16***
FAREXPS	The number of years experience in farming	20.03	11.8	1.708**
TLU	Number of livestock the farmer own (TLU)	5.297	3.619	2.215**
DISMARK	Distance of farmers' homestead from the nearest market (minut	35.7	25.2	2.95**
DISTROD	Distance of farmers' residence to all weather road(minute)	38.35	25.96	4.143*
FRQCONEXT	Frequency of contact by extension agent	14.9	15.9	2.58**
	Extension Agents			
AGE	Age	38.69	8.49	2.174**
WORKEXP	The number of years of experience in work	15.31	7.26	2.552**
EDLEOEXT	Level of education status	1.81	0.849	1.809***
	Researchers			
AGE	Age	36.28	6.49	2.120**
WORKEXP	The number of years of professional experience in work	13.17	6.47	2.046***

Source: own computational result, 2010. *** Significance at 10%,** significance at 5%,*Significant at 0.1%.

Appendix Table 4.15 Definition, Units of Measurement and Summary of the Discrete (Dummy) Variables Used In the Logistic Regression

Explaining variables	Description	χ2- value
ACCEXTSE	2 if the household head farmers have access to extension services; 1 otherwise	4.436**
ACCINPUT	2 if the household head farmers have access to inputs; 1 otherwise	-2.31*
SORINFO	2 if the household head farmer obtained multiple sources of information; 1 otherwise (Both from demonstration(DEMONST) and training/ seminars (TRWORKINFO)	8.76**
LDRFSOC	2 if the household head farmers have participated in leadership of formal social institutions; 1 otherwise	10.482**
STKMETNG	2 if the researchers used Stakeholders meeting as sources of research agenda setting;1 otherwise	2.918***
PRBOARD	2 if the researchers used problems identified by regional BoARD as sources of research agenda setting;	2.822***
PERSOBS	2 if the researchers used personal observations as sources of research agenda setting;1 otherwise	2.822***
POENVPR	2 if the researchers and extension agents perceives the policy environment affected linkages; 1 otherwise	1.201
DVFRMSYS	2 if the researchers and extension agents perceives the Diversity of farming system affected linkages;	0.850
DONDEP	2 if the researchers and extension agents perceives Donor dependency affected linkages; 1 otherwise	2.946***
INCENTPRO	2 if the researchers and extension agents perceives the Motivational and incentive problems affected linkages; 1 otherwise	6.356**
STATSPRO	2 if the researchers and extension agents perceives Status differences affected linkages; 1 otherwise	3.431***
STRCPROB	2 if the researchers and extension agents perceives the Structural Problems affected linkages; 1 otherwise	8.959**
MANGPRO	2 if the researchers and extension agents perceives the Managerial problems affected linkages; 1 otherwise	0.210
PLTIMGTPRO	2 if the researchers and extension agents perceives the Planning and Time Management problems affected linkages; 1 otherwise	5.763**
LACKLNKPO	2 if the researchers and extension agents perceives , Lack of transparent & accountable linkage mechanism affected linkages; 1 otherwise	3.046***

LMTPRTST	2 if the researchers and extension agents perceives limited participation of other stakeholder ,NGO, input multiplying agencies affected linkages; 1 otherwise	4.859**
HUMNPRO	2 if the researchers and extension agents perceives human resource Problems affected linkages; 1 otherwise	4.011**
FINPRO	2 if the researchers and extension agents perceives financial resource Problems affected linkages; 1 otherwise	1.020
PHYSPROB	2 if the researchers and extension agents perceives physical resource Problems affected linkages; 1 otherwise	1.020
WORKOVREX	2 if the researchers and extension agents perceives high work overburden of the extension staffs affected linkages; 1 c	0.020***

Appendix Table 4.16: Multicollinearity test result for the continuous explanatory variables of household farmers (N=100), extension agents (N=26), and researchers (N=18)

Respondents & sample size	Continuous Variables	Collinearity Statistics	
		R^2 Value(Tolerance)	VIF
Household Farmers (N=100			
	Educational level	.942	1.062
	Age of the Household	.982	11.38
	Farming Experience	.934	1.017
	Livestock ownership in TLU	.913	1.096
	Distance from all weather roads in minute	.289	3.462
	Distance from the nearest market center in minutes	.292	3.428
	Frequency of contact per year with extension agents	.934	1.071
Extension agents (N=26)			
	Age of the extension personnel	0.980	12.478
	Educational level of the extension personnel	0.734	1.362
	Year of experience of the extension agents	0.86	11.562
Researchers (N=18)	Age of the researchers	0.206	4.859
	Year of professional experience of the researchers	0.206	4.859

Appendix Table 4.17: Contingency Coefficients of Discrete Variables in Binary Logit of the Household Farmers

	ACCEXTSE	LDRFSOC	ACCINPUT	DEMONST	TRWORKINFO
ACCEXTSE	1				
LDRFSOC	0.264	1			
ACCINPUT	0. 78	0.264	1		
DEMONST	0.205	0.189	0.095	1	
TRWORKINFO	0.276	0.230	0.123	0.230	1

Appendix Table 4.18: Contingency Coefficients of Discrete Variables in Binary Logit of the Researchers

	POENVPR	DVFRMSY	DONDEP	HUMNPR(	FINPRO	PHYSPRO	INCENTPRO	STATSPRO	STRCPROI	MANGPR	PLTIMGT	LACKLNK	LMTPR'	PRBOAR	PERS(	STKMETNG	WORKOV
POENVPR	1																
DVFRMSYS	0.00	1															
DONDEP	0.35	0.055	1														
HUMNPRO	0.12	0.158	0.175	1													
FINPRO	0.34	0.108	0.15	0.086	1												
PHYSPROB	0.34	0.108	0.15	0.086	1.00	1											
INCENTPRO	0.18	0.120	0.33	0.189	0.454	0.267	1										
STATSPRO	0.47	0.447	0.37	0.00	0.243	0.120	0.267	1									
STRCPROB	0.31	0.200	0.05	0.158	0.108	0.189	0.120	0.447	1								
MANGPRO	0.25	0.316	0.17	0.125	0.171	0.331	0.189	0.236	0.175	1							
PLTIMGTPRO	0.08	0.277	0.16	0.175	0.150	0.329	0.331	0.372	0.316	0.055	1						
LACKLNKPO	0..00	0.200	0.38	0.040	0.271	0.239	0.329	0.447	0.16	0.055	0.200	1					
LMTPRTST	0.08	0.055	0.38	0.316	0..391	0.2651	0.265	0.149	0.088	0.385	0.194	0.277	1				
PRBOARD	0.37	0.239	0.03	0.189	0.130	0.036	0.0.39	0.342	0.378	0.265	0.194	0.277	0.29	1			
PERSOBS	0.09	0.239	0.33	0.189	0.454	0.357	0.357	0.267	0.378	0.033	0.478	0.051	0.03	0.331	1		
STKMETNG	0.16	0.255	0.01	0.0	0.193	0.342	0.152	0.342	0.403	0.269	0.204	0.239	0.03	0.265	0.3	1	
WORKOVREXT	0.64	0.316	0.175	0.41	0.24	0.51	0.52	0.04	0.61	0.02	0.21	0.002	0.29	0.21	0.2	0.23	1

Appendix Table 4.19: **Contingency Coefficients of Discrete Variables in Binary Logit of the Extension Agents**

