DILLA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

# MAPPING AND QUANTIFICATION OF CROP-LIVESTOCK INTERVENTIONS IN AFRICA RISING SITES OF ETHIOPIAN HIGHLANDS

(A THESIS)

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# MAPPING AND QUANTIFICATION OF CROP-LIVESTOCK INTERVENTIONS IN AFRICA RISING SITES OF ETHIOPIAN HIGHLANDS

BY

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A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES OF DILLA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTERS OF SCIENCE DEGREE (MSC) AGRICULTURAL ECONOMICS

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APPROVAL SHEET

**DILLA UNIVERSITY**
**SCHOOL OF GRADUATE STUDIES**

We the undersigned certify that the thesis prepared by Melese Mulugeta Gobena, entitled ôô **Mapping and Quantification of Crop-Livestock Interventions in Africa RISING Sites of Ethiopian Highlands** and submitted in partial fulfillment of the requirements for the Master of Science (MSc) in Agricultural Economics complies with the regulation of the university and meets the accepted standards with respect to originality and quality.

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# APPROVAL FROM THE ADVISOR

I, the undersigned certify that I have read and evaluated this thesis entitled ñ**Mapping and Quantification of Crop-Livestock Interventions in Africa RISING Sites of Ethiopian Highlands''** prepared under my guidance and done by Melese Mulugeta Gobena (ID. No. RPGAE 016/14). I recommend that it should be submitted for defense as fulfilling the thesis requirements.

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# STATEMENT OF AUTHOR

I, the undersigned, declare that this thesis work entitled ô **Mapping and Quantification of Crop-Livestock Interventions in Africa RISING Sites of Ethiopian Highlands'',** is my original work, that it has not been submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate, that I followed all ethical and technical principles of scholarship in the data collection, data analysis and preparation of the report, and that all the sources that I have used or quoted have been indicated and acknowledged.

Name: Melese Mulugeta Gobena

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# BIOGRAPHY OF THE AUTHOR

The author was born in Sidama Zone, Arbegona district at specific place called Duwancho (80 Km southeast of Hawassa), in July 1986 G.C. He attended elementary School education at Bochessa elementary school (grade 1-7), Kunicha elementary school (grade 8) and completed his secondary school at Arbegona Senior Secondary school. After that he joined Tabor (Hawassa) Comprehensive Senior Secondary and Preparatory School for attending Preparatory level programme in September 2003. Later on he joined Hawassa University in September 2004 G.C. and graduated in B.Sc. Degree in Agricultural Resources Economics and Management in July 12, 2007 G.C.

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# DEDICATION

I dedicate this paper to my Late younger brother Samuel Mulugeta, who suddenly departed from us at the age of 21 year.

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# Acronyms

| | |
|---|---|
| AEA | Agricultural Extension Agents |
| AEZ | Agro Ecological Zones |
| AR | Africa RISING |
| ATA | Agricultural Transformation Agency |
| CSA | Central Statistical Agency |
| DA | Development Agents |
| FtF | Feed the Future |
| FPR | Farmer Participatory Research |
| GDP | Gross Domestic Product |
| GTP | Growth and Transformation Program |
| HYV | High Yield Varieties |
| IDT | Innovation Diffusion Theory |
| KM | Kilometre |
| LPM | Linear Probability Model |
| MLE | Maximum Likelihood Estimation |
| NGO | Non Governmental Organizations |
| NPV | Net Present Value |
| OLS | Ordinary least Squares |
| PRA | Participatory Rural Appraisal |
| PLA | Participatory Learning and Action |
| PPS | Probability Proportion Sampling |
| PVC | Participatory Varietal Selection |
| RD & E | Research, Development and Extension |
| RISING | Research In to Sustainable Intensification for Next Generation |
| SE | Standard Error |
| SNNPR | Southern Nations Nationalities Peoplesô Region |
| SPSS | Statistical Package for Social Sciences |
| UNDP | United Nations Development Program |
| US | United States |
| USA | United States of America |

# ABSTRACT

*Agriculture is the backbone of the Ethiopian economy and therefore this particular sector determines the growth of all the other sectors and, consequently, the whole national economy. The agricultural sector contributes 42% to the country's GDP, on average, crop production makes up 60% of the sector's outputs whereas livestock accounts for 27% and other areas contribute 13% of the total agricultural value added (CSA, 2015). The sector is dominated by small-scale farmers who practice rain-fed mixed farming by employing traditional technology, adopting a low input and low output production system. RD&E in smallholder agriculture often focuses on specific elements of the farming system, sometimes leading to the introduction of improved agricultural technologies. There has been a plenty of efforts to achieve sustainable intensification in agricultural production, but many efforts fail to map the dissemination of the crop-livestock interventions, to quantify the inputs saved and the extra amount of outputs obtained by the use of improved technologies and to identify the factors affecting the dissemination of the crop-livestock intervention. As a result, this study was conducted with the objectives of mapping the dissemination of the crop-livestock interventions, quantification of the inputs saved and extra outputs obtained and identification of the factors affecting the dissemination. The study was conducted in the eight kebeles of four districts; Lemo from Hadiya Zone, South region; Sinana from Bale Zone, Oromia region; Basona Worena from North Shewa Zone, Amhara region and Endamehoni from South Tigray Zone, Tigray region. In order to generate relevant data, 160 farm households who were participating in the Africa RISING project were selected using multistage sampling technique. This study also showed that potato (ware and seed) varieties introduced by the project propagated within and outside of the intervention locations. Farmers liked potato for its adaptability and high productivity in all four locations. The duality of the function (food and income) of the potato for the smallholders households make it the most disseminating crop across all sites. Potato yield on average was 16 tons per hectare where as the existing national average was 10 tons per hectare. An average yield of wheat was 21.5 quintals per hectare, average barley yield was 13 quintals and average faba bean yield was 14 quintals per hectare. Interms of profitability potato could fetch on average 62713 birr per hectare when the market price is high, but due to the perishability of the potato and market fluctuation, the net return is not consistent. Faba bean returns about 25866 birr per hectare and wheat returns 10187 birr per hectare whereas barley returns on average 3361 birr per hectare. The most important factors affecting the dissemination of the crop-livestock interventions in the study areas are: education level of the farmers in schooling years, technology characteristics of the interventions, farmers' perception about the yield, and time after the intervention, extension contact and communication channels. Hence, the future crop-livestock interventions seeking to achieve sustainable intensification should carefully consider and choose improved agricultural technologies suitable for the particular agro-ecologies and should give due attention for the factors that affect the dissemination of the crop-livestock technologies.*

***Key words**: Crop, livestock, interventions, sustainable, intensification, dissemination, mapping, quantification.*

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

Agriculture is the backbone of the Ethiopian economy and therefore this particular sector determines the growth of all the other sectors and, consequently, the whole national economy. The agricultural sector contributes 42% to the countryǿs GDP (CSA, 2015). On average, crop production makes up 60% of the sectorǿs outputs whereas livestock accounts for 27% and other areas contribute 13% of the total agricultural value added. The sector is dominated by small-scale farmers who practice rain-fed mixed farming by employing traditional technology, adopting a low input and low output production system. The land tilled by the Ethiopian small-scale farmer accounts for 95% of the total area under agricultural use and these farmers are responsible more than 90% of the total agricultural output. The small-scale farmers produce 94% of the food crops and 98% of the coffee, the latter being the leading export item for the country, whereas the private and state commercial farms produce just 6% of food crops and 2% of the coffee (Atsbaha, G. S. , and Tessema, B., 2010).

Agriculture is the primary activity in Ethiopia, where about 84 percent of the countryǿs population engaged in various agricultural activities and generates its income for household consumption to sustain its livelihood. Moreover, the country generates the lion share of its foreign currency earnings from the sales/export of agricultural commodities abroad and above all, the sector is believed to be the main source of capital to be accumulated for the process of establishing the future industrialized Ethiopia, which again shows the determinant role played by the sector to bring about sustainable economic development for the country in the years to come (CSA, 2015).

This reflects that the countryǿs aspiration for achieving overall economic growth largely depends on the performance of the agriculture sector. The sector requires substantial transformation in order to sustain economic growth, reduce poverty and ensure food security. To this effect, the Government of Ethiopia has established the National Agricultural Transformation Agency (ATA) with the mandate of identifying systemic constraints to agricultural development and growth, design solutions that will help to achieve sustained structural transformation and support the coordination and integration of agricultural development projects among various institutions. The agricultural sector is the countryôs major source of economic growth under Ethiopiaôs Growth Transformation Plan (GTP), with attention given to productivity and production increase which is crucial for the country's effort to attain food security and increase export earnings.

Agriculture in Ethiopia has experienced steady growth since, 2004. Though the overall trend is encouraging, both in terms of overall agricultural production and productivity, the sector suffer from major structural problems. Despite an average government investment close to 13% of the total expenditure in agriculture sector, even than Ethiopian agriculture remains using low input, low-value output and subsistence oriented, and is vulnerable to frequent climatic shocks (UNDP, 2015).

Cropï livestock farming systems, which are common in smallholder farming communities in many developing countries, are inherently complex. Initially, this can be a daunting prospect for research, development and extension (RD&E)ï based attempts to improve system performance, which is typically measured as increased productivity of individual crop and livestock activities or, more generally, as increased household welfare. RD&E in smallholder agriculture often focuses on specific elements of the farming system, sometimes leading to the introduction of a new technological component (e.g. fertiliser, new cultivar, veterinary medicine) or practice (e.g. silage-making, early weaning). However, although this approach may be both realistic and inevitable when limited resources are available to support system improvement, RD&E must also take into account the wider farming system (Winter B., 2011).

Research on the diffusion of innovation has been widely applied in disciplines such as education, sociology, communication, agriculture, marketing, and information technology, etc (Rogers, 1995; Karahanna, et al., 1999; Agarwal, Sambamurthy, & Stair, 2000). An innovation is ñan idea, practice, or object that is perceived as new by an individual or another unit of adoptionò (Rogers, 1995). Diffusion, on the other hand, is ñthe process by which an innovation is communicated through certain channels over time among the members of a social systemò (Rogers, 1995). Therefore, the IDT theory argues that ñpotential users make decisions to adopt or reject an innovation based on beliefs that they form about the innovationò (Agarwal, 2000).

In large and heterogeneous countries, such as Ethiopia, agricultural potential is unevenly distributed over space, and the distribution of production patterns reflects this landscape (Jordan Chamberlin and Emily Schmidt, 2011). Mapped zones of smallholder production systems have long been recognized as important in Ethiopia precisely because of such landscape heterogeneity (Westphal 1975, Hurni 1998, De Pauw and Bruggeman, 1988)

The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) in Ethiopian Highlands is a program is supported by the United States Agency for International Development as part of the U.S. governmentôs Feed the Future initiative. The project focused on the sub-sectors (sub systems) such as livestock feed, small ruminant, wheat, barley, potato, faba-bean. Participatory Varietal Selection (PVS) is one of the activities of the project. However, the main focus is not basic research but introducing and promoting new technologies and promoting model activities to the farmers of other areas

The highlands of Ethiopia are characterized by mixed crop livestock farming systems where the crop and livestock sub-systems complement each other (Getachew et al,. 1993). Thus, enhancing the resource use efficiency through crop-livestock interventions, thereby allocating efficiently their available resources such as land, labour, capital and other inputs to the best alternative uses requires intensifying the input uses sustainably. Therefore, there was a need to measure efforts by scientific study through mapping and quantification of the crop-livestock interventions, their dissemination, and the relative gains from the crop-livestock interventions.

## 1.2 Statement of the Problem

Efforts to develop agriculture are expected to result in improved agricultural production; ñimprovedò obviously having multiple interpretations. Better technologies have to be generated and put into use. Agricultural scientists by training and tradition want to believe that new technologies drive agricultural development. Research findings are passed through transformative and communicative stages and finally result in improved production. This default linear model is valid in some cases, and utterly wrong in others. How farmers perceive adoption and diffusion of agricultural innovations is therefore a key element in our position of agricultural research for development. Research projects like Africa RISING project aspire to maximize the impact of research outputs and that become reality only through seeing the changes brought about by the use of improved practices in terms of the input saved, outputs added and the transfer and dissemination of the improved technologies and practices. There are a lot of efforts and resources employed by both governmental and non-governmental bodies to bring sustainable intensification through use of improved agricultural technologies. But those efforts fail to document the dissemination of crop-livestock interventions beyond the point of the introduction. They also fail to report the amount of the inputs saved and extra amount of outputs obtained due to the use of improved agricultural technologies and rarely identify the factors determining the dissemination process. Therefore, this study shows the changes seen in Africa RISING project locations through quantifying the inputs and outputs, and mapping the dissemination of the crop-livestock interventions.

## 1.3 Objectives

### 1.3.1 General Objective:

The general objective of the study was to show whether the crop-livestock technologies were disseminated beyond the intervention areas and quantifying the saving in the inputs used and gains in outputs obtained from crop-livestock interventions in the study area.

### 1.3.2 Specific Objectives

The study was conducted with the following specific objectives:

1. To examine the crop-livestock interventions dissemination through mapping.
2. To quantify the relative gains from crop-livestock interventions.
3. To identify the factors affecting the dissemination of the crop-livestock interventions.

## 1.4 Significance of the study

Since generating and adopting improved agricultural technology requires a lot of resources, researchers and research organizations can easily judge their efforts from the value of the inputs used, input saved and extra amount of the outputs obtained from the improved technology. Therefore, this study will help them to examine their contribution to the livelihoods of the rural majority and to develop new insights for exploring better technical changes for further improvement of agricultural technology adoption.

The knowledge of actual constraints for technology dissemination, potentials of the technologies for difference making, farmersô response for adoption, their resource utilization and productivity situations are important for pinpointing areas of concentration of the countryös policy prescriptions regarding adoption and dissemination of improved agricultural technologies. In addition a better understanding of how improved agricultural technologies are affecting production and productivity in agriculture is essential for designing development policies and shaping the direction of the smallholdersô development. By quantifying the impact of the improved technologies, the study is expected to generate pertinent information for different stakeholders. Moreover, the result of the study can be used as springboard for other similar studies by making some additions to the knowledge pool of the dissemination of the improved agricultural technologies research system.

## 1.5 Purpose of the study

The purpose of the study was to map the dissemination of the introduced agricultural technologies and to quantify the gains from improved agricultural technologies over existing practices in Africa RISING sites. In doing so, the improved agricultural technology dissemination treated in light of the main elements of diffusions such as the innovation, communication channels, time and the social system. The intent with which this study was undertaken is to map the dissemination of the agricultural technologies and also the study comprises comparison of relative gains and the analysis of the factors affecting the dissemination.

## 1.6 Scope and Limitation of the Study

The scope of this study was restricted to the mapping the quantification of the outputs from in the Africa RISING project sites. In addition, this study taken into account dissemination of improved technologies by the project in respective sites. Moreover, the study investigated various factors which affecting the dissemination of the interventions.

However, as a matter of fact that this study is posed to investigate only interventions dissemination at a particular point of time, it didnöt employ time series approach since the study was designed to be completed in one season. The study also didnöt conduct any treatment aimed for this particular purpose and the data used for this study was generated from farmersô annual production data by the questionnaires. As a result, only simple descriptions were made with regard to comparison of the technologies dissemination across regions. The study neither looked into depth on agronomic performances of the technologies nor genetic aspects, but it emphasize on dissemination, the underlying factors affecting for dissemination and quantification of the inputs and outputs in economic terms.

# CHAPTER 2

# 2. REVIEW OF THE LITERATURE

## 2.1 Theoretical background

The history of the adoption and diffusion research can be dated back to as early 1940s beginning with the study of hybrid maize diffusion in Iowa, USA, by the rural sociologists Ryan and Gross (1944). Although the period indicated was taken as an important period with respect to a modern type of adoption and diffusion, there are evidences showing that studies were undertaken on the subject prior to that period. A review of literature on high yielding seed varieties (Ruttan and Binswanger, 1978) suggested that neither farm size nor farmers tenure has been a serious constraint on adoption. Although different rate of adoption by farm size and tenure have been observed, the available data implied that within a few years of introduction, the lags in adoption due to size or tenure have usually disappeared. Of course, non-adopters will have foregone the potential gain of early adoptions and may already have suffered as a consequence. However, these conclusions have not been altered by more recent research.

Moreover, the results from the past studies can be briefly summarized as insights of the adoption of agricultural technologies and its determinants. Research on the diffusion of innovations suggested that the distribution (frequency of adopters overtime) tends to follow a bell-shaped curve resembling normal distribution (Rundquist, 1994). It its cumulative form, the normal distribution forms the logistic curve which looks like the S-shaped curve often found in adoption studies. Griliches (1957) and Mansfeld (1961), Mahajan and Robert (1985), and Feder et al (1985) have discussed the S-shape of the cumulative adoption plotted overtime.

Feeder et al (1985) attributes the diffusion path of aggregate adoption of new technologies to the dynamics of the spread of information. In explaining and interpreting the S-shaped diffusion curve, Mansfield (1961) hypothesized that the rate of adoption is a function of the extent of economic merit of of the technology, the amount of investment required to adopt the technology and degree of uncertainity associated with the technology. Hagerstand (1967), meanwhile, offered an information transfer explanation.

## 2.2 Adoption and diffusion of agricultural innovations – theories and concepts

### 2.2.1 What Is Diffusion?

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas. Communication is a process in which participants create and share information with one another in order to reach a mutual understanding. This definition implies that communication is a process of convergence (or divergence) as two or more individuals exchange information in order to move toward each other (or apart) in the meanings that they ascribe to certain events. We think of communication as a two-way process of convergence, rather than as a one-way, linear act in which one individual seeks to transfer a message to another. Such a simple conception of human communication may accurately describe certain communication agent seeks to persuade a client to adopt an innovation (Rogers and Kincaid, 1981).

Diffusion of innovations has been studied by many disciplines (e.g. anthropology, sociology of various brands, education, medicine, communication studies, marketing, business administration, etc.). From an initial domination of sociology, economics has gradually taken over, possibly because of a stronger emphasis on the theoretical basis for adoption, and its policy relevance.

The sociologist Everett Rogersô seminal work on diffusion of innovations (1995) is a good starting point into this area of study. An innovation according to Rogers is ñan idea, practice or object that is perceived as new by an individual or other unit of adoptionò. Diffusion is seen as ñthe process by which an innovation is communicated through certain channels over time among members of a social systemò. A technological innovation usually has two components: a hardware aspect (the tool, product) and a software aspect (how to use the hardware). For good reasons studies of diffusion of innovations have often addressed individual innovations, in practice innovations often come in packages ï clusters ï and are interrelated and interdependent.

The characteristics of innovations explain their rate of adoption. Five such characteristics of importance are discerned: 1) The relative advantage reflects how the innovation is subjectively perceived superior to the previous idea; 2) Compatibility reflects how the innovation is perceived ñconsistent with the existing values, past experiences, and needs of potential adoptersò; 3) Complexity reflects the perceived difficulty to understand and use the innovation; 4) Trialability is ñthe degree to which an innovation may be experimented with on a limited basisò; and 5) Observability reflects how the results of an innovation are visible to others. An innovation can further be changed or modified (re-invented) by a user.

Communication, through channels, provides information to a social system with the purpose to influence the knowledge and assessment of the innovation. Mass media is often more effective in creating awareness of an innovation, whereas personal contacts are more effective in forming an opinion about a new idea. Such interpersonal communication is facilitated if conveyors of information are optimally similar to the receiver in certain attributes.