	POENVPR	DVFRMSY	DONDEP	HUMNPR	FINPRO	PHYSPRO	INCENTPRO	STATSPRO	STRCPRO	MANGPR	PLTIMGT	LACKLNK	LMTPR	PRBOAR	PERS	STKMETNG	WORKOV
POENVPR	1																
DVFRMSYS	0.00	1															
DONDEP	0.35	0.055	1														
HUMNPRO	0.12	0.158	0.175	1													
FINPRO	0.34	0.108	0.15	0.086	1												
PHYSPROB	0.34	0.108	0.15	0.086	1.00	1											
INCENTPRO	0.18	0.120	0.33	0.189	0.454	0.267	1										
STATSPRO	0.47	0.447	0.37	0.00	0.243	0.120	0.267	1									
STRCPROB	0.31	0.200	0.05	0.158	0.108	0.189	0.120	0.447	1								
MANGPRO	0.25	0.316	0.17	0.125	0.171	0.331	0.189	0.236	0.175	1							
PLTIMGTPRO	0.08	0.277	0.16	0.175	0.150	0.329	0.331	0.372	0.316	0.055	1						
LACKLNKPO	0..00	0.200	0.38	0.040	0.271	0.239	0.329	0.447	0.16	0.055	0.200	1					
LMTPRTST	0.08	0.055	0.38	0.316	0..391	0.2651	0.265	0.149	0.088	0.385	0.194	0.277	1				
PRBOARD	0.37	0.239	0.03	0.189	0.130	0.036	0.0.39	0.342	0.378	0.265	0.194	0.277	0.29	1			
PERSOBS	0.09	0.239	0.33	0.189	0.454	0.357	0.357	0.267	0.378	0.033	0.478	0.051	0.03	0.331	1		
STKMETNG	0.16	0.255	0.01	0.0	0.193	0.342	0.152	0.342	0.403	0.269	0.204	0.239	0.03	0.265	0.3	1	
WORKOVREX	0.64	0.316	0.175	0.41	0.24	0.51	0.52	0.04	0.61	0.02	0.21	0.002	0.29	0.21	0.2	0.23	1

Appendix 4.20 Questionnaires Prepared For Researchers and Extension Agents

Section I. Personal Characteristics of Researchers and Extension Agents

1. Name of the respondent:________________________
2. Name of the organization: ________________________
3. Position held by the respondent : ______________
4. Sex 1=female 2= male
5. Age: ____________
6. Marital status: 1=Single 2= Married 3= Divorced 4=Other ,Specify
7. Educational level : 1=Diploma 2=Bsc 3=Msc 4=PhD 4=other ,specify
8. What is your area of specialization? ______________
9. Year of experience? ______________
10. What is your present job title? ______________
11. What are the concrete activities of your organization?
    1) Extension only 2) Research only 3) Extension and research 4=other, specify
12. What are the constraints affecting the activities of your organization?________________________

Section 2. Psychological Related Characteristics

13. How many crop technologies have been generated/ transferred by your organization? Amongst them, how many are finger millet varieties and technologies? List them?
14. How many of them are currently under production by farmers?______________________
15. What are the peculiar characteristics of each of the finger millet varieties/ technologies?______________
16. What are the demerits of each of the finger millet technologies?
17. Which of the improved finger millet varieties/technologies is highly preferred by farmers? How? ______________

Researchers/Extension agents Awareness of Farmers Best Local Finger Millet Varieties and Practices

18. Do you know any local finger millet varieties/practices that were perceived to be better than some of the improved finger millet varieties of the research system and are rated highly by farmers? 1= No Yes=2
19. If no, why? ________________________
20. If yes, name at least one local finger millet varieties that farmers rated highly?______________________

Researchers/Extension Agents Perceptions of the Factors Limiting Adoption of Improved Finger Millet Varieties

21. What you perceived to be the major factors limiting farmers' adoption of improved finger millet varieties in the study area?

Characteristics of Finger millet Technologies

22. How would you rate the following attributes of improved finger millet variety/ technology to you by using a 4-point response scale? **Key:** 1= Deficit 2= Satisfactory 3= Very good 4= Excellent

Attributes of the finger millet technology	Deficit	Satisfactory	Very good	Excellent
	1	2	3	4
Relative advantage				
Giving economic benefits in the short term				
Saving time and labour				
High degree of economic profitability				
Low initial costs				
Compatibility				
Building upon existing practices				
Consistent with indigenous knowledge systems				
Complexity				
Easy to do				
Easy to learn				
Trialability				
Applicable on a small scale before full adoption				
Observability				
Its effects/yields are easily observable by friends				
Easy to communicate and describe to others				
Addressing gender needs				
Satisfies the felt needs of men households				
Satisfies the felt needs of Women farmers				
Satisfies the felt needs of both men and women farmers				

Section 3. Institutional Characteristics
Research/ Extension and farmers Contact

23. Do you have contacts with extension agents /Researchers of Mecha woreda? Yes (2) No (1)
24. If yes, number of years since first contact ....years.
25. Do you have contacts with farmers of Mecha woreda who cultivates finger millet varieties'? Yes (2) No (1)
26. If yes, number of years since first contact ....years.

Frequency of Contact

27. How many times per year do you visit the extension agents/researchers?________________
28. How many times per year do you visit the farmers?________________________
29. How is your relationship to extension/research organizations? (1) Loose (2) Weak (3) Strong
30. How is your relationship to farmers and farmers groups? (1) Loose (2) Weak (3) Strong
31. Based on your professional experience, what could be the most critical factors limiting your contacts with extension agents/researchers?____
32. And what could be the most critical factors limiting your contacts with farmers?...........

Section 4: Linkage Section

Linkage Mechanisms

33. What linkage mechanisms or strategies are being used by your institute/center to create effective research-extension-farmers linkage system in general and to foster joint technology development and delivery system in particular?
34. Indicate the types of linkage mechanisms of each linkage functions that are regularly used in your organization to link with extension/research organizations and farmers?

No	Linkage Functions	Linkage Mechanisms	Actors	No (1)	Yes (2
1	Planning and review	Joint problem identification	Extension/Research		
			Farmers		
		Joint priority planning and setting committees or Meetings	Extension/Research		
			Farmers		
		Joint programming and review committees or Meetings	Extension/Research		
			Farmers		
		Joint technology release committee or meetings	Extension/Research		
			Farmers		
2	Collaborative professiona activities	a) Joint adaptive trials	Extension/Research		
			Farmers		
		b) Joint field visits	Extension/Research		
			Farmers		
		joint demonstration trials	Extension/Research		
			Farmers		
		d)Joint surveys/diagnostic survey	Extension/Research		
			Farmers		
3	Exchange of resources	a) Financial agreement	Extension/Research		
			Farmers		
		b) Contract for services	Extension/Research		
			Farmers		
		c) Exchange of personnel	Extension/Research		
			Farmers		
		d) Staff rotation	Extension/Research		
			Farmers		
4	Dissemination of knowle information	a) Publications	Extension/Research		
			Farmers		
		b) Seminar/ Workshop	Extension/Research		
			Farmers		

		c) Technical Reports	Extension/Research		
			Farmers		
		d) Farmers exchange tour	Extension/Research		
			Farmers		
		e) Demonstration trials	Extension/Research		
			Farmers		
		f) field days	Extension/Research		
			Farmers		
		g) Audio-visual material	Extension/Research		
			Farmers		
		h) Trainings	Extension/Research		
			Farmers		
5	Feedback	a) Evaluation surveys	Extension/Research		
			Farmers		
		b) Evaluation meetings	Extension/Research		
			Farmers		
		c) Evaluation field visits	Extension/Research		
			Farmers		
		Publication of reports by monitoring and evaluation te	Extension/Research		
			Farmers		
6	Coordination/networking	a) Coordinator positions	Extension/Research		
			Farmers		
		b) Research extension liaison positions	Extension/Research		
			Farmers		
	Others ,specify				

Involvement in Selected Linkage Mechanisms

35. In which of the following linkage activities/mechanisms have you involved/participated with extension agents/researchers ,and farmers regarding finger millet technology development and delivery system in the last two cropping seasons (2008 and 2009 years).

Linkage Mechanisms	Years and frequency of participation							
	In 2008 and Frequency of participation				In 2009 and Frequency of Participation			
	Not participated	1 times	2 times	3times	Not participated	1 times	2 times	3 times
Joint problem identification								
Joint priority planning , programming and setting committees or meetings								
Joint technology release committee or meetings								
Joint adaptive trials								
joint demonstration trials								
Joint surveys/diagnostic survey								
Publications								
Seminar/ Workshop								
Technical Reports								
Farmers exchange tour								
Field days								
Trainings								
Evaluation meetings								
Evaluation field visits								
Others ,specify								

36. In your experience what are the benefits that your institution gets from participation in joint research-extension-farmers finger millet linkage activities/mechanisms?__________________________________

Type of participation

37. In your experience which of the following statements best describes the relationship that exists between researchers with extension agents and farmers?

Type of participation	Please tick (✓)	
	With Extension /Research	With Farmers
None		
Conventional/Contractual: The research organization has sole decision-making power over most of the decisions in the innovation process, and can be considered the 'owner' of the process. Others are formally or informally 'contracted to provide services and support.		
Consultative: Most of the key decisions are made and kept with research but emphasis is put on consultation and gathering information from others especially for identifying constraints and opportunities, priority setting and /or evaluation.,		
Collaborative: researchers/extension agents and farmers/groups collaborate as equals, emphasising linkages through an exchange of knowledge, different contributions and a sharing of decision-making power during the innovation process.		
Collegial: researchers/extension agents and farmers/ groups work together as colleagues or Ownership and responsibility are equally distributed among partners ,and decisions are made b agreement or consensus among all actors		
Farmer experimentation: The research organization builds links between farmers' indigenous knowledge systems, the experiences of other partners and researchers' scientific knowledge systems in implementation of new agricultural technologies.		

Section 5. Organizational Related Factors

Researchers and Extension Agents Sources of Ideas for Setting Research/Extension Agenda

38. What major sources of ideas do you use for setting work priorities in general and in finger millet technology development and delivery system in particular?

1= research/extension community itself, including fellow research staff members
2= research/extension objectives determined by the research institute thematic area
3= farmers as a source of ideas
4= based on own interest
5= stakeholders meeting/REFAC
6= based on problems identified by BoARD
7= others, specify

39. From your professional experience, what could be the major limiting factors affecting the performance of linkages between research, extension and farmers?

40. What could be improved for further strengthening of research-extension-farmers linkage system for technology development and delivery system in general and for better participation in finger millet linkage activates in particular?

Section 6. Context of Technology System Related Factors

Technology System Context (policy environment, donor policies and the nature of existing farming system)

43.Rate how strongly agree or disagree with the following statements or indicate how do you characterize the linkage between research and technology transfer (extension organization) is influenced by the technology system context?

Key: 1= No 2= Yes

1	**Context of Technology System**	No	Yes	Reasons
A	**Policy environment**			
	Policy makers recognize research and technology transfer as two components of the same system and that they deal with from a systems perspectives			
	Policy makers assume leadership by providing research and extension with performance incentives; by promoting the complimentarity of research, extension and others of the system; by enforcing accountability; and by clearly defining mandates.			
B	**The structure of farming system**			
	The farming systems are diverse and agro ecologically, and socio-economically complex. and it poses difficult problems to the quality, quantity and diversity of human resources required and affected the feedback system and linkages			
C	**Donor Involvement:**			
	Lack of coordination between a donor and the national system lead to projects that are not sustainable, discontinuity and duplication of efforts, and fluctuations in the performances of linkages between research and technology transfer and may lead to a halt of the project when donor fund ceases			

Section 7. Structural Related Factors

Effects of Structure and Organization of Research and Extension Organizations on linkages

41. Rate how strongly agree or disagree with the following statements or indicate how do you characterize the linkage between research and technology transfer (extension organization) is influenced by the structural and organizational conditions?

Key: 1= No 2= Yes

2	**Effects of Structure and Organization on linkages**	1	2	Reason
A	**Missing critical tasks**: certain tasks required of any agricultural technology system are not performed. e.g. identifying farmers problems or multiplying seeds of improved plant varieties and /or technology evaluation, etc			
B	**Missing linkage mechanisms:** certain mechanisms that should be in place, such as joint planning and review or research-extension liaison, have never been created			
C	**Duplication of Effort/redundancy:** research and technology transfer /extension are each performing the same task, separately.			
D	**Non –functional linkage mechanism:** mechanism exist but did not function or used .e.g. a joint committee for monitoring and evaluating research results has been formally created but meets either rarely or not at all			
E	**Idle and ineffective linkage mechanisms:** mechanisms are operational but ineffective or the results are not forthcoming. a joint review committee meets regularly, for e.g. but its recommendations are ignored			
F	**Fluctuation in the operation of linkage mechanisms:** e.g. change from RELC to REFAC			
G	**Lack of cohesion:** lack of consensus on priorities and respective responsibilities of research and extension to perform their duties in the mandates			
H	**Differences in legal status:** differences in the administrative and legal status of research and extension pose problematic e.g. both organizations are in the same or different ministry and organizations			

Section 8. Managerial Factors

Managerial Issues for Linkages

42. Rate how strongly agree or disagree with the following statements or indicate how do you characterize the linkage between research and technology transfer (extension organization) is influenced by managerial issues for linkages?

Key: 1= No 2= Yes

4	**Managerial Capacity**	1	2	Reasons For your answer/s
A	Managers lack the essential skills for running the research/extension organization, those for managing linkages, unable to provide leadership, to build a team, to communicate effectively, or to deal with conflicts			
B	**Planning And Time Management**			
	The time devoted to linkages is carefully planned and inherently optimize the financial and human resources needed for linkages			

Section 9. Resource Factors

Resource Issues for Linkages

43. Rate how strongly agree or disagree with the following statements or indicate how do you characterize the linkage between research and technology transfer (extension organization) is influenced by resource issues for linkages?