Time is a main factor in the decision-making process, innovativeness and an innovationôs rate of adoption. In the innovation-decision process, an individual passes through the stages: knowledge, persuasion, decision, implementation (adoption) and confirmation (post-adoption assessment). Information is sought at the various stages to reduce uncertainty about the usefulness of the innovation. The decision stages result in adoption or rejection of the idea.

Innovativeness is an expression for how early an individual or other unit of adoption is adopting a new idea compared to other members of the social system. Adopters are divided into five categories, each with its own characteristics: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards. Finally, rate of adoption is the relative speed with which an innovation is adopted by members of a social system.

The social system with its interrelated units shares an interest in finding solutions to a common goal, i.e. to improve their agricultural system to enhance livelihoods. Such a system has a social and communication structure that facilitates or impedes the diffusion of innovations in the system. Norms, being part of the social system, are the established behaviour patterns for system members. Often opinion leaders play a crucial role in influencing system members. Change agents may have the explicit role to influence members in a certain direction. Both opinion leaders and change agents are central actors in diffusion of innovations.

Three main types of innovation-decisions can be distinguished: independent individual decisions (adopt a HYV), collective decisions (soil conservation on hillsides), and authority imposed decisions. The accumulated adoption over time, i.e. the diffusion, is frequently found to follow a sigmoid distribution. In marketing applications, this feature has often been used to predict and influence diffusion.

Rogersô account for innovation adoption and diffusion does not give theoretical explanations to how adoption decisions are actually made. A classic article by Feder(1985) is a frequent departure for theoretical analysis of decision making. This line of studies is mainly pursued by economists. The essence of his article and follow-up renderings on the subject include a number of complicating issues. Often distinct technological options are present. Several decision processes may then run simultaneously or sequentially. Farmers may therefore rather consider portfolios of innovations. Further, innovations may be divisible or of a lumpy character, presenting a dichotomous choice, which could be a deterrent to those interested in trying on a small scale. Lumpy investments may be only partially recoverable and adoption decisions may at times be close to irreversible. There may be fixed transaction or information costs associated, that may again deter resource-constrained farmers. Innovations may be scale-neutral or contain economies of scale, i.e. the innovation may favour better resourced households. For divisible innovations, the intensity of use is of great interest (e.g. proportion of land allocated, intensity of use per area unit). Technologies may show improved performance over time, or become cheaper due to economies of scale, and therefore gradually become more attractive to farmers, ceteris paribus. Diffusion of technologies is more complex than the spread of influenza.

Potential adopters are uncertain what an innovation may offer. Over time information from different sources and from the farmerôs own experience reduces this uncertainty. A better base is established for adoption/rejection and intensity of use decisions. The decision maker is assumed to maximize the utility of asset use over time, subject to various resource constraints, usually assuming a concave utility function. This can be expressed by static models, or by dynamic, sequential models that consider changing knowledge and conditions. In a dynamic model, new decisions depend on the results of previous decisions and their effect on wealth and income, and revised subjective knowledge about the utility of the innovation, including production outcomes, expected costs and revenues. Farmers gradually learn how to make better use of the innovation. For management-oriented improvements, a better systems performance may also materialize over time. Hence parameters determining farmersô choice are continuously updated.

Risk has been included in many models. Production, incomes and costs are not deterministically known. Farmers have their subjective perception of risks involved, and consider not just the expected mean outcome but also the distribution of risks around the mean. The subjective perception of risk may well deviate from the objective reality. It is often assumed that farmers are risk averse with the extent depending on several characteristics. To the farmer, the riskiness of an innovation compared to the old idea then matters; also whether the risk varies together with risks in other parts of the system or moves in the opposite direction. Some models suggest safety-first decision behavior, implying that farmers have to be assured of a minimum result, and not base their decision on expected results. Theoretical models of adoption behavior have looked into variables that may explain the decision to adopt or the intensity of adoption. Such factors include farm size, credit and information access, personal traits of the decision-maker, tenure arrangement, etc. Theoretical models for the aggregate adoption complement individual adoption models. Alternative assumptions regarding individual adoption behavior usually result in S-shaped curves. Cochraneôs technological treadmill suggests diminishing gains over time due to price declines following increased production due to adoption(Johan Toborn, 2011).

## 2.3 Technology Dissemination

Conventional extension theory, based on the central source model of technology development and diffusion, examines the role of various organizational arrangements and communication techniques in persuading farmers to adopt a recommended technology. The Training and Visit System, promoted extensively by the World Bank in the 1970s and 1980s, exemplifies this approach. The "transfer of technology" view of extension has been superseded (in the literature, if not widely in practice) by more participatory, community-based methodologies, reflected in the currently fashionable approaches of Participatory Rural Appraisal

(PRA), Farmer Participatory Research (FPR) or, more generally, Participatory Learning and Action (PLA).

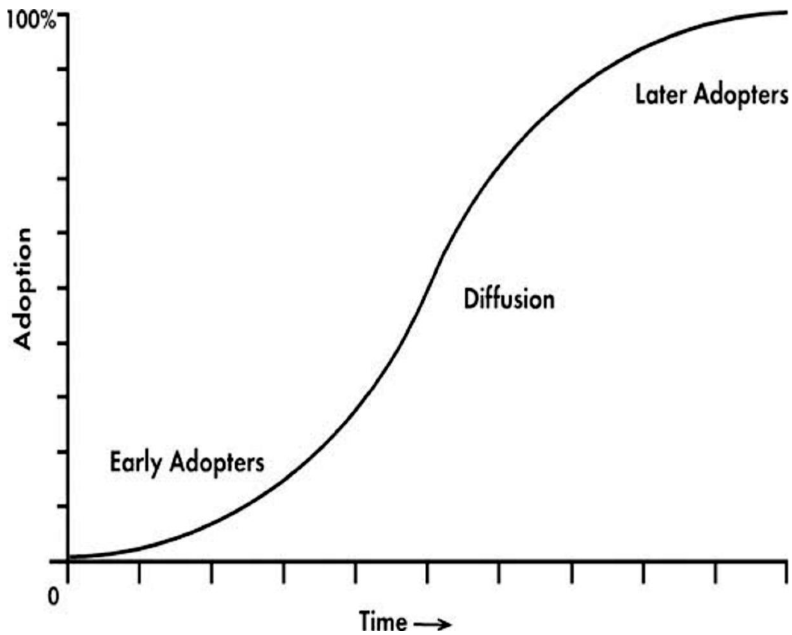
Such participatory methodologies have now been incorporated in development agency manuals and training courses worldwide. A recent set of guidelines for watershed development produced by the Ministry of Rural Development in an Asian country states that project staff need to be trained in the tools and techniques of project management, PRA methods, community organization, and other administrative and accounting procedures. Such statements hint at the rigid, top-down enforcement of "participatory" procedures. While institutional endorsement of innovative participatory approaches is to be welcomed, there is a concern that a preoccupation with methods (described as a "manual mentality") and their institutionalization within both government and non-government agencies will lead to unrealistic expectations of their general efficacy. This may distract attention from the complex requirements for successful research and extension projects. Rural development interventions, such as agricultural extension projects, involve a variety of social actors with diverse histories and agendas from both within and beyond rural communities. Hence, a project intervention needs to be recognized as part of an ongoing, continually renegotiated social process, not simply the execution of a pre-specified plan of action with expected outcomes.

Moreover, any technology dissemination activity takes place in a specific historical, political, economic, agro-climatic, and institutional context. The influence of these contextual factors may be crucial in determining the outcome of a particular extension project (Cramb, R.A. 2003).

## 2.4 Research Methods for Studying Diffusion

According to Everett M. Rogers et al., cited in Don Stacks and Michael Salwen (2006) most diffusion researchers have followed the methodological path set forth by Ryan and Gross in the hybrid corn study. Data are mainly gathered by personal or telephone interviews from respondents who are asked to retrospect about their time of adoption, the sources or channels of communication that they used in the innovation-decision process, to report their network links with others, and other variables such as their personal and social characteristics. The individual is usually the unit of analysis, although in recent years a number of studies have been conducted in which an organization is the unit of analysis (Wildemuth, 1992; Zaltman, Duncan, & Holbek, 1973). Inadequate scholarly attention has been given to the consequences of technological innovations (only anthropologists have investigated such consequences in any significant way).

Alternative methods of data gathering have been little utilized, even as a means to supplement the predominant approach of survey data gathering and quantitative methodologies of data analysis. One wonders why ethnographic methods like in-depth interviews and observation have not been utilized more widely, especially in the organizational innovation studiesð many of which are conducted by organizational communication scholars and by students of organizational behavior, both of whom increasingly utilize ethnographic methods. The dominant style of diffusion investigations is thus the quantitative analysis of data gathered by survey interview methods from large samples. The overall effect of these dominant research methods has been to emphasize an understanding of the diffusion process as the product of individual decisions and actions. Interpersonal influences on individuals in the diffusion process have been underemphasized because of the research methods used. Perhaps the approach to studying diffusion formulated by Ryan and Gross has become overly stereotyped. However, in recent years, several communication scholars have investigated the critical mass and individual thresholds in the diffusion process, especially for the spread and adoption of interactive innovations such as electronic mail or fax in an organization or in some other system (Markus, 1987; Kramer, 1993). At a certain point in the diffusion process for any innovation, the rate of adoption begins to suddenly increase at an inordinate rate. This take-off in the rate of adoption creates the S-curve of diffusion Table 2.1).




(Source: E. M. Rogers, 1995, New York: Free Press)

Fig 2.1: The Diffusion S-Curve

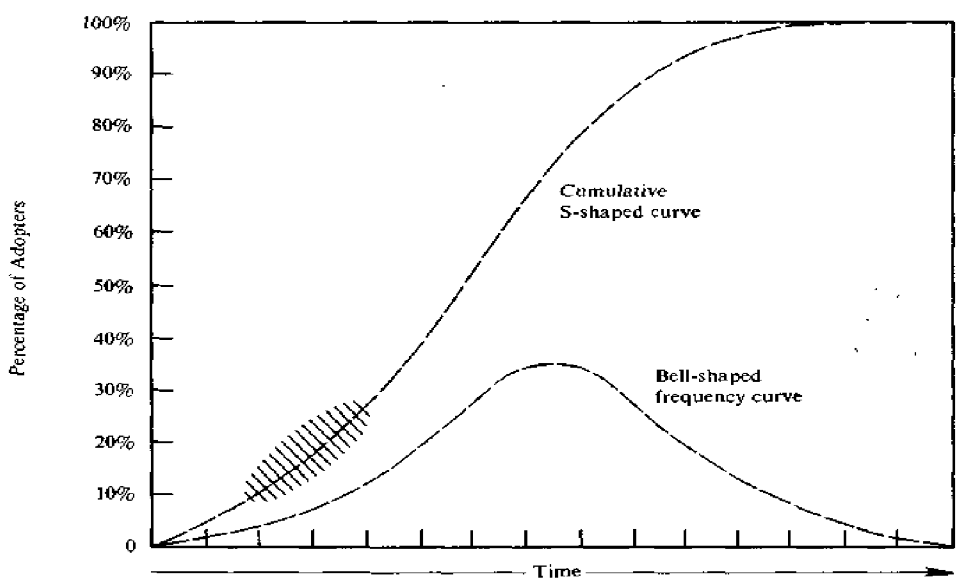
## 2.5 Social Structure and Diffusion

According to Everett M. Rogers (1983), the extent that the units in a social system are not all identical in their behavior, structure then exists within the system. We define *structure* as the patterned arrangements of the units in a system. This structure gives regularity and stability to human behavior in a social system; it allows one to predict behavior with some degree of accuracy. Thus, structure represents one type of information in that it decreases uncertainty. Perhaps we see an illustration of this predictability that is provided by structure in a bureaucratic organization like a government agency; there is a well-developed social structure in such a system consisting of hierarchical positions, giving officials in higher ranked positions the right to issue orders to individuals of lower rank. Their orders are expected to be carried out. Such patterned social relationships among the members of a system constitute *social* structure, one type of structure. In addition to this formal structure among the units in a social system, there is also an informal type of structure that exists in the interpersonal networks linking a system's members, determining who interacts with whom and under what circumstances.

We define such *communication structure* as the differentiated elements that can be recognized in the patterned communication flows in a system. Previously we mentioned the homophily principle, that most individuals in a system talk with others who are similar to themselves; a communication structure is thus often created in a system in which homophilous sets of individuals are grouped together in cliques. A complete lack of communication structure in a system would be represented by a situation in which each individual talked with equal probability to each other member of the system. Such a situation might occur when a set of complete strangers first come together. But regularized patterns soon begin to occur in the communication network of the system. And these aspects of communication structure predict, in part, the behavior of individual members of the social system.

## 2.6 The S-Curve of Adoption and Normality

The time variable allows researchers to classify adopter categories and to plot diffusion curves. Past research has generally shown that the adoption of an innovation follows a normal, bell-shaped curve when plotted over time on a frequency basis. If the cumulative number of adopters is plotted, the result is an s-shaped curve. Figure 2.2 shows that the same adoption data can be represented by either a bell-shaped (frequency) or an s-shaped (cumulative) curve.(Everett M. Rogers, 1983)




(Source: Everett M. Rogers, 1983)

Fig. 2.2**:** The bell-shaped frequency curve and the s-shaped cumulative curve for an adopter distribution.

## 2.7 Technology Development

In the conventional or "central source" view of agricultural research and development, technology emanates from "upstream" activities in the formal research system and is adapted by "downstream" research until it is ready for dissemination to farmers. Some people have used an analogy from home economics rather than hydrology, speaking of quarter-baked (notional), half-baked (preliminary), and fully baked (developed) technology. Others have referred to the development of experimental, prototype, and off-the-shelf technologies. All these analogies imply a linear process of technology development and dissemination, culminating in the adoption of new technologies by farmers. In practice, however, agricultural innovations are derived not only from the laboratories and research stations of the national and international centers but from multiple sources. These sources include research-minded farmers, innovative research practitioners at the local level, research minded administrators, non-government organizations (NGOs), private corporations, and extension agencies. In the "multiple source" model, technology consists of many old and new components. It evolves and is continually modified over time. Consequently, in contrast to technology transfer, there is no clear-cut, one-way progression from research to extension to adoption. In fact, technology adaptation cannot be separated from technology adoption. Adoption and adaptation are intertwined, in that adaptation of the technology frequently occurs in the process of implementing it on-farm (a phenomenon sometimes referred to as "reinvention"). Indeed, such adaptation is the norm, resulting from an ongoing process of "farmer experimentation." This experimentation is not confined to a few research-oriented farmers, but is the process by which almost all farmers incorporate technology into their farming systems. Technology supplied by the formal research and extension system, thus, becomes "raw material" for farmer experimentation. In other words, technology is only fully developed or adapted as part of a specific, operational farming system ( Cramb, R.A., 2003).

## 2.8 Factors affecting the diffusion and dissemination of interventions

Diffusion is the process by which an innovation is communicated through certain channels overtime among the members of a social system. The four elements of a diffusion are, therefore, innovations, communication channels, time and the social system (Rogers, 1983; Adjeberg-Asem, 1988). When new ideas are invented, they are diffused and adopted or rejected. We use the concept of diffusion in our study in term of understanding how many farmers know and use of technology. Valera et al. (1987) reported that the community is composed of different groups of people, in general, diffusion of innovation will take place only within groups of people who are homogenous in terms of problems, aspirations and needs. According Cruz (1987), time is an important factor in the process of diffusion. The systemôs social structure can have an important influence on the spread of new ideas. It can impede or facilitate the rate of diffusion and adoption of new ideas. The norms, social statuses, hierarchy, and so on of a social system influence the behavior of individual.

There are number of factors that influence the extent of adoption of technology such as characteristics or attributes of technology; the adopters or clientele, which is the object of change; the change agent (extension worker, professional, etc.); and the socio-economic, biological, and physical environment in which the technology take place Cruz (1987). Farmers have been seen as major constraint in development process (Cruz 1987). They are innovators or laggards. Socio-psychological trait of farmers is important. The age, education attainment, income, family size, tenure status, credit use, value system, and beliefs were positively related to adoption. The personal characteristics of extension worker such as credibility have good relationship with farmers, intelligence, emphatic ability, and sincerity, and resourcefulness, ability to communicate with farmers, persuasiveness, and development orientation. The biophysical environment influences the adoption. The conditions of the farm include its location, availability of resources and other facilities such as roads, markets, transportation, pests, rainfall distribution, soil type, water, services, and electricity. For instance, farmers whose farms were irrigated were the earliest adopters of new rice varieties, while those without water were the late adopters. The innovation diffuses slowly if product price is low (Truong Thi Ngoc Chi and Ryuichi Yamada, 2002).

According to Haile Kibret, (1998) cited in Atsbaha Abraha and Tessema Bekele (2010) the Ethiopian agriculture has been suffering from various external and internal problems. It has been stagnant due to poor performances as a result of factors such as: Low resource utilization (e.g. the proportion of cultivated land compared to the total amount of land suitable for agriculture and the amount of water available for irrigation is far below the capacity and thus compels the sector to be rain fed); low-tech farming techniques (e.g. wooden plough by oxen and sickles); over-reliance on fertilizers and underutilised techniques for soil and water conservation; inappropriate agrarian policy; Inappropriate land tenure policy; ecological degradation of potential arable lands; and increase in unemployment rate due to increase in the population.

Creating impact from RD&E efforts is all about adoption, which is rarely universal and instantaneous. A considerable body of literature, citing examples from both severely resource-limited developing countries and more developed, resource-rich economies, probes the chequered adoption record of many agricultural technologies (e.g. Pampel and van E., 1977; Guerin and Guerin 1994; Scoones and Thompson 1994; Rogers 2003; Cramb et al. 2004 cited in Winter B., 2011). After identifying how the central technologies or practices from an RD&E effort might positively affect the performance of the targeted community and its farming systems, the next step is to identify and present the adoption pathway(s) through which the new technology or improved practice must proceed to create that impact. This will involve establishing a clear understanding among the stakeholders (the project team, any linked collaborating agencies and participating smallholders) of the various roles, responsibilities and resources of each party in realising the proposed outcomes (Winter B., 2011)

It is vital to recognise that new technologies and knowledge that emerge from RD&E efforts will operate within a system and may have systemic impacts on smallholder production outcomes and livelihoods. Project workers need to keep in mind the likely effect of a proposed RD&E intervention, particularly if they are less familiar with the smallholder community. Having a working knowledge of the local language is an advantage, and partnering with local people trained or experienced in farming systems is essential. They must also focus on the effectiveness of the intervention within the wider system in which the elements are embedded and through which the impacts will manifest themselves. Some sidetracking may be essential to make progress on the main project objectives. In many farming systems, improving one component of the system's performance will require addressing and resolving constraints in some other part of the system. These constraints may even lie outside the immediate mandate of the RD&E effort. (Winter, 2011)

As stated by Henry M.B. and Alex R.G (1999), communication channels and social structures have been found key actors in the process of diffusion. Both of them determine the speed of diffusion and adoption. Mass media channels have been found to be rapid and efficient means of informing an audience about an innovation. Established behaviors that are part of social structure have been found to define a range of tolerable behavior and serve as a standard for members of the system in accepting an innovation, hence the impact on speed of diffusion. The adoption and diffusion of interventions and innovations is apparently influenced by a variety of factors. According to Blackledge(1979) cited in Henry M.B. and Alex R.G., (1999), include among the factors that inhibit the diffusion are the following: he absence of technical and economic feasibility studies, market analysis to assess the product or process potential, unwillingness of the users to technologies to take risks on unproven technologies, lack of adequate financing mechanism and, the institutions lack of capabilities to transfer completed research result as a package acceptable to the user.

Alhassan (1994) indicated that poor institutional arrangement and inadequate links between developers and users of technologies could hamper the diffusion process. An enabling policy has also been sighted as a major factor in enhancing the adoption and diffusion of innovations. Banerjee (1992) argues that since development of inventions has to take place within the framework of economic and political set-up of a country, this very set-up becomes a function of a country's research development base for the successful diffusion of innovations. Nichol (1992) stressed the need for an enabling policy for the transfer of technology where that the three factors necessary for the diffusion of innovations: information about technical feasibility, information about demand for a new process or product, and investment funds. IFPRI (2011) has also indicated that there are number of factors responsible for the effective diffusion and dissemination of the agricultural technologies. Among them the major one include; spatial factors, technology characteristics, infrastructures, market access, and agro-ecologies and farming systems.

# Chapter 3

# 3. Methodology

## 3.1 Description of the Study Area

This study was conducted in areas where Africa RISING project is operational and the study spans four regions accordingly- SNNPR, Oromia, Amhara and Tigrai regions. According to the Figure 3.1, from each region, one district has been selected for the AR project and hence each district was considered for this specific study.

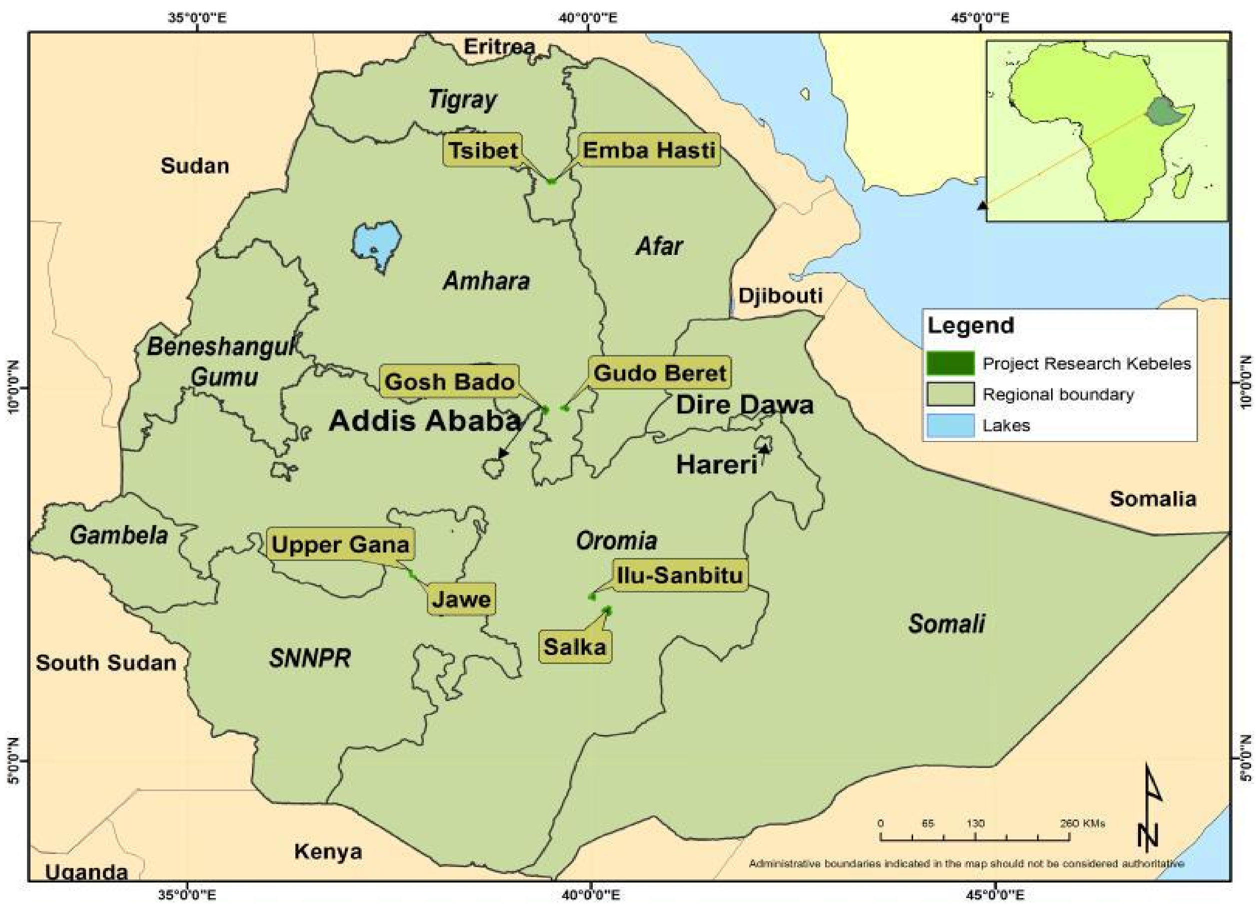



Fig. 3.1: Map showing the 4 experimental sites in 8 kebeles

Source: Barry P., Adugna T., and Harriet M., ILRI, 2015

### 3.1.1 Description of Lemo District

Lemo district is one of 11 districts found in the Hadiya Zone, SNNPR. A part of the Hadiya Zone, Lemo Woreda is bordered on the south and southeast by the Kembata Tembaro Zone, on the southwest by Soro Woreda, the west by Konteb, and on the north by the Gurage Zone; most of its eastern boundary is defined by the course of the Bilate River. The woreda has total population of 137,687 where male is 68,123, female is 69,564 (CSA, 2013)

The Woreda is approximately located between 10°17'-10°45'N latitude and 37°00'-37°10E' longitude. Hossana and Ginbichi, the town of woredas located Southern of Addis Ababa at a distance of 230 km and 260 km, respectively. The mean annual temprature of Lemo is 15-20 C°, elevation ranges from 1501-2500 masl. In the study areas, the annual rainfall pattern is starting from June to September which receives 1001mm-1200 and. The plain topography combined with the available of optimum climatic and fertile soil condition makes the Woredas suitable for mixed crop-livestock production.

### 3.1.2 Description of the Sinana District.

Sinana District is one of the 20 districts found in Bale Zone of Oromia region. Sinana is one of the districts in the Oromia Region of Ethiopia which is located in the north western corner of Bale zone. It has the population of male 75,188, female 69,113 and total 144,301 (CSA, 2013). Sinana district is one of the significant areas in agricultural production of Bale Zone. Most of the populations are rural dwellers (CSA, 2007). According to the Oromiya regional data compiled by Degne Lemma 2009, it is also known for its richness in biodiversity with different flora and fauna. Robe is a nearby town and located in the Bale Zone of the Oromia Region in south-central Ethiopia, this town has a latitude and longitude of 7°7ʹN 40°0ʹE with an elevation of 2,492 metres (8,176 ft) above sea level. The major sources of income generation for the people of this sinana district depend up on various agricultural practices. The soil sustaining methods followed by these farmers include crop rotation, application of natural manure and chemical fertilizers (Yamaga R.R and Tilaye Atinaf, 2013).

### 3.1.3 Description of the Basona Worena District

Basona Worena District is one of the 23 districts Found in North Shewa Zone of the Amhara Regional state. Basona Worena district is comprised of 30 *kebeles* of which Goshe Bado and Gudo Beret have beenmselected for testing the initial set of production interventions. It has population of male 69,014, female 66,608, and total 135,622,(CSA, 2013) and almost 100% Orthodox in religion. The district capital, Debre Birhan also serves as the zonal capital for the North Shoa zone and is therefore a major supplier of inputs and services and trading and processing. Part of the district has a well-developed road networkð see map with main socio economic characteristics. Most of Basona Worena is classified in Agro-Ecological Zone (AEZ) ómoist Degaö. The bulk of the area receives rainfall between 900 and 1050 mm annually and most of the area is between 2250 and 3200masl. Average temperature in most of the district varies between 9ï15ºC. The majority of the soils are Cambisols and Vertisols with some Arenosols in the undulating lower parts of the district. Most of the area is cultivated with some grazing areas at mid and high altitude (Abiro Tigabie, et al., 2015)

### 3.1.4 Description of Endamehoni District

One of the sites where study conducted is in the southern zone of Tigray region. Southern zone of Tigray is one of the seven administrative zones in the Tigray National Regional State. Southern Zone is located in the southern most boundary of Tigray Region. There are five districts in the zone and has a total population of 613,563 of which 51 percent are female.

Endamohoni district in which the study conducted is located about 660 km North of Addis-Ababa and 120km south of Mekelle. It has an estimated area of 50,718 hectar, bordering with Woredas of E/Alage, Ofla, Raya Azebo and Amhara region in the South. The Woreda has a total of 18 Kebeles administrations. Endamohoni district is known for its high potential for wheat, barley, faba bean and maize production and it is rich in livestock. Except for the very small areas under vegetables and fruits, crops in all farms are grown under rain fed condition(Endamohoni District BoARD, 2014).

Endamehoni district is comprised of 18 PAs out of which Emba Hasti and Tsibet have been selected for testing the initial set of production interventions. The total population is 84,739of whom 42,052 are men and 42,687 women; 2986 or 3.52% are urban inhabitants. The district has a population density of 37.04, which is less than the Zone average of 53.91 persons per km2. Most of Endamehoni district is classified in Agro-Ecological Zone (AEZ) ódry (woina dega)ö. The area receives rainfall between 600ï1000 mm annually and most of the area is rather mountainous with valleys and ridges ranging from 1600 till well above 3000 masl. Average temperature varies with altitude. The majority of the soils are Vertisols with some Cambisols. Less than 50% of the land is cultivated (Mohammed Ebrahim, et al, 2015).

## 3.2 Sampling Procedure

Multi-stage sampling procedures were employed for the selection of respondents. For the selection of the regions, districts and kebeles the purposive sampling procedure adopted based on the Africa RISING project interventions and simple random sampling method as an instrument in selecting the sample farmers from those participating in the crop-livestock interventions in Africa RISING project sites.

**In the first stage, selection of region:** SNNPR, Oromia, Amhara and Tigray regions were selected purposively as the study area based on Africa RISING crop-livestock interventions.

**In the second stage, selection of Zones:** Hadiya from SNNPR, Bale from Oromia South Gojjam from Amhara and South Tigray Zone from Tigray were purposively selected as in the case of region selection.

**In the third stage, selection of Districts:** Lemo from Hadiya(SNNPR), Sinana from Bale(Oromia) Basona from South Gojjam(Amhara) and Endamehoni from South Tigray Zone (Tigray) were selected due to the same reason as is in case of region and zone selection.

**In the fourth stage, selection of Kebeles:** Jawe and Upper Gana ebeles from Lemo, Hadiya Zone (SNNPR); Salka and Ilu-Sanbitu kebeles from Sinana Woreda, Bale Zone(Oromia); Goshe Bado and Gudo Beret kebeles from Basona Woreda, South Gojjam Zone (Amhara); and Tsibet and Emba hasti kebeles from Endamehoni Woreda, South Tigray Zone (Tigray) were selected by the same reason as is in case of region, zone and woreda (district) selection.

**In the fifth stage, selection of the respondents:** Before selecting the sample household heads (respondents) from each kebele, the list of the beneficiaries was collected from Africa RISING project records. Those farmers who were using the improved technology given by Africa rising had considered as beneficiaries. After then beneficiaries were categorized into two strata in each kebele, which includes disseminators and non disseminators. Among the beneficiaries, those farmers who had transferred to other farmers the technology distributed by Africa RISING either through transfer of input, knowledge or practices were considered as disseminators and those farmers who hadnất transferred the technologies but used and adopted the Africa RISING technologies were considered as non disseminators. The selection of sample household heads was selected from all the eight kebeles on the basis of probability proportionate to size sampling. To determine the sample size Kothari formula has been used as follows;

$$\mathbf{n} = \frac{Z^2 \cdot P.q.\ N}{e^2\ (N-1) + Z^2 \cdot P.q}$$

Where, n= sample size

e= acceptable error term (0.0625) and

P=0.25 q=0.75 are estimates of the proportion population to be sampled

N=total population

Z=95% confidence interval under normal curve (1.96)

Accordingly, the formula suggests 160 sample sizes, which included 120 disseminators and 40 non disseminators for this study.

Table 3.1: Beneficiaries distribution of each study area

| Kebeles | Total Population | Total Beneficiaries ($N= N_1+N_2$) | Total Disseminators ($N_1$) | Total Non-disseminators ($N_2$) |
|---|---|---|---|---|
| Jawe | 914 | 173 | 130 | 43 |
| Upper Gana | 796 | 173 | 130 | 43 |
| Salka | 1502 | 121 | 88 | 33 |
| Elu-sanbitu | 1872 | 134 | 99 | 35 |
| Goshe Bado | 1254 | 76 | 62 | 14 |
| Gudo Beret | 1602 | 113 | 80 | 33 |
| Tsibet | 1107 | 121 | 88 | 33 |
| Emba-hatsi | 1107 | 78 | 65 | 13 |
| Total | 10154 | 989 | 742 | 247 |

Source**: Africa RISING, 2016**

**The allocation of total sample size in two categories was shown as below:**

Disseminators sample size ($n_1$) $= nxN_1/N = 120$

Non-disseminators sample size ($n_2$) $= nxN_2/N = 40$

Whereas:

$N$= Total population size of the beneficiary in the study area

$N_1$ = Population of disseminators

$N_2$ = Population of non-disseminators

$n$ = Total sample size of the study

$n_1$ = Sample size selected from disseminators

$n_2$ = Sample size selected from non disseminators

Table 3.2: The selection of the sample household heads in the the study area

| **Kebele** | **Disseminators ($n_1$)** | **Non- disseminators ($n_2$)** | **Total Sample size ($n= n_1 + n_2$)** |
|---|---|---|---|
| Jawe | 20 | 7 | 27 |
| Upper Gana | 20 | 7 | 27 |
| Salka | 14 | 5 | 19 |
| Elu-sanbitu | 15 | 5 | 20 |
| Goshe Bado | 13 | 3 | 16 |
| Gudo Beret | 12 | 5 | 17 |
| Tsibet | 14 | 5 | 19 |
| Emba-hatsi | 12 | 3 | 15 |
| **Total** | **120** | **40** | **160** |

Source**:** Own computation, 2016

## 3.3 Method of Data Collection and Sources of Data

### Method of data collection

The methodologies employed include both qualitative and quantitative approaches and the data collected from both primary and secondary sources. Survey used to collect most of the quantitative and qualitative data through structured questionnaires. Moreover, participatory rural appraisal methods were also in use to gather reliable firsthand information from the beneficiaries of the technologies to supplement the surveys. Both primary and secondary data were collected from relevant sources. The primary data pertaining to the farmers who participate in the technology dissemination were gathered from sample respondents through structured questionnaires, which designed to generate data on adoption, dissemination and diffusion of the intervention of the improved agricultural technologies, factors affecting the dissemination process, diffusion pathways and quantification of the outcomes from the technology adoptions as a result.

**Source of data**

Both primary and secondary data were collected from relevant sources. The Primary data were collected from the respondent farmers. The structured questionnaire and GPS readings were used together to collect the primary data. The primary data pertaining dissemination were gathered from sample respondents through structured questionnaire, which was designed to generate data on adoption, dissemination and diffusion of the intervention of the improved agricultural technologies, factors affecting the dissemination process, diffusion pathways and quantification of the outcomes from the technology adoptions as a result.

The secondary data were collected from the records kept by the project sites staffs about the participants played great importance as a secondary source of data. Data on socio-economic and demographic characteristics used from the respective districts.

## 3.4 Methods of Data Analysis and Econometric Model Used

Appropriate econometrics models was employed to treat both qualitative and quantitative data and analyzed by using SPSS 20 and also GIS software used to map the diffusion pathway. The study employed both descriptive statistics and econometric model to analyze the data. Farmerös adoption behavior especially in low income countries influenced by a complex set of socio-economic, demographic, technical, institutional and biophysical factors (Feder, Et al 1985). Hence, modeling sample farmersô response to agricultural innovations has become important both theoretically and empirically.

### 3.4.1 Mapping of the Crop-livestock interventions dissemination

Crop-livestock interventions were disseminated from the direct participants in the intervention areas to the farmers who are within and outside of the intervention areas who are not directly taking part in the project. The given agricultural technology has its own attributes and based on the desirability of the attributes to the farmersô preferences, the farmers in the given locality of the intervention or outside of the intervention location acquire the improved practices, technologies or inputs from the fellow farmers. An effort was put to capture the expanse of the dissemination where the Africa RISING interventions were taken. To address this, GIS software used to identify the location of the interventions and dissemination. The intervention locations across all site indicated as an ōintervention kebelesö and highlighted in similar colors on the map so as to help the reader grasp the areal delimination of the interventions. Kebeles and districts which were outside the initial intervention locations from there farmers acquired the improved agricultural technologies and practices through their own effort identified as dissemination kebeles and districts and highlighted in similar colors. Here the intention was to indicate the spread of the Africa RISING interventions beyond the specific location of the intervention. GIS softaware employed to depict the intervention location and dissemination locations.

### 3.4.2 Quantification of values and input saved and extra value of output obtained

As used by Mengistu Ketema (2003), in order to quantify the value of inputs saved, the resources required to produce the per hectare new technology level of output using the old technology was estimated. The difference between this figure and the resources actually used to produce the new technology level of output represents the value of inputs saved because of the higher level of efficiency due to the new technology. There, the assumption is that it is possible to produce new technology level of output with old technology by using more and more units. Following Mengistu Ketema (2003), algebraic expression of this relationship is as follows;

Letting: $Y_N$ = per ha output with the new technology,

$Y_O$= Per ha output with the old technology,

$R_N$= Value of the input used to produce $Y_N$,

$R_{ON}$= Value of inputs required to produce $Y_N$ with old technology

r= Percentage of increase in output per hectare under the new technology with the old technology value of inputs per hectare

$S_R$ = Value of per hectare inputs saved to produce $Y_N$ with the new technology

Therefore,

$$R_{0N} = (1+\frac{r}{100})R_N \quad (1)$$

$$S_R = (\frac{r}{100})R_N = R_{ON} - R_N \quad (2)$$

The quantity of extra output obtained with the new technology using the old technology volume of inputs was estimated as follows;

$Q_{ex}$ = φY/r (3)

Where $Q_{ex}$ = is the quantity of extra output due to technical change;

φY = is the change in output per hectare (φY = $Y_N$ - $Y_O$)

r = is the ratio percentage brought about by the technology to the total change in output.

### 3.4.3 Profitability Analysis

For profitability analysis, comparison of the net return gained from the improved agricultural technologies was made on the basis of local and improved technology adoptions. Therefore, data for different cost items for the improved technologies and the return from the technologies (yield X market price) will be taken into account to make comparison.

To derive the net benefit of the alternative activities the total cost was subtracted from the total benefit both for local and improved technologies. According to Gittinger (1992), NPV is the discount stream of expected receipts from the technology and the technologyǿs cost and specified as;

$$NPV = \times \left(\frac{B_t - C_t}{(1+i)^t}\right)$$

Where t = Time horizon from year 1 to n, $C_t$ = Total cost, $B_t$ = Total benefit in year t, i = Interest rate , and C = Initial cost.