Key: 1= No 2= Yes

3	**Resource Issues For Linkages**	1	2	Reasons
A	**Human Resources**			
	Motivation and rewards			
	Reward systems currently in use are compatible with the missions and goals of technology system			
	Promotion, training ,and peer recognition is based on the relevance and effective use of technologies rather than on the number of scientific publications			
	Researchers acknowledge the importance of linkages but do not always perceive them as their responsibility			
B	**Human Resource Mix**			
	The mix of human resources with different personal attributes, attitudes, behaviors, motivations and goals in the organizations is enough to able to carryout linkage activities			
	Differences in the status of research and extension staffs educational difference between them can sometimes be			

	so wide that cooperation between the two groups is severely handicapped			
	Technical qualifications of researchers in developing and delivering relevant technologies that is, products that are technically, socioeconomic ally and environmentally solutions to the needs and problems of producers			
	Technical qualifications of extension staffs in methodology or knowledge and skills of facilitation or meeting their duties and responsibilities effectively			
C	**Financial Resources**			
	Financial resources are often inadequate for the linkage requirements of a system			
	There is successful management of funds for linkages by providing a budget for linkage mechanisms, flexibility in fund management and timely release of funds			
	There is no access or availability of funds for linkage activities			
	Supporting training of farmers in skills through allocating enough funds			

Appendix 4.21 Questionnaires Prepared For Household Farmers

Questionnaire Number:________________________
Date of Interview: Day: _______Month:_____________Year:_____________
Interviewed by: ___________________________
Zone: ___________________________Code:__________
Woreda/District: ___________________ Code: __________
Kebele: ___________________________ Code: __________
Got': ____________________________ Code: __________

Section I: Household Demographic Characteristics

I) Human Capital/household composition

1. Name of the Farmer: ____________________________
2. Sex: 2= Male 1= Female
3. Age: _______
4. Marital Status: 1=Single 2=Married 3=Divorced 4=Widowed
5. How Many Children Do You Have? ____________ .
6. How Many Dependants (Children and Other Persons) Are You Presently Responsible For: ____________Dependants?
7. Educational Level: 1=Illiterate 2=Read Only 3=Read and Write 4=Primary School 5=Secondary School 6=College 7=University
8. Religion: 1= Orthodox 2= Muslim 3 =Catholic 4=Other, Specify

9. Fill in the Appropriate Box about the Respondents (Family Members Both Children and Dependants; Educational Level; Sex; Age; Relation to the Household; Major Activities and Labor Force).

Code:

Sex: 2= Male 1=Female

Relation to the Household /Family: 1= Household Head 2= Wife 3= Daughter 4= Son 5= Grand Son 6= Grand Father 7= Mother 8= Other, Specify_______

Educational Level: 1=Illiterate 2=Read Only 3=Read and Write 4=Primary School 5=Secondary School 6=College 7=University

Major Occupation: 1= None 2= Crop Farming 3= Animal Husbandry 4= Trade 5= Student 6= House Keeping 7= Off-Farm Employment 8=Other, Specify

Major Activities Done On Own Farm: 1= None 2= Land Clearing 3= Ploughing 4= Seeding 5= Busting (Gulgualo) 6= Weeding 7= Harvesting 8= Threshing 9= Other, Specify______

	Family members	Sex	Age	Relation to the HH	Educational level	Major Occupation	Major activities In farm

1.1 Farming Experience

10. How Long Have You Been In Farming? _________

Section 2. Socio-Economic Characteristics

ii) Natural Capital

1.1 Land Resources And Use

11. Size of Own Land Holding________ha, 12. Size of Land Imported/rented in_______ ha ;13. Size of Land Exported/rented out_______ ha; 14. Total Size of Land Operated________ ha

15. Characteristics of Fields and Common Practices on Fields Owned or Operated.

Tenure Status: 1=Rented In; 2= Rent Out; 3=Share Cropped in; 4=Owned and Operated; **Soil Color:** 1=Black; 2=Yellow; 3=Brown; 4=Red; 5= Gray **; Soil Texture:** 1=Silt; 2=Sandy; 3=Gravel; 4=Stony; 5=Fine; **Soil Classification:** 1=Medium; 2=fertile; 3=infertile **Slope:** 1=Flat; 2=Gentle; 3=Steep

Land Use	Farm Size/ha	Tenure Status	Soil Color	Soil Texture	Soil Classification	Slope
Agric. Arable Land						
Perennial Cropped Land						
Grazing Land						
Communal Land						
Forest						
Others ,Specify						

III) Financial Capital

1.1 Capital Resources

16. Fill the Types of Capital Resources

Equipment-------------------- Machinery----------------

1.1 Livestock Resources

17. Livestock Resources and Inventory

Type of Animal	**Number**				**Type of breed**		**Current Market P**
	Owned Beginning of Year		Sold During the Year				
					Local	**Improved**	
	2008	2009	2008	2009			
Cattle							
Oxen							
Cow							
Bulls							
Calves							
Goats							
Sheep							
Poultry							
Layers							
Broilers							
Bee Hives							
Donkey							
Horse							

1.2 Farm production : Crop production

18. Crop Production Pattern in the last two cropping season

Section 3. Farmers' Institutional Characteristics

IV physical Capital

Infrastructure

19. Name of the nearest urban center: ___________20. Distance from the nearest urban center (in hr): ___________

21. Distance from all weather road(in hr): ___________21. Where did you sell your product? ___________22. Distance of your home from the nearest market center(in hr)? (Where most farmers sell their crops) if different from the nearest urban center.

23. Means of transportation from nearest market center to your home? ___24. Cost of transportation from your home to the nearest market center? (Birr Per): Person _________ Quintal of grain_______

25. How far is the nearest farmers training center from your home(in hr)? ___________

26. How far is the nearest district office of agriculture from your home(in minute)? ___________

HOUSING

27. Number of houses:________1) grass_________2) iron sheets_________-

V. Social Capital

Social Participation

28. How many organizations do you belong to presently?What are these organizations and the positions you hold in them?

Political participation

29. What political position(s) if any do you occupy in your village?
    1=Village Head 2=Assistant village head 3=Councilor 4=Village elders/chief 5=others

Previous Extension and Research Contact

30. Do you have contacts with researchers? Yes (2) No (1)
31. If yes, number of years since first contact ....years.
32. Do you have contacts with extension agents of Mecha woreda who cultivates finger millet varieties'? Yes (2) No (1)
33. If yes, number of years since first contact ....years.

Frequency of Contact

34. How many times per year do the researchers visit you?________________
35. How many times per year do the extension agent/s visit you?________________

Section 4. Psychological Related Characteristics

36. How is your relationship to research organizations?(1) Loose (2) Weak (3) Strong
37. How is your relationship to extension organizations?;(1) Loose (2) Weak (3) Strong
38. Based on your farming experience, what could be the most critical factors limiting your contacts with extension agents?

____

39. And what could be the most critical factors limiting your contacts with researchers?
40. List some farm practices that have been introduced to you by your agent?

Technologies Recommended	Adopted	Not Adopted	Reason for non-adoption
1			
2			
3			
Others			

Finger Millet Production Practices

41. How many local finger millet variety/ies have you grown until now? List their names?
42. Rate the types of local finger millet variety/ies in terms of their characteristic traits using a 4-point response scale as
1= Poor 2= good 3= very good

	Characteristics/traits 1= poor 2= good 3= very good	Types of local finger millet variety/ies A=		B =		C =		D =		E =	
	Average yield		Qt/ha		Qt/ha		Qt/ha		Qt/ha		Qt/ha
	Earliness		Month		Month		Month		Month		Month
	Disease resistant										
	Grain color										
	Quality of injera										
	Quality of arki/tela										
	Straw yield										
	Threshing										
	Weeding										
	Overall										

43. Have you grown any of the local finger millet varieties in the last two cropping seasons (2008 and 2009, respectively)?
44. 2) Yes 1) No; If no, why?________________

45. If yes, which of the local finger millet varieties have you grown in the last two cropping seasons (2008 and 2009, respectively)?_______________ -

Do you know or aware of improved finger millet varieties/technologies? 2= Yes 1= No