Benefit-Cost ratio is obtained by dividing the present value of the benefit stream by the present value of the cost stream. It is specified as;

$$B/C = \frac{\sum \frac{B_t}{(1+i)^t}}{\sum \frac{C_t}{(1+i)^t}}$$

### 3.4.4 Factors affecting the technology dissemination

Conceptually, the model was used to examine the relationship between dissemination and factors influencing diffusion involves a mixed set of qualitative and quantitative data. The dependent variable is dichotomous taking two values, 1 if the event occurs and o if it doesnǿt. Estimation of this type of relationship requires the use of qualitative response models. In this regard, linear probability model, logit, and probit models are 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 (OLS) methods as a mechanical routine, the result will be beset by the several estimation problems (Aldrich and Nelson, 1984; Gujarat, 2003)

Although Ordinary Least Squares (OLS) regression estimates can be computed for binary models, the error terms are likely to be heteroscedastic leading to the 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 admissible 0-1 bound, which violate the basic tenets of the probability. To alleviate these problem and produce relevant empirical outcomes, the most widely used qualitative response model are logit and probit models (Amemiya 1981). However, Madala (1992) and Gujarat (2004) have noted that the logistic and cumulative normal functions are very close in the mid-range, but the logistic function has slighter heavier-tails than the cumulative normal function. That is, the normal curve approaches the axis more quickly than the logistic curve.

The logit model based on cumulative probability function was used in this study. Ignoring the minor difference between the logit and probit models, Liao (1994) and Gujarat (2004) 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 model is largely a matter of convenience (Green, 2003; Gujarat 2004). But the logit model is conceptually easier to use and leads itself to a meaningful interpretation than other types (Pindyck and Rubinfeld, 1981, Green, 2003; Gujarat, 2004).

Following Gujarat (2004) and Madala (1992), the logistic distribution of the dissemination of the agricultural technology can be specified as;

$$Pi = \frac{1}{1+e^{-zi}} \quad (1)$$

Where $P_i$ is the probability of disseminatin a given technology and ranges from 0 to 1. $Z_i$ is the function of a vector of n explanatory variables and expressed as;

$$Z_i = \beta_0 + \times \beta_i X_i \quad (2)$$

Where $\beta_0$ is the intercept and $\beta_i$ is a vector of unknown slope coefficients. The relationship between $P_i$ and $X_i$, which is a non-linear, can be written as;

$$Pi = \frac{1}{1+e^{-\beta o+\beta iXi+\cdots\beta nXn}} \quad (3)$$

The slope tell how the log-odds in favour of disseminating crop-livestock interventions changes as the independent variable change. If pi is the probability of disseminating a given crop-livestock intervention, then 1-Pi represents the probability of not disseminating and can be written as;

$$1\text{-}Pi = 1 - \frac{1}{1+e^{-zi}}$$

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

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

Dividing the equation (1) by (4) and simplifying gives:

$$\frac{Pi}{1-Pi} = \frac{1+e^{zi}}{1+e^{-zi}} = e^{z} \quad (5)$$

Equation (5) indicates simply the odd-ratio in favor of disseminating a given intervention. It is the ratio of the probability that technology be disseminated to the probability that it not be disseminated. Finally, the logit model is obtained by taking the logarithm of the equation (5) as follows;

$$L_i = \ln\left(\frac{P_i}{P_i}\right) = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \ldots + \beta_n X_n \qquad (6)$$

Where $L_i$ is log of the odd ratio, which is not only linear in X, but also linear in the parameters. Thus, if the stochastic disturbance term $u_i$ is taken into account, the logistic model becomes;

$$Zi = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \ldots + \beta_n X_n + u_i \qquad (7)$$

The econometric model was employed in this study, and variables that are assumed to influence dissemination decision of crop-livestock intervention was tested. The parameter ($\beta_i$) of the model was estimated using the iterative Maximum Likelihood Estimation (MLE) procedure due to the non-linearity of the logistic regression model. The MLE procedures yields unbiased, asymptotically efficient, and normally distributed regression coefficients (parameters). The logistic regression slope coefficients can be interpreted as the change in the log odds associated with a one unit change in the dependent variable (Xi), ie, it tells us how the log odds in favor of disseminating crop-livestock interventions changes by one unit. The $\beta_0$ is the log odds in favor of disseminating a given intervention when all the explanatory variables assume value of zero.

**Testing of Multicollinearity**

Prior to the estimation of the logit model, multicollinearity diagnosis among the independent variables should be undergone to unravel the net effect of each variable on the fitted model. This is due to the fact that multicollinearity is essentially sample phenomenon in the sense that even if the X variables are not linearly related in the population, they may be so related in the particular sample at hand(Gujarat, 2004). For this study, Variance Inflation Factor (VIF) was used to identify the collinear continous explanatory variable which is given by the formula as shown below.

$$VIF = \frac{1}{1-R_j^2}$$

Where $R^2_j$ is the $R^2$ value that was found when the $j^{th}$ continous explanatory variable was regressed on the remaining continous explanatory variables in the model. And since VIF is the term in the computation of variance of each partial regression coefficients, as a rule of thumb, if the VIF of a variable exceeds 10, that variable is said to be highly collinear.

Likewise, to identify the collinearity among the qualitative explanatory variables Coefficients of Contigency (CoC) were computed using the formula shown below.

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

Where C is the Coefficents of Contigency, $\chi^2$ is a Chi-square of random variable and n is the total sample size. As a rule of thumb, if Coefficients of Contigency of a variable exceeds 0.75, that variable is said to be highly collinear.

### 3.4.5 Definition of variable and Working Hypothesis of the study

#### 3.4.5.1 Dependent Variable

The dependent variable of this study, which is dichotomous in nature, represents the dissemination status of the crop-livestock interventions. It was represented in the model as DISSEMINATOR = 1 if the given intervention was disseminated and NON DISSEMINATOR=0 if the intervention was not disseminated.

### 3.5.4.2 Independent Variables

The independent variables that were hypothesized to affect the dissemination of crop-livestock intervention are combined effect of various factors such as household characteristics, socio-economic characteristics, institutional characteristics and technological characteristics. Based on the review of the dissemination, diffusion and adoption literatures, past findings and researches, 16 explanatory variables, which expected to be related to the crop-livestock interventions dissemination, were considered in this study and examined for their effect.

**Age of the Household Head (AGEH)**: It represents the age of the household head in years. Different age groups respond differently to the technologies of interest. Age of the farmers is directly related with farming experience thereby dictating the position of the farmers in relation to the dissemination of crop-livestock interventions. Since farmers with huge farming experience has been familiar with the existing farming practices, they are supposed to be slow in dissemination, while young farmers expected to be more innovators and respond quickly as compared to older farmers. It was hypothesized that age is negatively related to the dissemination of the crop-livestock interventions. It is a continuous variable.

**Formal education status of Household head (FOEDUC)**: Represents the level of formal schooling completed by the household head in years. It was assumed that the level of formal schooling of the farmers would enhance the dissemination of the crop-livestock interventions. It was expected that as the farmersô formal education increases their awareness towards improved technologies would increase. Hence, it was hypothesized that education is positively related to the dissemination of the crop-livestock interventions. It is a continuous variable.

**Size of farm land (FARMSIZE):** This refers to the total arable farmland that a farmer owns measured in hectares. Land is the critical resource for the farmers and farmer operating on larger farmland generally can put some of his tenure to adopt improved agricultural innovative practices. The hypothesis in this study was that farmland size is positively related with the dissemination of crop-livestock interventions. It is continuous variable.

**Total Income of the household (TOTINC)**: Total income of the household per year generated from all source of income. It is expected that farmers with high income would dare to invest on new interventions. It was presumed that the level of income of the farmers is positively related to the dissemination of crop-livestock interventions and is a continuous and measured in birr.

**Time after the intervention (TIME)**: It represents the time duration after the introduction of the interventions. Time is one of the major factors which plays vital role for the dissemination of the crop-livestock interventions. It was expected that the interventions would be disseminated over years across areas. As a result, it was hypothesized that time is positively related with the dissemination. It was measured in years and it is a continuous variable.

**Non/Off-farm income(NOFI):** This variable refers to the effect of availability of non/off-farm income for the dissemination of the crop-livestock interventions. It was expected that some of the farmers might be engaged in non/off-farm activities to generate cash income such as renting labor, renting out oxen, petty trade, handcraft, etc. This additional income increases the farmerôs financial capacity and is expected to increase the probability of investing in new agricultural technologies. Hence, availability of non/off-farm income opportunity was hypothesized to influence dissemination of crop-livestock interventions positively. It was identified as whether non/off-farm income is available or not and is dummy variable.

**Availability of farm labour (LABAV):** This variable refers to the availability of the adequate labour need for farm operation as and when the farmers need. It could be either family labour or hired. The availability of the labour expected to influence the dissemination positively. Farmers who are not sure of the labour availability would not dare to adopt crop-livestock interventions. Therefore, labour availability was expected relate positively. It is dummy variable.

**Price of output (PRICEO)**: Refers to the price of output obtained from the use of crop-livestock interventions. Farmersô use improved technologies with a view that it would bring to them better benefits interms of production and price of the output. Farmers would prefer to adopt the interventions that which would result in more outputs that receive higher price. It is dummy variable which take 1 if the price is high or 0, otherwise.

**Farmers' perception about the Yield (PERCY):** Refers if the farmer perceives that the yield (output) or impact of the given intervention higher, the adoption of improved practises are expected by them. This variable measures the farmers recognition of the superiority or inferiority of the given crop-livestock intervention as compared to their existing practises. Hence, it was hypothesized that the perception about the yield influences the dissemination of crop-livestock interventions positively.

**Extension Contact (EXTCON):** It refers to the frequency of farmersô contact with the extension workers for the purpose of information exchange with regard to improved agricultural innovations. Since most of the agricultural inputs are delivered through extension system. Therefore, farmers who are in regular contact with development/extension agents are expected to get information sooner and to decide to be engaged in. Sometimes farmers rely on persuasion by the extension workers on the potential importance of improved practices and hence extension contact is expected to positively influence the dissemination of the crop-livestock interventions. It is dummy variable.

**Price of input (PRICEI)**: Price of input of a improved technology would hinder the dissemination of the interventions since many farmers cannot afford to purchase the input with high price. Hence, high price of the input discourages farmers from using the technologies. This would halt the dissemination of the crop-livestock interventions. Hence, it was hypothesized that the price of inputs negatively related to the dissemination. It is dummy and measured by giving the value 1 if the price is high and 0, otherwise.

**Infrastructure (INFRA)**: it refers to the infrastructure facility in areas where the intervention is made. Interventions are introduced with purpose of bringing meaningful economic benefit to the users. Infrastructures like road and market access would determine the pace with which information flow and the interventions spread across areas. Therefore, the availability of infrastructure would positively affect the dissemination of the crop-livestock interventions. It is dummy variable.

**Effectiveness Communication channel (COMCHAN)**: it refers to the media through which the information regarding the interventions is carried over to the beneficiaries. The communication channels through which the interventions are disseminated would largely affect the dissemination process, because the dissemination would be only as good as the effectiveness of the communication channels. Consequently, communication channels positively affect the dissemination of the crop-livestock interventions. It is dummy variable.

**Willingness of the farmers to take risk (FWRISK)**: Represents willingness of the farmers to take the risk associated with use of new technologies. The dissemination of the new interventions assumed to be function of the farmersô risk taking behaviour. The risk taking farmers tend to use the new technologies at the early phase of the introduction while some at late phase. Generally, it is supposed that the of crop-livestock intervention would be dissemination more as the farmers become risk taking towards the use of the new technologies. Hence, it was hypothesized that risk taking behaviour is positively related to the dissemination of the intervention. It is a dummy variable.

**Technology characteristics (TECIXS)**: It entails inherent characteristics of the crop-livestock interventions under consideration. If the technology to be disseminated is proven interms of productivity and other parameters as evaluated by the farmers, it would be disseminated faster and the technologies with undesirable attributes tend to be disseminated with very little or no progression. Hence, crop-livestock interventions with desirable attributes would be expect to be disseminated. Hence, technology attributes are positively related to the dissemination. It is a dummy variable and measured by giving value if the technology is superior or 0, otherwise.

**Market Availability for the outputs (MARKAV):** Refers to the availability of potential demand for the produce produced. Since farmers are rational decision makers they look at on a number of factors before they decide to engage in a given intervention. Among the decision factors, market availability for the outputs they produce is critical. Farmers would opt to go for the intervention which is more promising with regard to output marketability and it was hypothesized that market availability influences positively the dissemination of the crop-livestock interventions. It is dummy variable.

The description regarding all the explanatory variables included in this study is given below (Appendix 5).

# CHAPTER FOUR

# 4. RESULTS AND DISCUSSIONS

This chapter presents findings obtained after the analysis of data. A detailed description of socioeconomic characteristics, Africa RISING crop-livestock interventions, quantification of inputs and outputs, profitability analysis and factors affecting the dissemination of crop-livestock interventions were presented. The study was conducted only for the locations where crop-livestock interventions were operational. The collected data of the study had analyzed statistical software such as SPSS 20. The detail of each was discussed under their respective topics as below.

## 4.1 Socio-economic Characteristics

### 4.1.1 Sample household heads by sex

The household heads sex composition across project sites is presented in Table 4.1. Out of the total sample respondents, 80 percent of the respondents found headed by male and the rest (20%) were female headed households. There were slight differences among sites with respect to the sex of the household head composition. Of the four sites where the study is conducted, Endamehoni District has about 25% female headed households and 75% male headed; Lemo had 20% female headed and 80% male headed households; Sinana with 18% female head and 82% male heads; and Basona with 83% male head and 17% female head. Since the interventions were intended to be engendered, female farmers are integral parts of the activities being undertaken in Africa RISING project sites though their number is low as compared to the number of male. This was due to the fact that many women take part in under the auspices of their husbands as a result they were not accounted independently as is in the case of female headed households.

Table 4.1: Sex wise distribution of sample households heads

| District | HHH Sex | Beneficiaries | | | | | |
|---|---|---|---|---|---|---|---|
| | | Disseminators | | Non-disseminators | | Total | |
| | | N | % | N | % | N | % |
| Lemo | Male | 32 | 80 | 8 | 80 | 40 | 80 |
| | Female | 8 | 20 | 2 | 20 | 10 | 20 |
| Sinana | Male | 25 | 86 | 7 | 70 | 32 | 82 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Female | 4 | 14 | 3 | 30 | 7 | 18 |
| Basona | Male | 19 | 73 | 8 | 80 | 27 | 75 |
| | Female | 7 | 17 | 2 | 20 | 9 | 25 |
| Endamehon | Male | 21 | 84 | 8 | 80 | 29 | 83 |
| | Female | 4 | 16 | 2 | 20 | 6 | 17 |
| Total | Male | 97 | 80 | 31 | 78 | 128 | 80 |
| | Female | 23 | 20 | 9 | 22 | 32 | 20 |

Source: Survey data, 2016

### 4.1.2 Age of the sample household heads

Table 4.2 shows that the average age of the sample farmersô household heads for each district. The total mean age of Lemo district sample farmers was 45.57 with standard deviation of 9.13. The total mean age of Sinana district sample was 44.22 with standard deviation of 10.76. The total mean age of Endamehoni sample farmers was 46.14 with standard deviation of 14.03. The total mean age of Basona Worana district sample farmers was 51.91 with standard deviation of 12.63. The composite mean age of the participants in the interventions is 46.79 with the standard deviation of 11.80. The minimum and maximum age in the the Lemo was 24 and 65 years, Sinana minimum 27 and the maximum 72 years, Basona Worena minimum 27 and the maximum 70, and Endamehoni minimum 28 and maximum 72. The overall minimum age was 24 and maximum age 72 years (Appendix 1).

Table 4.2: Age of sample household heads

| Districts | Beneficiaries | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Disseminators | | | Non-disseminators | | | Total | | | |
| | N | Mean | S.E | N | Mean | S.E | N | Mean | S.E | t-value |
| Lemo | 40 | 45.23 | 9.60 | 14 | 46.9 | 7.23 | 54 | 45.57 | 9.13 | 0.858 |
| Sinana | 29 | 44.28 | 10.80 | 10 | 44.00 | 11.26 | 39 | 44.22 | 10.76 | 0.261 |
| Endamehoni | 26 | 46.5 | 14.8 | 8 | 45.20 | 12.51 | 34 | 46.14 | 14.03 | 3.051 |
| Basona | 25 | 53.48 | 12.72 | 8 | 48.0 | 12.02 | 33 | 51.91 | 12.63 | 0.764 |
| Total | 120 | 46.09 | 11.94 | 40 | 46.07 | 10.63 | 160 | 46.79 | 11.80 | 2.684 |

Source: Survey data, 2016

### 4.1.3 Family size of the sample households

According to the Table 4.3, the average family size of the sample households was estimated to be 8.16, 7.92, 6.3 and 5.13 for Lemo, Sinana, Endamehoni and Basona Worana districts, respectively. The minimum family size across all districts was 2, and the maximum family size is 15, 14, 13 and 10 for Sinana, Lemo, Endamehoni and Basona Worana districts, respectively (Appendix 1). The mean family size for the whole sample farmers is 7(Table 5) and the overall sample farmersô minimum was 2 and maximum family size was 15 which was observed at Sinana distrit(Appendix 1).

Table 4.3: Family size of the sample household heads

| Districts | Beneficiaries | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Disseminators | | | Non-disseminators | | | Total | | | |
| | N | Mean | S.E | N | Mean | S.E | N | Mean | S.E | t-value |
| Lemo | 40 | 8.23 | 2.78 | 14 | 7.60 | 2.63 | 54 | 8.16 | 2.58 | 0.142 |
| Sinana | 29 | 8.34 | 2.84 | 10 | 6.60 | 3.27 | 39 | 7.92 | 2.95 | 0.228 |
| Endamehoni | 26 | 6.30 | 2.39 | 8 | 6.30 | 2.36 | 34 | 6.30 | 2.35 | 1.065 |
| Basona | 25 | 5.05 | 1.75 | 8 | 5.32 | 2.27 | 33 | 5.13 | 1.88 | 0.798 |
| Total | 120 | 7.17 | 2.84 | 40 | 6.45 | 2.68 | 160 | 7.00 | 2.80 | 1.745 |

Source: Survey data

### 4.1.4 Educational level of the sample household heads

Table 4.4 shows the educational status of the sample farmers across study sites. At Lemo district nearly one fourth (24%) of the sample farmers found to be illiterate and the about 40% farmers have got the formal education ranging from grade one to eight. About 28% of sample farmers had high school education level ranging from grade nine through twelve, and the remaining 8% got some kind of vocational training after high school. An average year of schooling was 6.58 years which was high as compared to other districts with standard deviation of 4.53 years.

Sinana district had lowest illiterate sample households(7.7%) as compared to the other three districts with the vast majority(67.5%) of the farmers lying within the educational category either first(1-4) or second(5-8) cycle of the primary school. The remaining one fourth of the Sinana district sample farmers had secondary school. Mean level of formal education attain was 6.28 years with the standard deviation of 3.3 years. Unlike other districts, Basona Worana district has overwhelmingly illiterate sample farmers. About 51.4% farmers do not have formal education. But fairly more than one third (37.2%) got primary level education. The remaining 11.4% had high school level education. The mean schooling years for Basona was 2.48, which was lowest education attainment with the standard deviation of 3.2 years.

At Endamehoni district, about one quarter (19.4) of the sample farmers had no formal education, and like that of Sinana district, has majority of farmers (66.7%) with the primary education level. The remaining 14% had high school education. Endamehoni had an average education level of 4.94 years with the standard 3.19 years. For the sake of comparison, the composite education level was taken for the whole sample, and accordingly, about 23.1% of the total sample farmers are illiterate, with more than nearly half (53.3%) with primary level education and 20.6% of the sample farmers got high school level education and the remaining slim proportion (3%) of the sample farmers got some kind of training after high school completion. An average education in schooling years was 5.24 with standard deviation of 3.98.