46. If no, Why?_______________

Do you ever grow improved finger millet varieties/technologies? 2= Yes 1= No

47. If no, why?_______________

48. If yes, what types of improved finger millet varieties/technologies do you grow?

49. List them? 1_______________ 2_______________ 3_______________

Do you know the recommended seed rate of finger millet? 2= Yes 1= No

50. If yes, what is the recommended seed rate per hectare?_______________

51. Do you know the recommended fertilizer rate of finger millet?
2= Yes 1= No

52. If yes, what is the recommended rate per hectare? DAP/ha_________ UREA/ha_______

53. Do you know the recommended rates of pesticides and herbicides of finger millet? 2= Yes 1= No

54. If yes, what is the recommended rate per hectare? Pesticides _______ herbicides

55. When did you plant the improved finger millet varieties/technologies first?_____

56. How did you know about it? _________ Where did you get the seed first? _______________

57. Where did you get the seed now? For what purpose do you normally cultivate finger millet?1= food 2= cash 3= both

58. In mix or sole farming system? If mix, with which crops?_______________

59. Rate the types of improved finger millet variety/ies in terms of their characteristic traits using a 4-point response scale as 1= poor 2= good 3= very good:

Characteristics/traits 1= poor 2= good 3= very good	Types of improved finger millet variety/ies A=		B =		C =		D =		E =	
Average yield		Qt/ha		Qt/ha		Qt/ha		Qt/ha		Qt/ha
Grain color										
Disease resistant										
Earliness		Month		Month		Month		Month		Month
Quality of injera										
Quality of arki/tela										
Straw yield										
Threshing										
Weeding										
Overall										

60. Have you grown any of the improved finger millet varieties in the last two cropping seasons (2008 and 2009, respectively)?

61. 2) Yes 1) No-- If no, why?_____If yes, which of the improved finger millet varieties have you grown in the last two cropping seasons (2008 and 2009, respectively)?_________

62. Which of the improved finger millet variety/ies/technology/ies, do you perceived to be better than your or farmers local finger millet varieties and rated highly by farmers? In what?_What is the biggest land size you planted improved finger millet so far? ____

63. Fill the finger millet farm production activities that you practiced in the last two cropping seasons (2008 and 2009, respectively)?

Years	finger millet planted	Area per/ha	Planting	Yield obtained /ha	Amount sold	Consumed (%)	Selling price (Birr)	Seed rate (kg/ha)	Fertilizer rate (kg/ha) DAP	UREA
2008 & 2009	Local variety									
	1									
	2									
	Improved									
	1									
	2									

Farmers Sources of Obtaining Agricultural Information

64. What are the sources of expertise, advice or information on agricultural activities in general and in finger millet technologies in particular?

No.	**Sources of information**	Yes=2	No =1
1	Neighbors		
2	Farmers own experience		
3	Parents/children/relatives		

4	Extension staffs		
5	Research staffs		
6	NGO staffs		
7	Cooperatives		
8	Churches		
9	Farmers field day		
10	Farmers exchange visit		
11	Demonstrations		
12	Community leaders		
13	Market place		
14	Trainings/workshops/seminars		
Others			

65. What are the types of information received by farmers on agricultural activities in general and in finger millet technologies
66. in particular, and rate using a 4-point response scale?

Key: 1= None 2=Deficient 3=Adequate 4= Good 5= Excellent

Types of information	Key	Sources information
Awareness /understanding information that new varieties/technologies exist		
Technical information: technical details of farming practices or operational skills on how to grow new varieties, manage pests, recommended row spacing, ploughing depths, sources of improved seeds)		
Marketing information: linkages to or information on channels and institutions for marketing of your products, commodity prices at different locations		
Policy		

Characteristics of Finger millet Technologies

67. How would you rate the following attributes of improved finger millet variety/ technology to you using 4-point response scale?

Key: 1= Deficit 2= Satisfactory 3= Very good 4= Excellent

Attributes of the technology	Deficit	Satisfactory	Very good	Excellent
	1	2	3	4
Relative advantage				
Giving economic benefits in the short term				
Saving time and labour				
High degree of economic profitability				
Low initial costs				
Compatibility				
Building upon existing practices				
Consistent with indigenous knowledge systems				
Complexity				
Easy to do				
Easy to learn				
Trialability				
Applicable on a small scale before full adoption				
Observability				
Its effects/yields are easily observable by friends				
Easy to communicate and describe to others				
Addressing gender needs				
Satisfies the felt needs of men households				
Satisfies the felt needs of Women farmers				
Satisfies the felt needs of both men and women farmers				

Decision making behaviour

68. How did you make finger millet planting decisions on your farm lands?
Decision was imposed from outside [ ] From my observation and experience [ ] Negotiation with my colleagues
Don't know Other, specify ____________________

Adoption, Discontinuation or Rejection

69. Are you still cultivating any of the improved finger millet varieties? No [ ] 1 Yes, [ ] 2

70. If no, why are the improved finger millet varieties/ technologies is no longer in use? Please give a reason?
71. Have you transferred the technologies /improved finger millet varieties, to other farmers? No [ ]1 Yes,[ ] 2
72. If no, why have you not transferred the technologies to other farmers? Please give a reason.

Farmers Perceptions of the factors limiting adoption of improved finger millet varieties

73. What you perceived to be the major factors limiting farmers' adoption of improved finger millet technologies/varieties
74. in the study area?____

Perceptions of outcomes of adoption of finger millet technologies at household level

75. If you have adopted the improved finger millet variety/technology at household level, what is your perception of the following statements regarding the condition of your household as a direct result of adopting the finger millet technology?

Household conditions	Perceptions			Give reasons for your a
	Decreased	Remained about the same	Increased	
	1	2	3	
Area allocated for improved finger millet variety				
Household farm incomes				
Household cash savings				
Household off-farm income				
Food production				
Quality of household diets				
Education of household members				
Labour requirements				
Involvement in marketing activities				
Social networks				
Addressing gender needs/meet felt needs of and women farmers/				

Section 5. Linkage Section

Have you participated/involved with researchers and extension agents regarding any technology development and delivery system in the last two cropping seasons (2008 and 2009 years)? 2) Yes 1) No ;If no, why?

76. If yes, which extension activities organized by your agent last two farming years are you aware of?

Activities	Awareness		Participation		Level		
	Yes	No	Yes	No	High	Modera	Low
On farm demonstrations							
Training of group Leaders/contact							
Farmers trainings							
Planning and review							
Group meetings/discussion							
Meeting with Researchers/							
Supervisors							
Joint field days							
Diagnostic Research							
On farm Adaptive Research							
Evaluation of technologies							
Identification of problems							
Visit to Research Institute							

Linkage Mechanisms

77. Indicate the types of linkage mechanisms of each linkage functions that are regularly used by research and extension organizations, respectively to link with farmers? Please rate how you strongly agree or disagree.

No	Linkage Functions	Linkage Mechanisms	Actors	No (1)	Yes (2)
1	Planning and review	Joint problem identification	Extension		
			Research		
		Joint priority planning and setting committees or meetings	Extension		
			Research		
		Joint programming and review committees or meetings	Extension		
			Research		
		Joint technology release committee or meetings	Extension		
			Research		
2	Collaborative professional activities	Joint adaptive trials	Extension		
			Research		
		Joint field visits	Extension		
			Research		
		joint demonstration trials	Extension		
			Research		
		d)Joint surveys/diagnostic survey	Extension		
			Research		
3	Exchange of resources	Financial agreement	Extension		
			Research		
		Contract for services	Extension		
			Research		
		Exchange of personnel	Extension		
			Research		
		Staff rotation	Extension		
			Research		
4	Dissemination of knowledge and information	Publications	Extension		
			Research		
		Seminar/ Workshop	Extension		
			Research		
		Technical Reports	Extension		
			Research		
		Farmers exchange tour	Extension		
			Research		
		Demonstration trials	Extension		
			Research		
		field days	Extension		
			Research		
		Audio-visual material	Extension		
			Research		
		Trainings	Extension		
			Research		
5	Feedback	Evaluation surveys	Extension		
			Research		
		Evaluation meetings	Extension		
			Research		
		Evaluation field visits	Extension		
			Research		
		Publication of reports by monitor evaluation team	Extension		
			Research		
6	Coordination/networking	Coordinator positions/Research extensi positio	Extension		
			Research		

Involvement in Selected Linkage Mechanisms

78. In which of the following selected linkage activities/mechanisms do you involved/participated with researchers and extension agents regarding finger millet technology development and delivery system in the last two cropping seasons (2008 and 2009 years)?.

Linkage Mechanisms	Years and frequency of participation							
	In 2008 and Frequency of participation				In 2009 and Frequency of Participation			
	Not participated	1 times	2 times	3times	Not participated	1 times	2 times	3 times
Joint problem identification								
Joint priority planning , programming and setting committees or meetings								
Joint technology release committee or meetings								
Joint adaptive trials								
joint demonstration trials								
Joint surveys/diagnostic survey								
Publications								
Seminar/ Workshop								
Technical Reports								
Farmers exchange tour								
Field days								
Trainings								
Evaluation meetings								
Evaluation field visits								
Others ,specify								

79. In your experience what are the benefits that you get as an individual from your participation in joint research-extension-farmers finger millet linkage activities/mechanisms?____________________

80. If you are not participated in joint research-extension-farmers- finger millet linkage activities/mechanisms, what could be the factors limiting your participation?____________________

81. From your farming experience, what could be the major limiting factors affecting the performance of linkages between research, extension and farmers?____________________

82. What could be improved for further strengthening of research-extension-farmers linkage system for joint technology development and delivery system in general and for better participation in finger millet linkage activates in particular?________

Type of participation

83. In your experience which of the following statements best describes the relationship that exists between farmers with researchers and extension agents?

Type of participation	Please tick (✓)	
	With Res	With Extension
None		
Conventional/Contractual: The research / extension organization has sole decision-making Power over most of the decisions in the innovation process, and can be considered the 'owner' of the process. Others are formally or informally 'contracted to provide services and support.		
Consultative: Most of the key decisions are made and kept with research/extension but emphasis is put on consultation and gathering information from others especially for identifying constraints and opportunities, priority setting and /or evaluation.		
Collaborative: researchers/extension agents and farmérs/groups collaborate as equals, emphasising linkages through an exchange of knowledge, different contributions and a sharing of decision-making power during the innovation process.		
Collegial: researchers/extension agents and farmers/ groups work together as colleagues or partners. Ownership and responsibility are equally distributed among partners ,and decisions are made by agreement or consensus among all actors		
Farmer experimentation: The research / extension organization builds links between farmers' indigenous knowledge systems, the experiences of other partners and researchers' scientific knowledge systems in implementation of new agricultural technologies.		

Appendix 22 Checklist Used For Group Discussions with Researchers and Extension agents.

a. Major challenges to meet organization goals?
b. What linkage strategies are being used at organizational and individual level?
c. Origin of the linkage mechanism: was it initiated by particular actors?
d. Who are the participants in the linkage mechanism?
e. Describe their activities?
f. When was the linkage used? What task did it carryout?
g. Specific outputs? Degree of formality?
h. Impact of the mechanism on performance?
i. Is it facilitative or a control mechanism?
j. Does it have an official mandated purpose?
k. Type and quantity of resources exchanged among actors, if any.
l. Type, quantity and source of required for the linkage mechanisms to function.
m. Who provides/control these resources?
n. Administrative level at which the mechanism operates?
o. Evidence and perceptions on the competence of participants in fulfilling their functions?
p. What, if any, decision-making powers are attached to the linkage mechanism under consideration?
q. Prioritize the most critical factors affecting linkages in order of importance?
r. Staff motivation? Reward System?
s. Organizational culture? Working relationship with
t. What are the main challenges of finger millet production?
u. What research efforts are being made for development of finger millet technology?

Appendix 23 Checklist Used For Key Informant Interviews of Researchers and Extension Agents (Mangers and experienced professionals).

a. Major challenges to meet the organization goals?
b. What linkage strategies are being used at organizational and individual level to address the actors and farmers?
c. Origin of the linkage mechanism?
d. Who are the participants in the linkage mechanism?
e. Describe their activities?
f. When was the linkage used?
g. What task did it carryout?
h. Specific outputs? Degree of formality?
i. Impact of the mechanism on performance?
j. Is it facilitative or a control mechanism?
k. Does it have an official mandated purpose?
l. Type and quantity of resources exchanged among actors, if any.
m. Type, quantity and source of required for the linkage mechanisms to function.
n. Who provides/control these resources?
o. Administrative level at which the mechanism operates?
p. Evidence and perceptions about the competence of participants in fulfilling their functions?
q. What, if any, decision-making powers are attached to the linkage mechanism under consideration?
r. Prioritize the most critical factors affecting linkages in order of importance?
s. Policy support to your organization? Reward system? Resource allocation procedures?
t. Organizational culture? Staff motivation? External pressure? Organizational structure? Staff-turn over?
u. Individuals' roles and capacities in full filling their responsibilities? Farmers production capacity?
v. Technology transfer agents work over load.
w. Main challenges of technology development and delivery system?
x. What are the main challenges of finger millet production?
y. Role of researchers, extension agents and farmers in finger millet technology development and delivery schemes?
z. What linkage strategies recommend for successful linkage among the actors?

Appendix 24 Checklist Used For Focus Group Discussions and Key informant interviews with Farmers

a. Major livelihood activities? Farm, off-farm, and nonfarm activities?
b. Major crops grown and animal reared.
c. What technologies were introduced to the localities? By whom? When? Relevance at farm level?
d. What are the roles of finger millet varieties as compared to other crop technologies?
e. What constraints' are associated with the variety?
f. What are the major actors involved or linked with farmers in the area? Their contribution to food security:
g. How is the working relationship with developmental agents? And where is the medium of contact most often used?
h. How is the participation of farmers in trainings, seminars, and field days?
i. Adequacy and capacity of development agents?
j. Role of model farmers and leaders of formal social organization?
k. How is the working relationship with researchers?
l. Which communication methods are frequently used by the agents to reach farmers?
m. Which communication methods do farmers mostly preferred?
n. How is the linkage between research and extension?
o. What challenges are associated with input delivery and credit system?
p. What infrastructural challenges noticed in the area? Credit, market, road, input delivery?
q. What challenges influenced production capacity?

ANNEX

Dependent Variable

The linkage mechanism is the concrete procedure, regular event, arrangement, device or channel which bridges the gap between components of the system and allows communication between them (Roling, 1989). An effective agricultural development, in general, and technology development and delivery system in particular, requires a good linkage mechanism particularly between research, extension and farmers. However, one key issue that major studies bring out is the question of 'what governs effective research-extension-farmers linkages system' that fosters participatory technology development and delivery, with a transparent, and accountable by the consent of all stakeholders. The principles and types of linkages vary across different studies depending upon specific situations of social, economical, organizational, political, managerial and other conditions that influence successful linkages. This proved to be complicated. As for instance, According to ISNAR (1993), research-extension-farmers linkage mechanisms can be grouped in various ways: by ways of communication (e.g., media, Top-down' versus 'Bottom-up'), by task (e.g., seed multiplication), by degree of formality (e.g., 'Formal' versus 'Informal' linkages), by managerial level (e.g., field trial team, steering committee), or by function (e.g., collaborative task).