Table 4.4: Schooling years of the sample households heads

| Districts | Beneficiaries | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Disseminators | | | Non-disseminators | | | Total | | | |
| | N | Mean | S.E | N | Mean | S.E | N | Mean | S.E | t-value |
| Lemo | 40 | 6.80 | 4.45 | 14 | 6.30 | 5.10 | 54 | 6.58 | 4.53 | 7.58 |
| Sinana | 29 | 6.17 | 3.03 | 10 | 7.50 | 3.27 | 39 | 6.28 | 3.30 | 2.89 |
| Endamehoni | 26 | 4.11 | 3.47 | 8 | 4.00 | 2.74 | 34 | 4.94 | 3.19 | 3.73 |
| Basona | 25 | 2.44 | 3.11 | 8 | 2.60 | 3.59 | 33 | 2.48 | 3.20 | 4.82 |
| Total | 120 | 5.21 | 3.97 | 40 | 5.10 | 4.11 | 160 | 5.24 | 3.98 | 8.78 |

Source: Survey data, 2016

### 4.1.5 Land inventory

Based on the Table 4.5, the average land inventory owned by the sample farmers in Africa RISING sites vary from one districts to other. Sinana district sample farmers owned on average about 4.5 hectares per household. The minimum land holding of Sinana district sample farmers is about 1.25 hectares, and the maximum about 15 hectares (Appendix 1). Compared to other districts, Sinana district sample farmers own large land size in every aspect. Basona Worana district sample farmers found to own the average land size of about 1.5 hectares, which is second largest average land size, next to Sinana district. The minimum land owned by the sample farmers is 0.5 hectare and the maximum is 3 hectares (Appendix 1). Lemo district sample farmers own on average about 1 hectare, where as the minimum land owned is 0.5 hectare and the maximum is 3 hectares (Appendix 1). The average land size owned by the sample farmers at Endamehoni district is about 0.75 hectare, whereas, minimum is 0.5 hectare and maximum is about 5.5 hectares (Appendix 1). The overall mean farm size owned by the sample households was nearly 2 hectares (Table 7) and the minimum and maximum farm size was 0.5 and 15 hectares respectively (Appendix 1).

Table 4.5: Farm size owned by the sample households heads in timads*

| Districts | Beneficiaries | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Disseminators | | | Non-disseminators | | | Total | | | |
| | N | Mean | S.E | N | Mean | S.E | N | Mean | S.E | t-value |
| Lemo | 40 | 4.65 | 2.49 | 14 | 4.35 | 2.67 | 54 | 4.59 | 2.50 | 1.801 |
| Sinana | 29 | 19.79 | 12.12 | 10 | 16.10 | 6.87 | 39 | 18.84 | 11.05 | 1.293 |
| Endamehoni | 26 | 2.52 | 1.37 | 8 | 1.88 | 0.82 | 34 | 2.34 | 1.27 | 0.251 |
| Basona | 25 | 6.29 | 2.60 | 8 | 5.57 | 2.61 | 33 | 6.20 | 2.52 | 4.003 |
| Total | 120 | 8.12 | 9.10 | 40 | 6.79 | 6.67 | 160 | 7.91 | 8.56 | 2.253 |

Source: Survey data, 2016 *timad = 0.25ha, or 1 ha = 4 timads

### 4.1.6 Farm experience of the sample households

Table 4.6 shows that average farm experience for sample farmers of the Lemo district is 22.71 with standard deviation of 9.01, and the minimum farm experience was 5 and the maximum was 40 years (Appendix 1). Sinana district sample farmers have a farming experience of on average 20.7 years with standard deviation of 8.82 (Table 4.6). The minimum and maximum farming experience for Sinana district was 10 and 40 years, respectively(Appendix 1). Based on Table 4.6, the average farm experience for sample farmers of Basona Worana district had about 26 years distributed with standard deviation 10.05, and the minimum 10 and maximum 43 years of farm experience (Appendix 1). The average farm experience for the sample farmers of the Endamehoni district found to be 27.6, which is the highest of all with standard deviation of 10.14 (Table 8) where as the minimum and maximum farming experience are 10 and 43 respectively (Appendix 1). The overall sample average farming experience was 24.5 distributed with standard deviation 9.75 (Table 4.6) and the overall minimum farm experience was 5 years and the maximum was 43 years (Appendix 1).

Table 4.6: Farm experience of the sample households heads

| Districts | Beneficiaries | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Disseminators | | | Non-disseminators | | | Total | | | |
| | N | Mean | S.E | N | Mean | S.E | N | Mean | S.E | t-value |
| Lemo | 40 | 22.72 | 9.04 | 14 | 24.25 | 8.71 | 54 | 22.71 | 9.53 | 0.807 |
| Sinana | 29 | 22.00 | 9.08 | 10 | 15.50 | 5.54 | 39 | 20.70 | 8.82 | 0.744 |
| Endamehoni | 26 | 27.84 | 10.18 | 8 | 27.00 | 10.56 | 34 | 27.60 | 10.14 | 3.707 |
| Basona | 25 | 27.58 | 9.59 | 8 | 23.70 | 11.10 | 33 | 26.44 | 10.05 | 1.256 |
| Total | 120 | 23.92 | 9.64 | 40 | 23.35 | 10.01 | 160 | 24.50 | 9.75 | 3.611 |

Source: Survey data, 2016

## 4.2 Types of Africa RISING Interventions and Scheme of Farmer's Participation

Crop-livestock interventions have been implementing different site specific and cross-cutting research activities that are meant for sustainable intensification. Since project runs in four regions, there are agro-ecological differences across sites which in turn dictate that some interventions are implemented in districts agro-ecology found suitable for them. As a result, some interventions were introduced as site specific and some intervention were implemented as cross cutting intervention across all sites. Types of interventions in which farmers participated were fruit trees, tree lucerne, enset, rain water pump for fruit/fodder, solar pump, crop residue (feed trough, crop residue storage), irrigated/rainfed fodder, faba bean/forage intercropping, yield gap(wheat), PVS, community seed multiplication (potato, barley, wheat and faba bean), raised bed/upgrading the bed and furrow system for relay cropping, mechanized options, ware storage technology (potato, wheat, faba bean), SWM (watershade- run off), rain water harvesting (Geo-membrane), and lupine.

Since Africa RSISNG project runs in four different sites, the project has paid due attention in selecting the agricultural technologies suitable for each site. Based on Table 4.7, potato varieties used were Gudene, Jalene and Belete at Lemo, Sinana and Endamehoni districts and Gera and Shenkola varieties at Basona Worana district. Wheat varieties were Digalu, Hidase, Kekeba, Huluka, Sofumar, Menzie, Tsehay and Mekele4. Barley varieties are Abdane, Bahati, and Shurube. Among faba bean varieties, Dosha was used at Lemo and Gebelcho was used at other three sites.

Table 4.7: Crop Varieties used for interventions in the study area

| Interventions | Districts | | | |
|---|---|---|---|---|
| | Lemo | Sinana | Basona Worana | Endamehoni |
| Potato (ware+seed) | Gudene, Belete and Jalene | Gudene and Belete | Gera and Shonkola | Gudene and Belete |
| Wheat | Digalu Hidase Kekeba | Hidase Huluka and Sofumar | Menzie and Tsehay | Mekele4 |
| Barley | - | Abdane Bahati and Shurube | - | - |
| Faba bean | Dosha | Gebelcho | Gebelcho | Gebelcho |
| Avocado | - | - | - | - |
| Apple | HAS, Navas A, | HAS, Navas A, | HAS, Navas A, | HAS, Navas A, |

| | | | | |
|---|---|---|---|---|
| | Etinger, Fruit, Red 30, and Navas B | Etinger, Fruit, Red 30, and Navas B | Etinger, Fruit, Red 30, and Navas B | Etinger, Red 30, and Navas B |

Source: Africa RISING, 2016

The number of farmers participating in the interventions increased from year to year and the same farmers also have been replicating in consecutive years once after they become beneficiary. Based on the result of the Table 4.8, 12% disseminators have participated only for one year, 29.1% participated for two years, 45.3% participated for three years and 13.7% participated for four years. Regarding non disseminators, 15.4% participated only for one year, 25.6% for two years, 51.6% for three years and 7.7% for four years. From the total sample respondents, 87.5% of the respondents were participated in more than one year, while the rest (12.5%) respondents were participated only one year.

Table 4.8: Number of years of participation in crop-livestock interventions

| Participation Years | Beneficiaries | | | | | |
|---|---|---|---|---|---|---|
| | Disseminators | | Non-disseminators | | Total | |
| | N | % | N | % | N | % |
| 1 | 14 | 12 | 6 | 15.4 | 20 | 12.5 |
| 2 | 34 | 29.1 | 10 | 25.6 | 43 | 26.9 |
| 3 | 53 | 45.3 | 20 | 51.6 | 76 | 47.5 |
| 4 | 16 | 13.7 | 3 | 7.7 | 21 | 13.1 |
| Total | 120 | 100 | 40 | 100.0 | 160 | 100.0 |

Source: Survey data, 2016

Farmers participating in Africa RISING crop-livestock interventions chose the type of intervention they would like to take part in and also the farmers could take part in more than one intervention based on their willingness and ability. In this sense many farmers have been engaged in one or more activities from the day they started participating. There were farmers who have been participating inasmuch as six activities. Based on Table 4.9, about 23.3 % of the disseminator sample farmers found to participate in one activity, 18.3% for in two activities, 26.7% in three activities 17.5% in four activities, 11.7% in five activities and 2.5% in six activities. 37.5% of the non disseminators participated only in one activity, 10% in two, 32.5% in three and 20% in four activities.

Table 4.9: Number of activities farmersô participated crop-livestock interventions

| Activities | Beneficiaries | | | | | |
|---|---|---|---|---|---|---|
| | Disseminators | | Non-disseminators | | Total | |
| | N | % | N | % | N | % |
| 1 | 28 | 23.3 | 15 | 37.5 | 41 | 25.6 |
| 2 | 22 | 18.3 | 4 | 10 | 26 | 16.3 |
| 3 | 32 | 26.7 | 13 | 32.5 | 47 | 29.4 |
| 4 | 21 | 17.5 | 8 | 20 | 30 | 18.8 |
| 5 | 14 | 11.7 | | | 14 | 8.8 |
| 6 | 3 | 2.5 | | | 2 | 1.3 |
| Total | 120 | 100 | 40 | 100 | 160 | 100 |

Source: Survey data, 2016

### 4.2.1 Farmers preference for Africa RISING interventions

Farmers in Africa RISING sites have been participating in a number of agricultural interventions which are meant to achieve sustainable intensification of agricultural production in face number of factors constraining agricultural productivity and to ensure food security of the smallholder farmers and to enable to produce surplus which is to be marketed. It is with this end goal that many actors interne in sector of agriculture. But undeniably, farmers themselves are both stakeholders and the target of interventions. As stakeholder, their participation is sought at each level of project cycle and, as target interventions are measured against the ultimate impacts it would have on the livelihoods of the farmers. Farmerôs preference towards the interventions thus greatly matters the success desired to be brought because farmers are rational decision makers. Since the resources available for farmers are limited, they only engage in interventions that they perceived beneficial and based on their perception the farmers have preference. As a result, preference of the farmers towards given intervention largely determines the dissemination of the interventions.

To this end, sample farmers were asked how they perceive different agricultural interventions in which they are participating in. Moreover, the sample farmers also prioritized and put in order of importance based on their preference at each districts. Prioritization was made between crop interventions and livestock interventions independently and they ranked from most preferred to least preferred intervention. From crop interventions, sample farmers in all four sites ranked potato as first, avocado second, faba bean third and apple fourth attractive intervention among others. Farmers at each district prioritized differently from one another since the crop types suitable for each agro-eology differ from distrct to district. Based on the result of the Table 4.10, farmers at Lemo district ranked in order of their preferability potato first avocado second, wheat third and faba bean fourth. For Sinana district potato, faba bean, wheat and barley chosed as most attractive interventions. For Basona Worana district, potato, wheat, barley and faba bean regarded as top four interventions in order of their importance. Endamehoni district sample farmers preferred potato, faba bean and apple as most liked three interventions. There are also livestock interventions which the farmers prioritized. Accordingly, feed storage, oat/vetch, tree lucern and feed trough interventions were selected by the farmers of the all sites as best four activities they have been engaged in.

Here below presented are the preferable attributes of the interventions that sample farmers found promising.

#### 4.2.1.1 Crop Interventions

**Potato**: Farmer across all sites preferred potato as the intervention is most attractive and disseminating to other areas in fast pace (Table 4.10). The potato attributes liked most by the sample farmers is high productivity, disease resistance, good growth, adaptation to the agro-ecologies, high demand, good output price, good for cooking and income generation. Farmers in Africa RISING sites produce potato either privately or in association with neighboring farmers whose land found side by side. The productivity of potato found to be higher as compared to the existing potato production practices and as a result farmers in all four sites prioritized potato first on yield basis. Farmers participate in scheme of ware potato production and seed potato production and they are able to generate considerable amount of cash income through sale of the potato. The potato varieties distributed are Gudene and Belete at Lemo, Sinana and Endamehoni districts; and Gera and Shenkola varieties at Basona Worana sites. Potato is the most disseminated intervention in all sites has wide acceptance. Due to the duality of the benefit the potato for farmers (food security and income generation aspects), potato has disseminated beyond one could imagine.

**Wheat**: According to the Table 4.10, the farmers have appreciated the wheat due to high yield, disease resistance and good seed color which is factor for marketability. But, the sample farmers indicated that the case of wheat is not as distinct as that of potato because they are familiar to use different selected varieties of wheat through governmental body (agricultural or extension office). The farmers has also substantiated that the average yield per unit area for wheat is more or less similar to their previous practices and also apparent economic benefit per unit area (which will be discussed later) is similar to the one with government extension supply. Some farmers said that Danfe variety is not preferred due to its unease for threshing.

**Faba bean**: Table 4.10 indicates that sample farmers identified the preferable traits of faba bean such as high yield, disease resistance and large bean size. Since faba bean is primarily produced for market, bean size was considered by the sample farmers as crucial factor for attracting demand and getting better price. Faba bean is preferred as one of the intervention areas which significantly help the farmers to generate handful cash income for smallholder farmers.

**Avocado:** For sample farmers introduction of avocado seen as game changing because the existing avocado trees planted by farmers at their homestead remain leafy and fruitless for more than ten year while the avocado varieties given for farmers by Africa RISING was cautiously selected and brought from research centers for their specific agro-ecological adaptability and as such it adapted easily and started flowering in three years. Farmers viewed early maturity as critical point of evaluation because they donᾳt want to waste land space and time.

**Apple:** Apple is new for all sites and farmers are optimistic due to the adaptability of the varieties delivered to them. Farmers also view as growing perennials as an opportunity to generate cash income yearly from small size of land and without need for extra labor expenditure.

#### 4.2.1.2 Livestock Interventions

Table 4.10 gives the prioritization of the farmers for livestock interventions as discussed below.

**Feed storage:** Because of the fact that farmers face shortage of feed for their livestock during dry seasons feed storage practices which maintain the crop residues without quality deterioration and quantity loss are preferred as an option to alleviate feed shortages. Most often farmers store crop residues by making hips on ground in an open area and underneath part of the hips decay and become useless. The external part of the hip is also exposed to sun and rain there is quality and quantity loss in crop residues. Feed storage techniques offer them the way to preserve the available feed resource for longer time

**Feed trough:** The other thing farmers liked about livestock intervention is feed trough. Farmers asserts that considerable amount of feed resource are waste unknowingly. Feed trough help to efficiently utilize feed resource and avoid any undue wastage.

**Oat/vetch mixture:** Farmers claimed that oat/vetch mixture is good for milking cows because it increases the milk yield. Moreover, it can be intercropped with other crops like faba bean thereby helping to economize land space. It is also palatable and cows easily adapt to feed it.

**Tree Lucerne:** Tree Lucerne is liked for its palatability and serves as supplementary feed during dry season. It is good especially for goats and also farmers use it as bee flora.

Table 4.10: Interventions prioritization by sample households

| Interventions | Prioritization of interventions at each districts | | | |
|---|---|---|---|---|
| | Lemo | Sinana | Basona | Endamehoni |
| Crop | 1. Potato | 1. Potato | 1. Potato | 1. Potato |
| | 2. Avocado | 2. Faba bean | 2. Wheat | 2. Faba bean |
| | 3. Wheat | 3. Wheat | 3. Barley | 3. Apple |
| | 4. Faba bean | 4. Avocado | 4. Faba bean | 4. Avocado |
| Livestock | 1. Oat/vetch | 1. Feed storage | 1. Feed storage | 1. Feed storage |
| | 2. Feed storage | 2. feed trough | 2. Tree lucern | 2. Oat/vetch |
| | | | 3 Oat/vetch | 3. Feed trough |

Source: Survey data, 2016

## 4.3 Mapping of the Dissemination of Interventions

According to the survey data the spread of the Africa RISING project interventions has been increasing both within the kebeles(villages) of interventions and outside of intervention kebeles. Potato is the most widely disseminated intervention both in terms of number of farmers and area coverage in all four sites. Since farmers use every year new varieties, wheat seed was not bought from fellow farmers unlike that of potato and hence the use of wheat seed wasnȇt spread for the production purpose. The transfer of seed of different crops and livestock interventions indicate that there is intense dissemination of potato seeds for production from farmers to farmers.

Figure 4.1, 4.2, 4.3 and 4.4 depicts the locations of the interventions and areas of dissemination. The location highlighted in red indicate the intervention made by the Africa RISING where as the locations highlighted in green indicate the locations where technologies were taken from the intervention areas in one or other ways. Table 4.11 shows that the Africa RISING interventions were taken from the intervention kebeles to neighboring kebeles and to other districts. For instance, potato seeds were transferred from Lemo district, Upper Gana and Jawe kebele to other neighboring kebele and other districts like Gombora, Gibe, Duna and Misha districts. In the same token, improved agricultural technologies disseminated to the neighboring kebeles of Sinana district and also transferred to other districts like Agarfa, Gasera, and Goro districts. Africa RISING interventions in Basona Worana district spread to numerous neighboring kebeles and from Endamehoni district to Emba Alage and Maichew districts. Since the sample farmers constitutes smaller proportion of the total farmers engaged in Africa RISING, drawing the exhaustive and exact map of technology dissemination may be cumbersome. But here the effort is to give the pattern and how the logistic multiplication of the technologies looks like. In most case, except Basona Worana, the dissemination of the technologies undertaken through the purchase of seed from farmers participating in the Africa RISING. In Basona Worana, in addition to the farmers to farmers technology transfer, district level office of Agriculture has facilitated the transfer of seed from Africa RISING intervention sites to the neighbouring kebeles. According to the survey data, bulky amount of seed transferred from Africa RISING intervention kebeles to neighboring kebeles and other districts at Lemo and Sinana sites. At Basona Worana and Endamehoni districts, the technologies were disseminated within intervention kebeles and to the neighboring kebeles.

The number of farmers actually receiving the improved seed from farmers participating in the project has been increasing. In terms of cumulative number of adopters, the trend of recipient farmers in the years following the launching of the project follows the usual S-shaped curve over time (Rogers, 1995). Few farmers would be willing to try a new seed variety at the initial stage. As they learn more about the interventions, more farmers will demand the interventions.