In the context of this study, a linkage mechanism by function or by their purpose was studied because, as it is more relevant for both research and extension which must regularly assess the performance of linkages between them from planning to evaluation, and to take corrective action if necessary, and secondly, linkage by dimensions and domains are very wide and complex to analyze and understand. Hence, this study focused on the narrow sense of linkage mechanisms by functions, or to describe the most important purpose for linkage between research, extension and farmers. Accordingly, sample researchers and extension workers indicated the functions and types of linkage mechanisms that were regularly used in their organizations to strengthen the research-extension farmers' linkages. The section made up of 25 items of six broadly defined linkage functions and the types spelt out below.

Planning and review functions; The specific linkage mechanisms for this function were a) Joint problem identification, b) Joint priority planning and setting meetings, c) Joint programming and review meetings, d) Joint technology release meetings

Collaborative activities; The specific mechanisms for this function were a) Joint adaptive trials, b) Joint field visits, c) joint demonstration trials, and d) Joint surveys

Exchange of resources; This includes a) Financial agreement, b) Contract for services, c) Exchange of personnel, d) Staff rotation

Dissemination of knowledge and information; The specific linkage mechanisms were a) Publications, b) Seminar/ Workshop, c) Technical Reports; d) Farmers exchange tour, e) Demonstration trials, f) field days, g) Audio-visual material, and h) Trainings.

Evaluation and feedback; It includes a) Evaluation surveys, b) Evaluation meetings, c) Evaluation field visits, d) Publication of reports by monitoring and evaluation team

Coordination, The specific linkage mechanisms for this function were a) Coordinator positions, b) Research extension liaison positions

To analyze and describe the prevailing research-extension-farmers linkage scenario in the study area, the sample researchers, extension workers, and farmers were asked whether they have been, a participant at least once in the last two production years from the above mentioned joint linkage mechanisms. Thus, considering participation in linkage mechanisms as a discrete measure is most appropriate when sample respondents typically participate or not-participate. Thus to analyze the linkage systems and factors affecting research-extension-farmers linkages, it was premised to dealt with the most common or frequently used linkage mechanisms where by the respondents have been participated jointly and have rated highly among all the other mechanisms in the last two years.

Hence, among the selected 14, the high scored or principal linkage mechanism, which fostered the participation of researchers, extension agents, and farmers in the last two years, was, joint field day. It is the institutional arrangement of research and extension to jointly participate with famers by organizing field days to evaluate and assess the performance of technologies under farm level, and for further planning, disseminating and wide scaling up of the technologies based on the reactions obtained from farmers. Thus, the two-year status of participation of researchers, extension workers, and farmers in joint field days was taken into account in defining and analyzing the linkage mechanisms and systems of research, extension, and farmers in the study area.

In the context of this study, Linkages is thus defined as the status of participation in joint field days at least once during the last two cropping seasons. As a result, the status of participation in field days is the dependent variable against which various explanatory variables that influence successful participation in linkage mechanisms of technology development and delivery are analyzed. Accordingly, a researcher, a farmer, or an extension personnel who has been participating in joint field days at least once in the last two years was considered as a "participants" otherwise a "non- participants". Still, this might be a narrower definition for the reason for the exclusion of the rest linkages mechanisms. However, it is believed that, the most promising, frequently used and prominent linkage mechanism jointly by the three actors, (in this case field days), would enable to know more about the nature and extent of the prevailing linkage system in the technology system of the study area.

Independent Variables

The independent variables of research-extension-farmers linkage study are those, which are expected to have influence on the dependent variable. Linkage literatures provide a long list of factors that may influence successful linkages between researchers, extension workers, and farmers for sound technology development and delivery of agricultural technologies. The combined effects of variables mentioned below are hypothesized to influence research-extension-farmers linkage in the study area.

Sex: It is a dummy variable, which takes a value of 2 if the respondent researcher, extension agent, and farmer is male and 1 otherwise. Several studies argued that that female-headed farmer have less access to improved technologies, land, credit and extension services than male-headed household. Therefore, it was expected that the male-headed household farmers are better participants of linkage mechanisms. Similarly, Sex is expected to positively influence towards male researchers and extension workers towards participation of joint research-extension-farmers linkage mechanisms.

Age: Age matters in any occupation. Some studies reported older farmers are less interested to participate in various activities with extension and are more likely to reject new agricultural technologies as compared to younger farmers. However, in this study, it was hypothesized that increased farmers age as well as increased age of researchers and extension workers, would have a positive impact on the participation decision in joint research-extension-farmers linkages.

Education Level: This is a continuous variable measured in years of schooling. It assumed that formal schooling of farmers is expected to enhance farmer's ability to perceive, interpret and respond to new events, and increase their willingness to participate in various extension activities and to adopt a new technology. Similarly, it is expected that high education level of researchers and extension workers assumed to foster participation in joint linkage mechanisms that dealt with various issues that require analytical skills.

Marital Status: This is a dummy variable, which assumed that married farmers are more likely to participate in various extension activities to increase production, and the need to ensure household food security can stimulate their participation. It was hypothesized that farmers' decision to participate with either extension or research might be influenced by their wives positively. On the contrary, a negative relationship between marital status of researchers and extension workers, and the probability of participation in research-extension-farmers linkage mechanisms was hypothesized, due to the fact that the decision to participate are mostly determined by the organizational goals and duties of the professionals and hence their wives influence on their participation may be less.

Farming and Professional Work Experience: In this study, a positive relationship between professional experience of researchers, extension workers, farmers and the probability of participation in joint research-extension-farmers linkages was hypothesized. It is assumed that farmers with longer farming experience are expected to be more knowledgeable and skillful and have better competence in assessing the characteristics of new technology than farmers with shorter farming experience, as a result it enhance their participation in various extension activities by closely linked with extension.

Farm Size of Household Farmers: This variable measured in hectares. In the study area, intensification was given priority due to the decline in farm size from time to time coupled with an alarming increase in rural population, hence it might reduces farmers linkage with extension and less likely to adopt improved technologies. Therefore, it was hypothesized; total size of cultivable land is negatively related to the probability of participation.

Family Size of Household Farmers: It is a continuous variable that refers to the number of family members of a given household. The family members are important in the operation of farm activities often implies a need for additional labor. It assumed to contribute the decision to contact with extension and/or to adopt new technologies positively.

Number of Livestock Owned (TLU): This variable defined in terms of Tropical Livestock Unit (TLU). Livestock may serve as a proxy for the capacity to bear risks of using new technology and capture wealth effect. Since livestock is important for farm operations, the farmer who benefits from power and animal products can have an extra income to influence the adoption of agricultural technologies, hence it might have positive influence on farmers' linkages.

Access and Frequency of Contact with Extension Agents: Agricultural extension services provided by Bureau of Agriculture at all levels represent the major source of information for farmers. These variables were measured as dummies and continuous in access and frequency of contact, respectively that the household farmer made per year with the extension agent. The higher the linkage between farmers and development agents, the more participation in training, demonstrations and field day, and hence, the more the information flows and the technological (knowledge) transfer between them. Those, it is assumed to positively affect the nature and extent of linkage system in technology adoption.