Table 4.11: The Location of Africa RISING interventions dissemination areas

| Intervention Districts (Kebele) | Intervention type | Dissemination District (*kebele)* |
|---|---|---|

| | | |
|---|---|---|
| Lemo(Upper Gana and Jawe kebeles) | Potato(seed) | **Lemo** (Upper gana, Jawe, Bukuna Checheyancho, Bobicho, Sebre, Bukurina Salata, Bushana,Bukuro)<br>**Gombora**:<br>**Gibe**: Mesmesa, Werecha<br>**Misha**: Was Gebeta, Girar ambat, Hadera<br>**Duna** |
| | Wheat | Jawe, Upper Gana, Sedama, Marduncho, Koshe, Shanko |
| | Faba bean | Upper Gana |
| Sinana (Selka and Ilu Sanbitu kebeles) | Potato(seed) | **Sinana**: Selka, Ilu sanbitu Selka bakaye, Alage, Asheta, Kabira Temu, Darara,<br>**Agerfa**: Sheneka, Amalema, Ali<br>**Gasera**: Denbal, Haro |
| | Wheat | **Sinana**: Selka oda, Ilu sanbitu Selka bakaye, Dabaye, Wayu hora, Obera,<br>**Agarfa**: Ali |
| | Barley | Sinana: Ilu sanbitu, Selka |
| | Faba bean | **Sinana**: Selka oda, Ilu Sanbitu, Selka bakaye, Besmana. Obera |
| Basona (Gudo beret and Goshe bado kebeles) | Potato(seed) | **Basona Worana**: Goshe bado, Gudo beret, Moy meda, , Adisge, Abamore, Aredana Sembega,Chin ber, Geda, Delbe ager, Boru ager, Tach mush, Abamote, Dube ager, Boru ager |
| | Wheat | **Basona Worana:** Mehal Amba, Weraye, Basona dengera, Nasira Kum amba, Abamete, Debre birhan 09 |
| | Barley | **Basona Worana**: Talak Amba |
| | Faba bean | **Basona Worana**: Goshe bado, Gudo beret, Adisge |
| Endamehoni (Tsibet and Emba hatsi kebeles) | Potato (ware) | |
| | Potato(seed) | **Endamehoni:** Emba hatsi, Tsibet, Belago, Shemtagesawsa, Hezeba T/Haimanot<br>**Amba Alage**: Ayba , Tehia |
| | Wheat | **E/mehoni**: Emba hatsi, Tsibet<br>**Emba Alage**: Ayaba, |
| | Barley | Tsibet |
| | Faba bean | **Endamehoni**: Tsibet**,** Emba hatsi<br>**Maichew:** 04 |
| | Feed trough | Emba hatsi, Tsibet |
| | Feed storage | Tsibet, Emba hatsi |

Source: Survey data, 2016

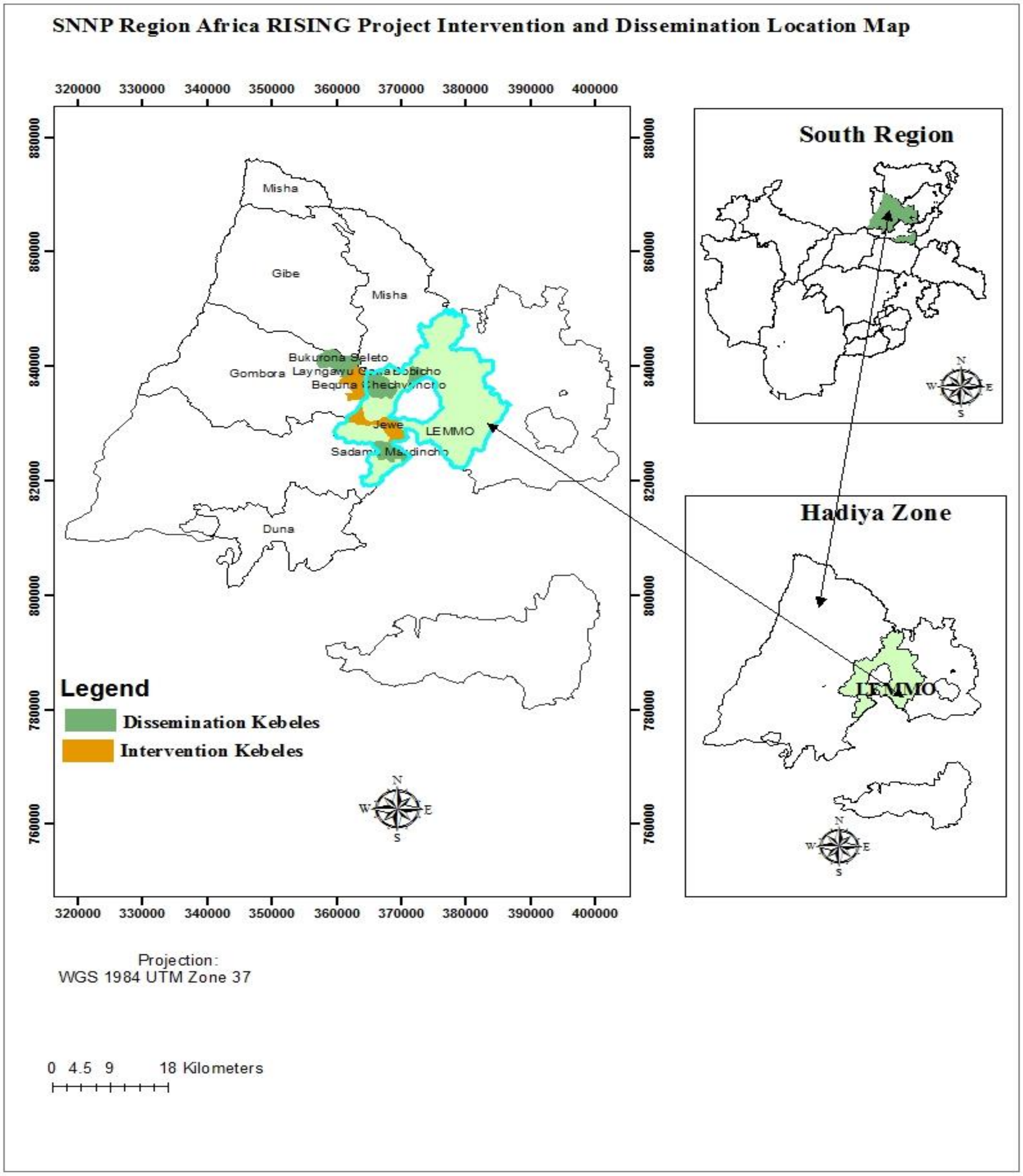



Figure 4.1: Map showing the Africa RISNG Project Interventions and dissemination locations in Lemo district, Hadiya, SNNPR.

Source: Own computation through GIS, 2016

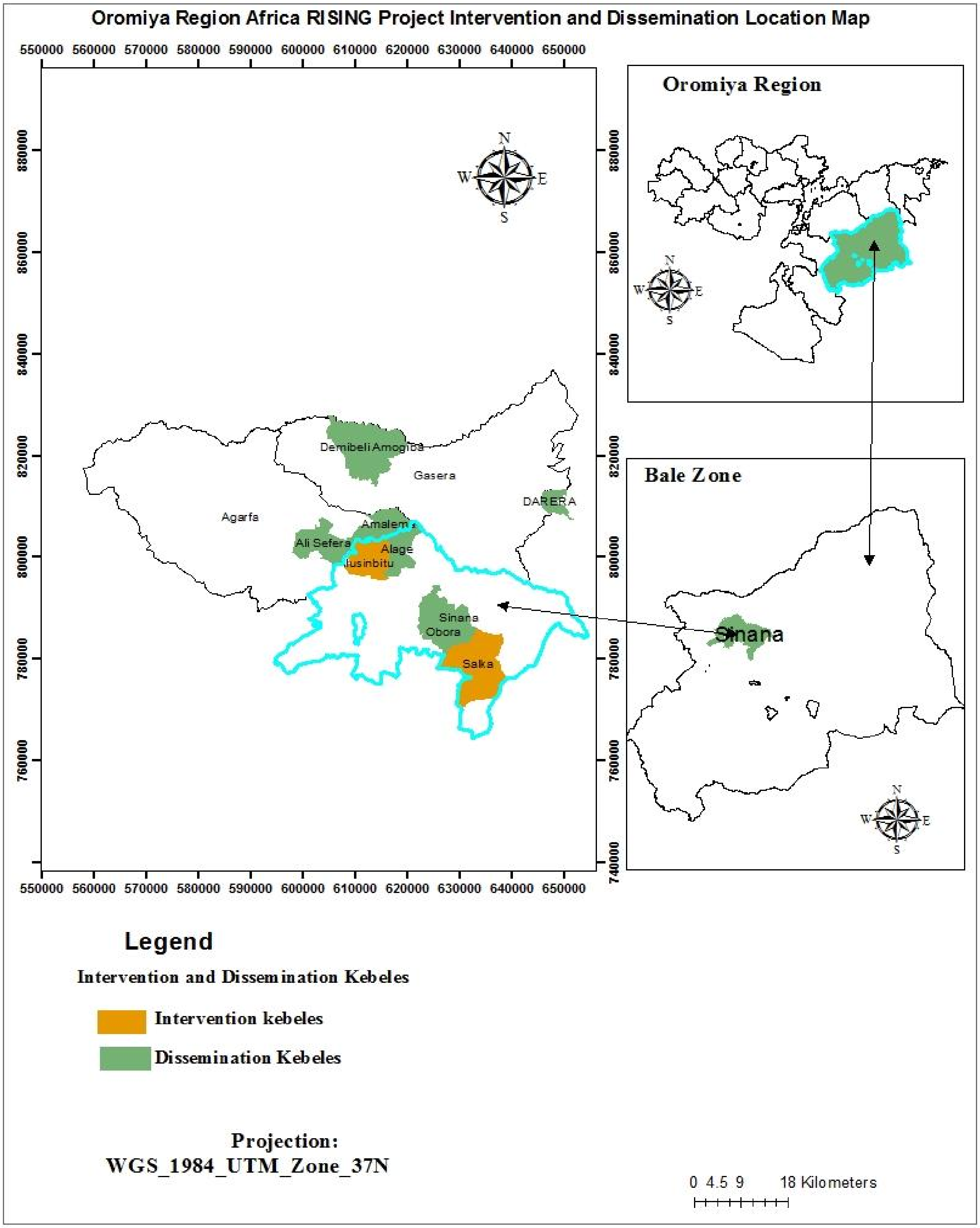



Figure 4.2: Map showing the Africa RISNG Project Interventions and dissemination locations in Sinana district, Bale, Oromia

Source: Own computation through GIS, 2016

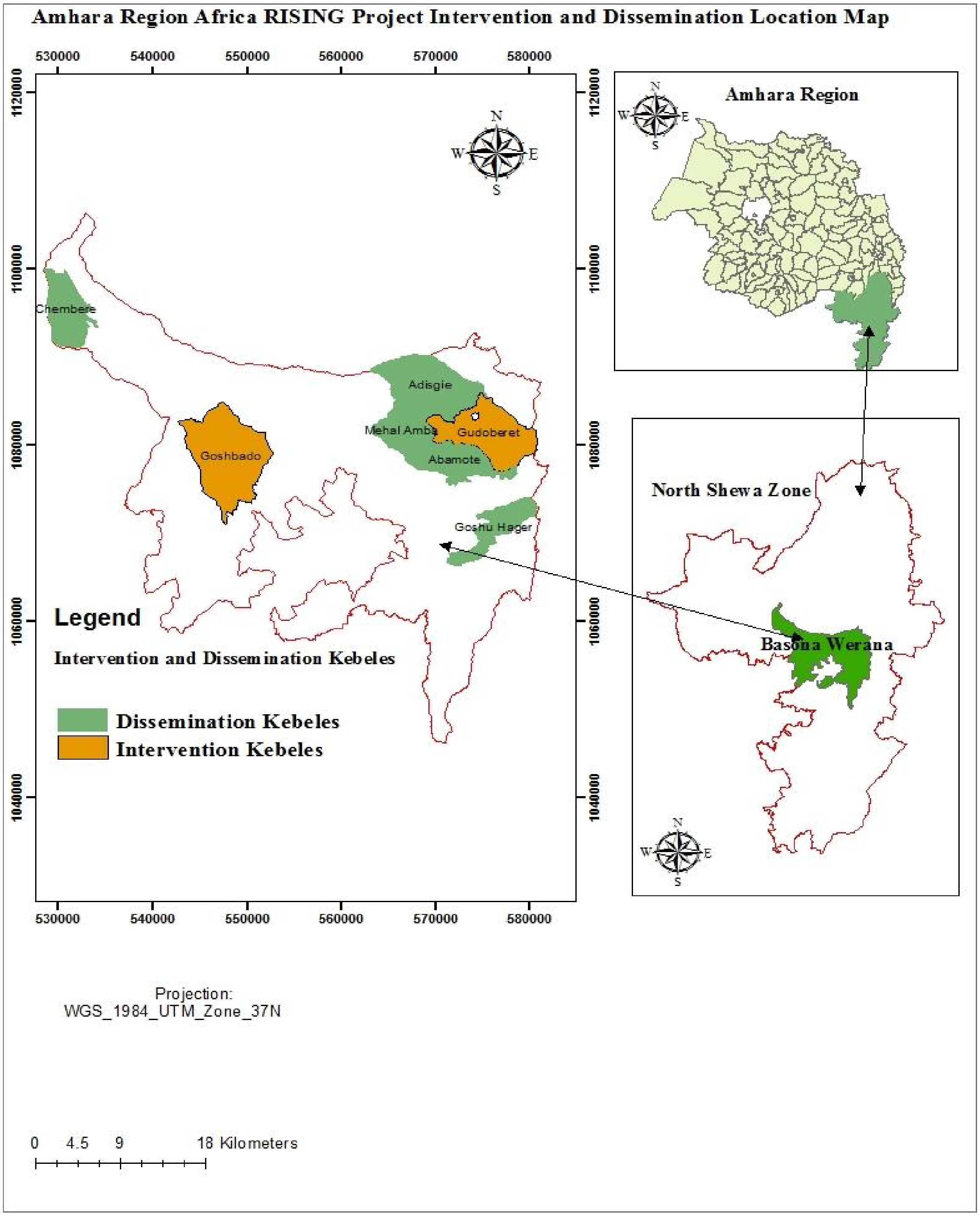



Figure 4.3: Map showing the Africa RISNG Project Interventions and dissemination locations in Basona Worena district, North Shewa, Amhara

Source: Own computation through GIS, 2016

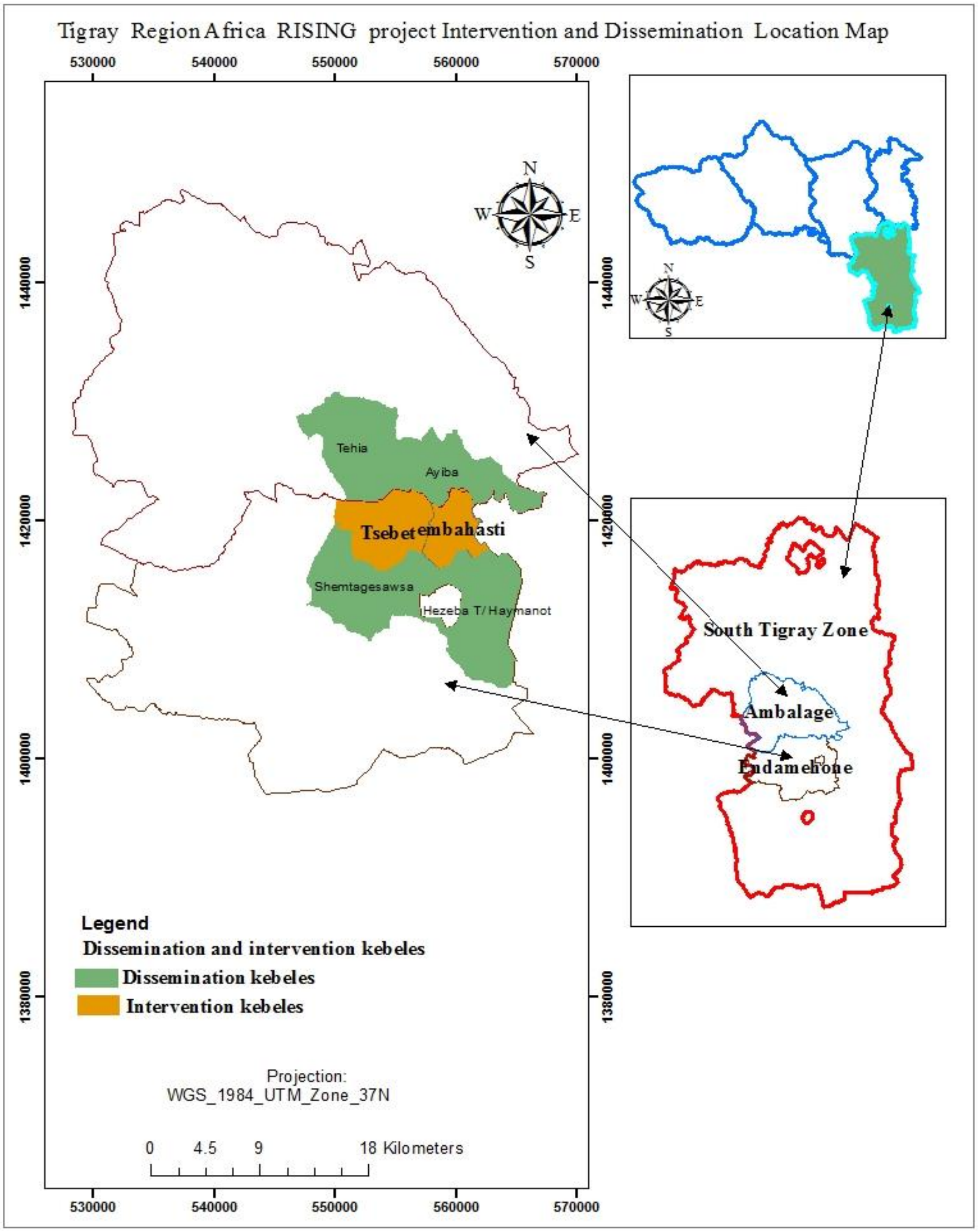



Figure 4.4: Maps showing the Africa RISNG Project Interventions and dissemination locations in Endamehoni district, South Tigray, Tigray

Source: Own computation through GIS, 2016

### 4.3.1 Source of information for Africa RISING interventions dissemination

The first batch of farmers engaged in Africa RISING interventions were selected by the kebele development agents and local administration in association with project staffs. About 45.8% of the sample farmers were initially informed and selected by the kebele DAs, kebele administration leaders in association project staff. Those farmers were made to be informed about the project purpose and scope, the farmersô responsibility and the provisions from the project. Since then the farmersô interest for Africa RISING has grown through year. As a result, farmers were engaged in different activities willingfully. After the first year of commence of the project demonstrations were organized on farm trial to popularize the interventions. Field project staffs facilitated field days on demonstration by inviting farmers and stakeholders. Then farmers were briefed about the potential differences they themselves compare the demonstrated technologies with their existing practices. Nearly one fourth (25.8%) of the sample farmers become interested after observing the farm trials at their neighbor farmersô farm and then they were impressed and decided to participate.

Through time, as the farmers came to realization of the fact that there is significant differences between the technology they were accustomed to use and the one being introduced by Africa RISING project through observing their neighbors farmers farm, they become impressed with what they have seen and become interested to take part in the next round. Based on the result of the Table 4.12, about 18.8% of the farmers interviewed indicated that they were informed and motivated by the farmers who are already participating in Africa RISING. Remaining 12% of the sample farmers were informed about the interventions by the experts but decided later by observing on-farm trials either at demonstrations during field days or observing fellow farmersô farm.