Timely Input Availability: Timely availability and supply of quality and quantity input is among the factors influencing farmers' successful linkages with extension and adoption of technologies. This variable was treated as dummy variable, and assumed to influence farmers' links with extension positively.

Distance from Market: It is a continuous variable that was measured in minutes. It refers to the distance between the farmers' residence and the nearest market center. As farm households are nearer to input output market places, it is expected to secure agricultural information regarding improved technologies at market place, and more likely to participate or link with extension for further technological information's, and in turn the higher will be the chance of adoption of technologies. Therefore, in this study it was hypothesized an inverse relationship between market distance and the joint linkages with extension agents.

Distance To Nearest Farmers Training Center: This variable refers to the time a farmer may need to walk to get the extension agent. As a farmer is nearby his development agent, there may be a chance to have more contact hours than the farmer may who live at a farther distance. More contact may help a household to be convinced by the development agent and are expected to participate in various extension linkage mechanisms positively.

Distance to All Weather Roads: It is a continuous variable measured in minutes. It refers to the time a farmer may need to walk from home to get to the main all weather roads. As farmers' home gets closer to the main road, they can have access to transportation facilities, which might increase their links with extension. More over in the study area, research centers have given priority to undertake various research trials, and field days on roadside accessible famers' fields than those farther from the main road. Therefore, it was expected to be negatively related to farmers' linkages.

Participation of the Household in Leadership of Social Organizations: It is a dummy variable that takes a value of 2 if households participate in leadership of social organizations and 1, otherwise. It defines whether the respondent farmers have assumed any type of administrative responsibility in his village or PA level during the last two years. If the household heads assumed any type of responsibility, the chance of becoming accessible to information may increase and hence become willing easily and quickly than those, who do not assumed any type of responsibility. Moreover, the chances of being selected by extension or research to participate in various joint meetings, seminars, trainings and field days were expected to increase. Hence, participating in leadership in formal and informal organizations was expected to be associated positively with the decisions of farmers to participate in joint research-extension-farmers linkage mechanisms.

Farmers' Access and Sources of Information: referring to farmers various sources of obtaining agricultural information. Those farmers who have multiple sources of information tend to have more contacts with research or extension, with the advantage of getting information about new technology. It is, therefore, hypothesized positively.

Researchers and Extension Sources of Ideas for Setting Their Work Priorities: It referring to the sources they often use for ideas to set their work priorities. It further enables to know whether their idea to set work priorities was based on the consent of all stakeholders through joint participation of researchers, extension agents, and farmers. It was, therefore, hypothesized that researchers and extension agents' sources of ideas for setting their work agenda expected to affect and positively correlate with participation in joint research-extension-farmers linkage activities.

Awareness of Finger Millet Varieties and Practices: Keeping indigenous knowledge as a basis might yield baskets of sustainable technological options that satisfy the needs and constraints of farmers. Similarly, farmers' awareness of improved technologies is a precondition of its technology adoption. Hence, it is possible to conclude that awareness level of researchers and extension workers about farmers' best local finger millet varieties, and farmers awareness of improved finger millet technologies was hypothesized to positively influence their joint participation in finger millet linkage activities.

Policy Environment: It is a dummy variable that takes a value of 2 if researchers and extension agents perceive the problem and 1, otherwise. Previous research results have revealed that many research-extension linkage problems could be traced to problems of policy environment (e.g. ISNAR, 1987; Kaimowitz et al., 1989). They found that in many developing countries external pressure, effective leadership or intervention from policy makers is generally minimal. In the absence of effective external pressure, the institutions and personnel involved in research and extension tend to be motivated more by their own social and political needs than by the needs of resource-poor farmers. Therefore, it was hypothesized that that policy environment would influence research-extension linkage negatively.

The Structure of Farming System: This refers to the farming systems targeted by research and extension are diverse and agro ecologically, and socio-economically complex, and it is expected to pose difficult problems to the quality, quantity and diversity of human resources required and affected the feedback system and linkages. ISNAR, 1987; Kaimowitz et al., 1989 reported similar finding.

Donor Involvement: It is a dummy variable that takes a value of 2 if researchers and extension agents perceive the problem and 1, otherwise. This refers to the dependency of linkages in donor-funded projects was expected to fluctuate linkages between research, technology transfer, and farmers. As soon as the project ceases, it was expected that the linkage initiatives might lost and not be sustainable. Hence hypothesized to influence linkage negatively.

Resource problems: It is a dummy variable that takes a value of 2 if researchers and extension agents perceive the problems and 1, otherwise. This refers to resource related problems; mainly human, financial, and physical, were expected to affect linkages between research- extension- farmers for sound generation and transfer of technologies negatively. FAO (1997), ISNAR (1987), and Kaimowitz et al. (1989) also reported that adequate resources are lacking to achieve the stated goals. In a resource-limited situation, linkage activities suffer most.

Motivational and Incentive Problems: It is a dummy variable that takes a value of 2 if both perceive the problems and 1, otherwise. This refers to the incentive systems currently in use are not compatible with the goals of research and extension system, thus it was expected to influence joint linkages negatively. Previous research results (e.g. McDermott, 1987) also indicated that individuals might have little incentive to perform linkage activities, made obvious where researchers and extension agents avoid linkage activities such as adaptive field trials and preparation of written materials.

Status Differences: this is a dummy variable that takes a value of 2 if researchers and extension agents perceive the problem and 1, otherwise. This refers to integration was expected to be more difficult between groups of different status. In the study area, researchers in general have higher status than extension agents do. Perceived status differences expected to hinder the use of collaboration as a mechanism for strengthening links. (Seegers and Kaimowitz, 1989), Eponou (1990), and FAO (1997) also reported similar finding.

Structural Problems: This is a dummy variable that takes a value of 2 if researchers and extension agents perceive the problem and 1, otherwise. This refers to the available research-extension-farmers linkage mechanisms are operational but expected to be ineffective. Therefore, it was hypothesized to influence research-extension-farmers linkage negatively. The previous research results (e.g Kaimowitz et al., 1989) also showed the responsibility of managing linkage activities, conducting adaptive research, communication of research results, or, feedback from users to researchers is not generally assigned to individuals, or institute that manages in accountable manner.

Managerial Capacity: This is a dummy variable that takes a value of 2 if researchers and extension agents perceive the problem and 1, otherwise. It is assumed that research and extension managers lack the essential skills for running their organizations, including those for managing linkages, unable to provide leadership, to build a team, to communicate effectively, or to deal with conflicts, and thereby expected to influence research-extension-farmers linkage negatively. ISNAR study also found that many linkage problems were traced to managerial problems.

Planning and Time Management: This refers to the time devoted to linkages was not carefully planned by inherently optimizing the resources needed for linkages, thus it was expected to influence the level of research-extension-farmers linkage negatively. ISNAR (1987) also revealed that, planning of linkage activities is minimal in many developing countries.

Involvement of Extension Agents in Various Activities: This refers to the extension staffs had many tasks to perform other than transfer of technology and information, which included agricultural and credit administration, and input supply. Thus, it was expected that involvement of extension workers in non-agricultural activities might influence the level of research-extension-farmers linkage negatively. To summarize all the above potential explanatory variables were treated to identify the key factors influencing the performance of research-extension-farmers linkage in the study area.

DECLARATION

I the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university and that all sources of materials used for this thesis have been duly acknowledged.

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I confirm that this thesis has been submitted with my approval as a University Thesis Research Advisor

Ignatius Mberengwa (Ph.D.)

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