Field days and demonstrations were crucial source of information for the dissemination of Africa RISING interventions to non disseminators, who did not engage in Africa RSING interventions directly but adopted the interventions. About 42.5% of the non disseminators sample farmers begun to use Africa RISING interventions after they observed the technologies being demonstrated during field days. Other 40% claim they saw the farm of the neighboring farmers and then they decided to acquire for themselves. The remaining 17.5% of the indirect beneficiary sample farmers were informed by the friends or relatives who are engage as direct participant. Some of the last category of the farmers affirms that they received potato seed from relatives as gift and some acquired by buying. Farmers in those kebeles other than direct intervention kebeles become informed by the friends and relatives in direct intervention kebeles and acquired the seed through purchase.

Table 4.12: Sources of information for disseminations of sample households

| Source of information | Disseminators | | Non disseminators | | | Total |
|---|---|---|---|---|---|---|
| | N | % | Source of Information | N | % | N |
| DAs/experts/ | 55 | 45.8 | Field days | 17 | 42.5 | |
| Demonstrations and field days | 31 | 25.8 | Observation of neighbor farmers farm | 16 | 40 | |
| Informed and encouraged by farmers | 22 | 18.3 | Friends and relatives | 7 | 17.5 | |
| Informed by experts, but decided by observing demos | 8 | 6.7 | | - | - | |
| Informed by experts, but decided being impressed by fellow farmer | 4 | 3.4 | | - | - | |
| Total | 120 | 100 | | 40 | 100 | |

Source: Survey data, 2016

### 4.3.2 Farmers perception on Africa RISING interventions

Table 4.13 shows the opinion or perception of the sample farmers regarding Africa RISING interventions. About 99% of the sample farmers ardently agreed that their participation in Arica RISING interventions helped them to bring behavioral changes with regard to their willingness to adopt improved agricultural technologies. In the same token, 98% of the sample farmers said that adopting Africa RISING interventions have increased their income and also enable them to produce more and diversify crop and livestock production. More than 90% of the sample farmers affirm that the technology transfer and dissemination of interventions has been increasing.

Farmers initially thought the project as an aid scheme, but after they begun to participate in interventions and they become aware of the intervention intentions, their expectation was changed from thought of aid to issues pertaining to sustainable intensification. Many farmers sought to participate with the wrong motive of hoping that project would came just to do something for them but later they end up with being introduced with using improved and innovative agricultural technologies which would enable the farmers to increase production and productivity while ensuring issues of sustainability and the project has trained the farmers how to fish for themselves. During Focused Group Discussion (FGD) meeting at Lemo district, farmers boldy stressed that even though the project came to an end, its legacy will leave with farmers for long time because the farmers were introduced with number of improved innovative agricultural practices which the farmer themselves would do without presence of outsiders. They claim that many projects may come and go, but skills and knowledge the farmers acquired from Africa RISING project has already rooted and embedded within the agricultural practices of the communities and its dissemination is propagated as a result.

Table 4.13: Perception of sample households about interventions in the study area

| Perception criteria | Response | Beneficiaries | | | | | |
|---|---|---|---|---|---|---|---|
| | | Disseminators | | Non dissem. | | Total | |
| | | N | % | N | % | N | % |
| Does AR has impact on improving technology adoption behavior | Yes | 116 | 96.7 | 40 | 100 | 158 | 99.4 |
| | No | 4 | 3.3 | | | 1 | 0.6 |
| Does AR has increased your income | Yes | 115 | 99.1 | 39 | 97.5 | 154 | 98.7 |
| | No | 1 | 0.9 | 1 | 2.5 | 2 | 1.3 |
| Is there significant difference b/n AR and existing practices | Yes | 117 | 100 | 40 | 100 | 117 | 100 |
| | No | | | | | | |
| Technology transfer and dissemination trend | Increasing | 98 | 89.1 | 32 | 86.5 | 140 | 92.7 |
| | Decreasing | 2 | 1.8 | 3 | 8.1 | 3 | 2 |
| | No change | 10 | 9.1 | 2 | 5.4 | 8 | 5.3 |

Source: Survey data, 2016

## 4.4 Quantification of inputs and outputs of the Africa RISING interventions

**Potato**

Potato was one of the interventions Africa RISING project has intervened in and is the most disseminated and preferred activity by the farmers in all sites. According to the results of the Table 4.14 there are two types of potato interventions: Ware potato and Seed potato. Ware potato intervention was undertaken to let farmers to produce food potato and the seed potato producers were engaged in production of potato for seed purpose. Under the prevailing price of seed of the ware potato, seed saved by the use of improved varieties of ware potatoes per hectare was estimated at value of Birr 2800, 1800, 1710 and 300 for Endamehoni, Sinana, Lemo and Basona respectively, where as the average value of seed saved for all location found to be Birr

1960 all other things remain constant. Interms of the extra outputs added without adding the cost of ware potato seeds, Lemo district comes first with the extra outputs of about 3 tones and average yield of 16 tones per hectare, Sinana and Endamehoni districts stood at second with the extra outputs of 2.32tonnes and an average yield of 14 tones per hectare, and Basona district is third with the extra outputs of 1.92 tonnes and average yields of 15 tonnes. The average amount of extra output obtained for ware potato for all districts was 2. 39 tonnes and average yield was 14.75 tonnes.

Regarding to the amount of seed saved for seed potato, seed saved by the use of improved varieties of seed potatoes per hectare was estimated at value of Birr 5400 for Lemo, 4200 for Basona and Endememehoni and 1400 for Basona, where as birr 3640 for project average. In the same token to ware potato, interms of the extra outputs added without adding the cost of seed potato seeds, Lemo district comes first with the extra outputs of about 3.5 tones and average yield of 17 tonnes per hectare, Basona and Endamehoni districts stood at second with the extra outputs of 3.36 tonnes and an average yield of 16 tones per hectare, and Sinana district is third with the extra outputs of 1.44 tonnes and average yields of 15 tonnes. The average amount of extra output obtained for seed potato for all districts was 3.03 tonnes and average yield was 16 tonnes per hectare. Potato is produced mainly in three regional states (Amhara, Oromia, SNNPR). According to Anton Haverkort et al., (2012) about 80% of the potato produced can be found in Amhara and Oromia regions and about 15% found in SNNPR and the average yield of potato per hectare was very low(below 10tonnes/ha) and has been increasing due to various efforts being undertaken to improve the situation.

**Wheat**

Wheat was one of the Africa RISNG project crop-lvestock interventions. Table4.14 shows that Lemo district comes firs with the value of the wheat seed saved birr 146, Basona is second with birr 121, Endamehoni is third with the birr 55 and Sinana is fourth with birr 27 per hectare all other things remain constant. Average yield and extra outputs added per hectare respectively for Lemo district was 20 quintals and 1.17 quintals , for Sinana district was 24 quintals and 1.1 quintals , for Basona district 22 quintals and 1.05 quintal and for Endamehoni district was 20 quintals and 0.66 quintal. Project average for all districts was 87 birr seed value saved per hectare, 1.04 quintals extra outputs obtained per hectare and 21.5 quintals of average yield per hectare. As compared to other crops intervened for, the value of seed saved, and the extra outputs obtained found to be lower due to the fact that farmers have accustomed their selves to the use of selected varieties and the seed (varieties) which were distributed by Africa RISING project were already in use by the farmers except for the difference in fertilizer rate and other agronomic practices (row (planting vs. broad casting, weeding, land tillage frequency etc.).

**Barley**

Food barley was one of the research protocols undertaken across all project sites. Based on the reulst of the Table 4.14, with regard to the value of seed saved, Basona district comes firs with the value of the barley seed saved birr 744, Endamehoni is second with birr 570, Sinana is third with the birr 483. Average yield and extra outputs added per hectare respectively for Sinana district was 12 quintals and 2.07quintals , for Basona district 13 quintals and 2.04 quintal and for Endamehoni district was 14 quintals and 1.33 quintal. The project average for the three district was 599 birr barley seed value saved per hectare, 1.80 quintals extra outputs obtained per hectare and 13 quintals of average yield per hectare.

**Faba bean**

Faba bean was also intervened in all four sites and like other crops, differs from one district to other interms of value of seed saved, extra outputs added and average yield per hectare. Table 4.14 shows that Sinana district tops in value of faba bean seed saved and average yield per hectare with birr 1018 and 15 quintals respectively, and comes second interms of extra quantity of wheat outputs added with 2.04 quintals as a result of improved seed use. Lemo district comes second with regard to value of barley seed saved with birr 741 and average yield of 14 quintals and was first with in extra quantity(2.16 quintals) per hectare added with the old level of seed use. Endamehoni district was third with value of faba bean seed saved birr 649, extra output 1.95 quintals and average yield of 14 quintals per hectare and Basona district fourth with value of faba bean seed saved birr 212, extra quantity added 1.52 quintals with the old level amount of seed use and average yield of 13 quintals per hectare. An average quantity for the all districts of faba bean seed saved estimated to be birr 649 and with the extra output of 1.98 quintals obtained with the old level of improved seed use and an average yield of 14 quintals.

Table 4.14: Quantification of input saved and extra output added by the interventions

| Intervention type | District | Improved seed /tim | Local Seed /tim | Seed (AR-Loc) | AR Y/tim | Loc Y/tim | ($Y_{AR}$-$Y_E$) /tim | $Y_N$/ha | $Y_O$/ha | $R_N$ (Birr) | $R_{ON}$ (Birr) | R | $S_R$ | $Q_{ex}$ | $Y_N$-$Y_O$ | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ware Potato | Lemo | 5 | 6 | 1 | 4 | 2.5 | 1.5 | 16 | 10 | 14000 | 15710 | 20 | 1710 | 3 | 5 | 0.6 |
| | Sinana | 5 | 6 | 1 | 3.5 | 2.5 | 1 | 14 | 10 | 15000 | 16800 | 20 | 1800 | 2.32 | 4 | 0.58 |
| | Basona | 5 | 6 | 1 | 3.75 | 2.75 | 1 | 15 | 11 | 15000 | 15300 | 20 | 300 | 1.92 | 3 | 0.64 |
| | Endamehoni* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Project average | 5 | 6 | 1 | 3.68 | 2.56 | 1.13 | 14.72 | 10.24 | 14500 | 16460 | 20 | 1960 | 2.79 | 4.5 | 0.62 |
| Seed Potato | Lemo | 5 | 6 | 1 | 4.25 | 2.5 | 1.75 | 17 | 10 | 15000 | 20400 | 20 | 5400 | 3.5 | 7 | 0.5 |
| | Sinana | 5 | 6 | 1 | 3.75 | 2.8 | 0.95 | 15 | 11.2 | 15000 | 16400 | 20 | 1400 | 1.44 | 4 | 0.36 |
| | Basona | 5 | 6 | 1 | 4 | 2.5 | 1.5 | 16 | 10 | 15000 | 19200 | 20 | 4200 | 3.36 | 6 | 0.56 |
| | Endamehoni | 5 | 6 | 1 | 4 | 2.5 | 1.5 | 16 | 10 | 15000 | 19200 | 20 | 4200 | 3.36 | 6 | 0.56 |
| | Project average | 5 | 6 | 1 | 4 | 2.57 | 1.43 | 16 | 10..28 | 15000 | 18640 | 20 | 3640 | 3.53 | 5.7 | 0.62 |
| Wheat | Lemo | 31 | 35 | 4 | 5 | 4.25 | 0.75 | 20 | 17 | 1500 | 1646 | 12.8 | 146 | 1.17 | 3 | 0.39 |
| | Sinana | 31 | 35 | 4 | 6 | 5.5 | 0.5 | 24 | 22 | 1500 | 1527 | 9.08 | 27 | 1.1 | 2 | 0.55 |
| | Basona | 31 | 35 | 4 | 5.5 | 4.75 | 0.75 | 22 | 19 | 1500 | 1621 | 14.28 | 121 | 1.05 | 3 | 0.35 |
| | Endamehoni | 32 | 35 | 3 | 5 | 4.5 | 0.5 | 20 | 18 | 1500 | 1555 | 11.11 | 55 | 0.66 | 2 | 0.33 |
| | Project average | 31.25 | 35 | 3.75 | 5.38 | 4.75 | 0.63 | 21.5 | 19 | 1500 | 1587 | 11.81 | 87 | 1.01 | 2.5 | 0.40 |
| Barley | Lemo* | | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Sinana | 35 | 40 | 5 | 3 | 2.25 | 0.75 | 12 | 9 | 1650 | 2133 | 14.3 | 483 | 2.07 | 3 | 0.69 |
| | Basona | 35 | 40 | 5 | 3.25 | 2.5 | 0.75 | 13 | 10 | 1400 | 2144 | 11.2 | 744 | 2.04 | 3 | 0.68 |
| | Endamehoni | 35 | 40 | 5 | 3 | 2.5 | 0.5 | 14 | 10 | 1350 | 1920 | 14.3 | 570 | 1.32 | 4 | 0.33 |
| | Project average | 35 | 40 | 5 | 3 | 2.5 | 0.5 | 13 | 10 | 1466 | 2065 | 19.61 | 599 | 1.8 | 2 | 0.57 |
| Faba bean | Lemo | 45 | 50 | 5 | 3.5 | 2.75 | 0.75 | 14 | 11 | 2720 | 3461 | 11.11 | 741 | 2.16 | 3 | 0.72 |
| | Sinana | 45 | 50 | 5 | 3.75 | 2.75 | 1 | 15 | 11 | 2800 | 3818 | 25 | 1018 | 2.04 | 4 | 0.51 |
| | Basona | 45 | 50 | 5 | 3.25 | 2.75 | 0.5 | 13 | 11 | 2860 | 3072 | 25 | 212 | 1.52 | 2 | 0.76 |
| | Endamehoni | 45 | 50 | 5 | 3.5 | 2.75 | 0.75 | 14 | 11 | 2430 | 3054 | 11.11 | 624 | 1.95 | 3 | 0.65 |
| | Project average | 45 | 50 | 5 | 3.5 | 2.75 | 0.75 | 14 | 11 | 2702 | 3351 | 18.05 | 649 | 1.98 | 3 | 0.66 |

Source: Own computation, 2016 **Note:** *data unavailable, AR= Africa RISING, Loc = local, tim= timad. 1 timad= 0.25 ha

## 4.5 Profitability Analysis

One of the measures to evaluate the economic viability of activities is to look into the Net Present Value (NPV) of the given enterprises. According to the Table 4.15, the per hectare value of net present value for the ware potato was 51773 birr, 51705 birr and 39840 birr for Sinana, Basona Worena and Lemo districts respectively and the average across all sites was 47773 birr where as the net present value for seed potato was 69173 birr, 68405 birr, 60840 birr and 51720 birr for Basona Worena, Sinana, Lemo and Endamehoni districts in their respective order with the average net present value of 62713 birr. Potato (both seed and ware) seem to be high returning interms of net present value per hectare, but due to the perishablity, short shelf life, lack of agro processing industries and lack of the market to absorb the mass of production during harvesting period, farmers do not opt to invest a lot resource on potato production. Farmers forsee pesmistically that when they put whole of their plot under potato production, all farmers dump the potato to the market and the price would slump considerably. In fear of such risks, only few farmers dare to see potato as potential enterprise to generate handful cash. The vast majority of the farmers produce potato primarily for the household consumption. Benefit to Cost ratio for ware potato was 3.23 for Basona Worena which was highest, 3.04 for Sinana, and 2.65 for Lemo and the average was 2.97, and for seed potato the benefit to cost ratio was 4 for Basona Worena, 3.98 for Endamehoni, 3.52 for Sinana, and 2.97 for Lemo with an average of 3.66.

The net present value for the wheat was 13285 birr for Sinana, 10695 birr for Endamehoni, 10333 birr for Basona Worena and 6530 for Lemo districts. An average value for the four site was 10187 birr. Benefit to cost ratio for wheat enterprise was highest at Sinana with the ratio of 2.49, lowest at Lemo with the ratio of 1.72. Basona had the benefit to cost ratio of 2.09 and Endamehoni had 2.14. the average benefit to cost ratio for the all sites was 2.1. The net present value for the barley was 4780 birr for Endamehini, 3151 birr for Basona Worena, 2975 birr, for Sinana districts and an average value for the three site was 3361 birr. Benefit to cost ratio for wheat enterprise was highest at Endamehoni with the ratio of 1.84, lowest at Sinana with the ratio of 1.39. Basona had the benefit to cost ratio of 1.48 and the average benefit to cost ratio for the all sites was 1.48.

The highest net present value for the faba bean was 31950 birr at Sinana, 27080 birr for Endamehoni, 25320 for Lemo, 19692 birr for Basona Worena districts and an average value for the all site was 25866 birr. Benefit to cost ratio for wheat enterprise was highest at Sinana with the ratio of 5.46, lowest at Basona Worena with the ratio of 4.53. Endamehoni had the benefit to cost ratio of 4.91 and Lemo had 4.73 and the average benefit to cost ratio for the all sites was 4.92.

The reader should be aware and be cautious with the use of these figures as this study only considered the costs related to seeds, fertilizer and labour where as the costs related to land ownership and rental and the cost of chemicals were not accounted due to the irregularity of the data available for these items.

Table 4.15: Profitablity Analysis

| intervention type | District | $Y_n$ (Qt) | $P_Y$ (Birr) | B $Y_n$ x $P_Y$ (Birr) | C $X_i$ x $P_{xi}$ (Birr) | NPV B-C $Y_nP_y$-$XP_{xi}$ (Birr) | B/C |
|---|---|---|---|---|---|---|---|
| Potato /ware/ | Lemo | 160 | 400 | 64000 | 24160 | 39840 | 2.649007 |
| | Sinana | 140 | 550 | 77000 | 25295 | 51705 | 3.04408 |
| | Basona | 150 | 500 | 75000 | 23227 | 51773 | 3.229001 |
| | Endamehon* | - | - | - | - | - | - |
| | Total | 150 | 483 | 72000 | 24227 | 47773 | 2.971891 |
| Potato /seed/ | Lemo | 170 | 500 | 85000 | 24160 | 60840 | 3.518212 |
| | Sinana | 152 | 600 | 91200 | 22795 | 68405 | 4.000877 |
| | Basona | 168 | 550 | 92400 | 23227 | 69173 | 3.978129 |
| | Endamehoni | 160 | 475 | 76000 | 24280 | 51720 | 3.130148 |
| | Total | 162.5 | 531 | 86328 | 23615 | 62713 | 3.655648 |
| Wheat | Lemo | 20 | 780 | 15600 | 9070 | 6530 | 1.719956 |
| | Sinana | 24 | 925 | 22200 | 8915 | 13285 | 2.490185 |
| | Basona | 22 | 900 | 19800 | 9467 | 10333 | 2.091476 |
| | Endamehoni | 20 | 1000 | 20000 | 9305 | 10695 | 2.149382 |
| | Total | 21.5 | 901 | 19376 | 9189 | 10187 | 2.108703 |
| Barley | Lemo* | - | - | - | - | - | - |
| | Sinana | 12 | 880 | 10560 | 7585 | 2975 | 1.392221 |
| | Basona | 13 | 750 | 9750 | 6599 | 3151 | 1.477497 |
| | Endamehoni | 14 | 750 | 10500 | 5720 | 4780 | 1.835664 |
| | Total | 13 | 793 | 10313 | 6952 | 3361 | 1.483506 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lemo | 21.4 | 1500 | 32100 | 6780 | 25320 | 4.734513 |
| | Sinana | 23 | 1700 | 39100 | 7150 | 31950 | 5.468531 |
| | Basona | 19 | 1330 | 25270 | 5578 | 19692 | 4.530298 |
| Faba bean | Endamehoni | 20 | 1700 | 34000 | 6920 | 27080 | 4.913295 |
| | Total | 20.85 | 1557 | 32473 | 6607 | 25866 | 4.915071 |

Source: Own computation, 2016

Note: *not computed due to unavailability of data

## 4.6 Econometric Result and Discussion of Factors Affecting the Dissemination of the Africa RISING interventions

In assessing the factors that determine farmersô decisions to transfer, we require a model that deals with the dichotomous dependent variable ñdisseminated or not disseminated.ò This behavioral dependent variable can be used to examine the relationship with the independent variables. Such models cannot be estimated by either multiple regression or the ordinary least square (OLS) techniques. Multiple regression technique results in invalid parameter estimates and wrong magnitude of the effects of the independent variables on the dependent variables. In the case of OLS, assumptions that the variances of the error terms are constant and not correlated with the level of independent variables are violated. Consequently, four commonly used approaches to estimate such models are: the linear probability model (LPM), logit model, probit model, and the Tobit model (Gujarati, 1995). Like the OLS technique, the LPM is also plagued by several problems and is not generally recommended. The LPM provides predicted values that may fall outside the 0-1 intervals, thus violating the assumption of probability. The remaining model types give maximum likelihood estimators and overcome most of the shortcomings of linear probability model, by providing consistent and efficient estimates. Among the three other techniques proposed, we opted for the logit model framework as described by Maddala (1983) and Gujarati (1995). This model has been applied in a similar study (Grisley, 1994) and has been found to be efficient in explaining such dichotomous decision variables. In formulating the model, we assumed that Pi is the observed response of farmer i, (i. e. Pi = 1 for disseminated, otherwise Pi = 0), the decision to transfer by an $i^{th}$ farmer depends on $X_i$, which is a vector of factors representing the farmer-specific, economic, social, technology attributes, and farmersô perceptions. The disturbance term is represented by ($e_i$) and assumed to have a mean equal to zero.

Prior to the analysis of the data, it was found important to look into the problem of multicollinearity or linear association among the hypothesized variables. Variance Infilation Factors(VIF)(Appendix 2) were used to check multicollinearity problem in continuous variable and similarly Contigency Coefficients were used for dummy variables. In order to identify the variables influencing the dissemination of crop-livestock interventions, the binary logit(regression) model was estimated using Maximum Likelihood stimation procedure(Mesfin, 2005)

Based on the result of tests, variables that have showed high degree of correlation were eliminated from further analysis. It was concluded that there were no multicollinearity and association problem between a set of continuous and discrete variables, as the respective coefficients were very lowless than 10 for continuous variables and less than 0.75 for dummy variables) (Appendix 2 and 3 Finally the 5 potential continuous and the 11 discrete variables were entered into logistic regression analysis. In the course of analysis, forward method of variable selection was employed.

The model was assessed for its goodness of fit by examining how well the model classifies the observation data (in the classification table) or by examining of how likely the sample results actually are, given the estimates of model parameters (Hosmer and Lemeshow, 1989). The result indicates that (the model Chi-Square value) the parameters included in the model taken together were significantly different from zero at less than 1 percent level of significance. Thus, the hypothesis set that the entire coefficients except the intercept was rejected. The value of Chi-square(X= 82.4) also indicates the goodness of fitted model (Table 18).

Another measure of goodness of fit in the logistic regression model is seeing how much the observed value is correctly predicted. The fit is considered to be good if the overall correct prediction rate exceeds 50% (Callet, 1991 as cited in Mesfin, 2005). In other words, the observation is grouped as transferred if the computed probability of transfer/dissemination is greater than or equal to 0.5(50%) and as not transferred/disseminated, otherwise. Based on this the result showed that about 88.9% of the non disseminated and 80% of the disseminated were correctly predicted using the cut off value of 0.5. Overall, the model correctly predicted 85.7% of the sample cases (Table 18). Thus, the model predicted both disseminator and not disseminator groups of Africa RISING crop-livestock interventions accurately.

## 4.7 Explanation of the Significant Variables Influencing Dissemination

Maximum Likelihood was used to estimate the parameters of the variables that are expected to influence the dissemination of Africa RISING crop-livestock interventions(Table 4.16). In this model 5 potential continuous and 11 discrete variables were entered. Out of the total sixteen independent predictors, only six of which 0ne were continuous and five were dummies found to be significantly influencing the dissemination of crop-livestock interventions. Variables found to be significant included: formal education level of the household in schooling years(EDUC), technology characteristics of the Africa RISING interventions (TECIXS), and farmers perception about the yield(PERCY) found significant at 1% level of significance, time after the introduction of intervention in years(TIME) and frequency of extension contact (EXTCON) found significant at 5%probablity level, and communication channels effectiveness(COMCHAN) found to be significant at 10% level of significance(Table 18). With the above brief background, the effect of the significant explanatory variables on the dissemination of the crop-livestock interventions will be discussed in separate below.

**Education of the household in schooling years (EDUC):** The model shows that the formal education in schooling years associated with the dissemination of the crop-livestock interventions at 1% level of significance. The positive sign indicates that the farmers with higher schooling years tend to adopt new crop-livestock technologies and hence the increase in level of formal education years among the farmers would positively affect the level of dissemination. An educated farmer would be able to comprehend innovative ideas much more faster rate than uneducated counterparts. Education enhances the awareness level of the farmers towards new technologies. Educated farmers have more access to information and they would be able to utilize it in timely manner. The odds ratio of 1.713 for education implies that other things being constant, the odds-ratio in favor of dissemination of crop-livestock intervention increases by a factor of 1.713 as a farmers education level increase by one grade. In host of adoption and diffusion literatures, level of education attained by the farmers found to positively influence adoption and dissemination of crop-livestock interventions. Haji (2003) observed as the education level increases, the adoption of cross-bred dairy cows increased and Robera Merga

(2013) also found that more educated farmers are typically assumed to be able to process information and search for appropriate technologies to alleviate their production constraints. A study by Techane (2002) also agrees with this result.

**Technology characteristics of the Africa RISING interventions (TECIXS):** Technology characteristics found to influence significantly and positively at 1% level of probability. Farmers might opt to adopt and use technology with characteristics such as superiority of yield as compared to their existing practices, color quality cookability, ease for threshing, early maturity, and marketability. Once the given interventions are made, technology characteristics are the attractive power helps to further the technologies thereby spicing the dissemination. Study by Kormawa et al.(2004) supports the positive influence of the technology characteristics for the dissemination of crop-livestock interventions.

**Farmers Perception about the yield (PERCY)** found to influence the dissemination of the crop-livestock interventions positively and significantly. The model result shows that the farmersô perceptions about the intervened technologies largely dictate the dissemination of the interventions. When the farmers perceive the given intervention turn out to be high yielding, the transfer of those technologies would be fast and cover wider area without need of push from outsiders. In other words, if the farmers perceive that the given intervention would yield close to their existing one or lower they would not dare to adopt the new one. Study by Mesfin (2005) is in agreement with the notion that the way the farmers perceive about the yield of the new technologies influence the dissemination and Kormawa et al(2004) also reiterate the farmerôs perception are important factor in seed dissemination process.

**Time after the introduction of intervention in years (TIME):** Influence the dissemination of the crop-livestock interventions positively and significantly at 5% level of probability. Some of the farmers might begun to use the crop-livestock interventions during commence year and the remaining would decide year after year. Farmers differ in speed to adopt the new technologies and this adoptive decision difference would lead to the some to adopt earlier and some later. Some farmers decide after they become sure of the adaptability after observing the farm of early adoptrs fellow farmers. Flow of information takes time and hence time plays an important role for the dissemination of the crop-livestock interventions. Dissemination and diffusion literatures considers time as an important variable According to Rogers(1983), there are five adopters categories as time related to dissemination: 1) innovators, 2) early adopters, 3) early majority 4) late majority, and 5) laggards.

**Frequency of extension contact (EXTCON):** extension contact found to be significant at 5% in explaining the level and extent of the dissemination of the improved crop-livestock technologies. Development agents serve as communication channels between different outside interveners and farmers at grass root level. Therefore, farmers who have frequent contact with the extension workers would have an opportunity to exchange ideas on agricultural issues and this would facilitate the use of improved agricultural inputs. Besides, those farmers with frequent extension contact could be early responders to the newer interventions. Since most of the agricultural information and inputs are delivered through extension system, farmers with the prior experience to utilize the information from development agents to adopt the new technologies would act earlier to participate thereby contributing to the dissemination of the crop-livestock interventions. Studies by Kidane(2001), Techane(2002), Birhanu(2002), Haji(2003), Melaku(2005) and Samuel Moore(2014) are in line with the positive influence of the extension contact for the dissemination process.

**Communicaton channels(COMCHAN):** found significant at 10% probability level and positively influence the dissemination of the crop-livestock interventions. Effective communication channels facilitates the flow of information from outsiders to the target stakeholders and the availability of these information at required time, quality, and location would greatly pave the way for dissemination of the interventions. The farmers need information to decide whether to adopt or not, and the communication channels through which the information is passed down to farmers determine the efficacy of the information, and in turn, these information would be of paramount importance for the dissemination of interventions. Agricultural Extension Agents (AEAs), field visits, demonstrations and farmer-to-farmer approaches found to speed up the dissemination of the crop-livestock interventions. Study by Samuel Moore(2014) also agrees that it is through effective communication among the stakeholders that a technology is accepted and utilized. As a result, the successful adoption and efficient application of technology depends on the effective communication channels. Well known diffusion theorist Everret Rogers (1983) indicated the effectiveness of the communication channels influence the dissemination by dictating the quality of transfer of information along the communication channels.

Table 4.16: Maximum Likelihood Estimates result of the Logistic Model

| Explanatory variable | B | S.E. | Wald | Sig. | Exp(B) |
|---|---|---|---|---|---|
| AGE | -0.691 | 1.212 | 0.325 | 0.569 | 1.996 |
| EDUC | 0.538 | 0.104 | 26.570 | 0.000*** | 1.713 |
| FARMSIZE | 0.128 | 0.044 | 8.520 | 0.200 | 1.137 |
| TOTINC | 0.704 | 0.176 | 15.892 | 0.720 | 2.021 |
| TIME | 0.507 | 0.251 | 4.094 | 0.040** | 1.661 |
| NOFI | 1.871 | 1.435 | 1.700 | 0.192 | 6.496 |
| LABAV | 0.860 | 0.852 | 1.017 | 0.313 | 0.423 |
| PRICEO | 0.548 | 2.044 | 0.072 | 0.789 | 1.729 |
| PERCY | 0.567 | 1.520 | 0.139 | 0.009*** | 5.221 |
| EXTCON | 2.312 | 1.130 | 4.185 | 0.041** | 10.096 |
| PRICEI | -2.862 | 1.158 | 6.103 | 0.310 | 17.492 |
| INFRA | 1.654 | 1.094 | 2.287 | 0.130 | 5.229 |
| COMCHAN | 1.629 | 0.958 | 2.891 | 0.089* | 5.097 |
| FWRISK | 1.653 | 1.467 | 1.270 | 0.260 | 0.568 |
| TECIXS | 1.852 | 1.794 | 1.065 | 0.001*** | 6.371 |
| MARKAV | 0.367 | 1.094 | 0.112 | 0.737 | 1.443 |
| Constant | -7.014 | 2.294 | 9.348 | 0.002*** | 0.001 |

-2 log likelihood= 49.240

Model Chi-Squared= 82.37

Over all Model prediction= 85.7%

Over all prediction of disseminators= 88.9%

Over all prediction of non disseminators= 80%

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

N= 160

# CHAPTER FIVE

# 5. SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.1 Summary

The study was based on the data obtained from the rural household survey during April to July 2016. Eight intervention kebeles were selected from the four weredas and a total of 160 households were considered in the survey. Moreover, secondary data were obtained from various relevant sources. SPSS statistical package was employed to compute descriptive statistics, and to estimate the logit model in assessing the factors affecting the dissemination of the cropï livestock interventions. A total of sixteen explanatory variables were used in the estimation of logit model and six of them found to be significant in influencing the probability of the dissemination of the of the crop-livestock interventions. The important factors that influenced the crop-livestock intervention include education, time, and farmersô perception about yield, extension contact, effectiveness of communication channels and technology characteristics of the crop-livestock interventions.

Cropï livestock farming systems, which are common in smallholder farming communities in many developing countries, are inherently complex. Initially, this can be a daunting prospect for research, development and extension (RD&E)ï based attempts to improve system performance, which is typically measured as increased productivity of individual crop and livestock activities or, more generally, as increased household welfare. RD&E in smallholder agriculture often focuses on specific elements of the farming system, sometimes leading to the introduction of a new technological component (e.g. fertiliser, new cultivar, veterinary medicine) or practice (e.g. silage-making, early weaning). However, although this approach may be both realistic and inevitable when limited resources are available to support system improvement, RD&E must also take into account the wider farming system.

Mapping the dissemination of the Africa RISNG interventions indicates that different technologies introduced by the project disseminated both within and outside of the intervention locations. The study shows that the improved technologies specially potato were disseminated to many districts and kebeles at Lemo and Sinana sites and in Basona Worena and Endamehoni seed was transferred within district and kebele of intervention. Among the crops, potato was the most disseminated type of crop in terms of area coverage. In terms of yield acreage per hectare potato remain top as most promising crop to yield higher amount as compared to the current national average yield which is about 10 tonnes/ha, where as the improved varieties by the Africa RISNG could yield up to 17 tonnes/ha. The highest yield was recorded at Lemo district which was 17 tonnes/ha.

Regarding wheat production, farmers in all four project sites accustomed to use improved varieties and the yield recorded was fairly comparable to the existing national average yields. Since farmers hardly recycle the seed the produced for production purpose the transfer of the seed is rarely occurring. But there are differences in seed and fertilizer rate used under the framework of Africa RISING project and existing farmersô practices. Farmers acquire seeds and fertilizer from Bureau of Agriculture and the Development Agents (DAs) provide an advice regarding agronomic practices but the farmers resort to what is the so called ôBlanket recommendationö. As a result, there was a little prospect of the transfer of the seed of the wheat from farmers to farmers, but the practices which brings the yield difference remain the projectsô milestone. Sinana district, which is known for heavily mechanized wheat production in the country was the location where highest yield recorded which is 24qt/ha and the barley was highest at Endamehoni district with the yield of 13qt/ha. Faba bean has best performed in Sinana district with the 15qt/ha.

Interms of monetary value, Basona Worena district was cames top for ware potato with about 51713 Birr/ha where as Sinana comes first for seed potato with the value of 68405 birr/ha. For wheat Sinana district was first with the value of 13285 birr/ha and Endamehoni tops for barley with the value of 4780 birr/ha. Sinana comes first for the faba bean value with 27080 birr/ha. The reader should be aware that the value of the output per hectare estimated by using the prevailing market price of that specific locations and there would be price disparity across different areas.

There are number of the factors which seem to affecting the dissemination of the crop-livestock interventions, but the most significant factors are education level of the farmer, farmersô perception about the yield, technology characteristics, time after the intervention, extension contact and communication channel at 1%, 1%, 1%, 5%, 5% and 10% level of probability.

## 5.2 Conclusion and Recommendation

Characterization of farming system in project sites has shown that an intensified and diversified production system is adopted by farmers as a strategy to confront the problem of land scarcity, land degradation and risks of enterprise failure. An integrated crop-livestock production system is the basic feature of the study areas. A large number of crops grown and animals raised indicate that no single commodity oriented research and development effort could improve the food security and income status of the farmers.

Mapping of the dissemination of the crop-livestock interventions showed that the improved agricultural activities were taken beyond the locations of the intervention based on their adaptability and yield performance relative to the existing farmersô practices. Potato got disseminated widely beyond the intervention location at Lemo and Sinana areas and it was disseminated within the districts in the case of Basona Worena and Endamehoni districts. In terms of profitability, potato yields higher per unit area and when there is good market farmers could fetch handful cash but its profitability depend on the perishability of the crop and market seasonality. Potato remains potential and prospective crop for ensuring smallholders household food security despite market problems. Faba bean proves to be high returning in real terms since the output is not perishable as in the case of potato and there is better market demand throughout the year for faba bean. Wheat maintains consistent importance as cash source as there is better market and hence it is proved to be profitable per unit area. Barley is commonly produced for household consumption and plays vital role for food security.

The econometric result shows that an education level attained by the farming community was an important variable in significantly influencing the dissemination of the crop-livestock interventions. This indicates that the more educated the adopter farmers the more facilitated the diffusion of the given crop-livestock interventions from one farmer to another. Time was also found to have a strong positive relationship with the dissemination of the crop-livestock interventions. This indicates that as the time passes on the crop-livestock interventions spontaneously diffuse from the users to non-users.

Extension contact also found to have a strong positive relationship with the dissemination of the crop-livestock interventions. This entails the more the frequent the extension contact between the farmers and the development agents, the more facilitated the dissemination of the crop-livestock interventions. Extension contact makes important information available and accessible to the farmers thereby helping the farmers to decide to adopt and the farmers with the frequent contact with the extension agents contacts would be more innovators and quick to respond to the interventions. The farmers perception of the yield of the given crop-livestock intervention positively and significantly influence the dissemination of the new technologies. Since the farmers are rational decision makers, they have their own felt perception regarding the given intervention and such a prior impression would have significant role in furthering the new practices. If the farmers perceive the yield would be higher they would go for adopting the technologies thereby fastening the dissemination process.

The communication channels also positively and significantly influence the diffusion of the crop-livestock technologies. One of such channel for the transfer of the agricultural technology from adopter farmers to non adopters is farmer-to-farmer transfer of the technologies. Farmer-to-farmer transfer of the crop-livestock interventions is so powerful ways of technology dissemination due to the fact that farmers could easily get information regarding the given technology and also apart from information access, the farmers plot would be firsthand witness for the neighboring farmers thereby triggering demand for the innovative practices. Technology characteristics were also other important factor strongly influencing the dissemination of the crop-livestock interventions. Technology speaks of its own. Technology characteristics of the crop-livestock interventions greatly determine the prospect of the dissemination. If early adopters would prove that the given technology is of desirable traits, then it would be easier for the next farmers to adopt those technologies. On the basis of the findings of the study the following implications are recommended for further actions.

1. Since the Africa RISING interventions were undertaken with the predefined goal of sustainable intensification of the wider impact, it is expedient to look at which technology has got the prime attention from the farmers and then which technology got disseminated from farmers to other farmers based on the desirable traits they possess which are in

interest of farmersô preference. Keeping this in mind, potato (ware and seed) has been disseminated at fast pace and the farmers liked its adaptability and the yield performance. Therefore, the governmental and non-governmental entities should be intervene in future in maximizing the impact of the improved agricultural technologies and should consider potato as potential crop for quick dissemination to the wider areas in short period of time due to its paramount importance for the smallholder householdsô food security and income generation. Meantime, such future interventions should emphasize on ensuring the market availability for the potato production since market conditions pose serious impediment for the potato production.

2. Farmers in different location prefer varied improved technologies suitable to their conditions. Therefore, priority should be given accordingly, potato in all four locations; wheat at Sinana district, barley at Endamehoni district and faba bean at Sinana district.

3. While disseminating the crop-livestock interventions, the following factors need to be considered:

    i. To attain the faster dissemination, the future crop-livestock interventions should be made through more educated farmers.

    ii. Time is an important factor for the dissemination of the crop-livestock interventions. Some technologies diffuse faster and some slowly. Necessary caution should be taken by the interveners that it does not mean that there is no dissemination if the farmers were not fast enough to use the technologies.

    iii. The farmers give high place for the high yielder varieties and the interveners should consider the better yielding varieties before the delivery.

    iv. There should be an effective extension service in place for the given crop-livestock interventions to have wider impact.

    v. Crop-livestock interveners should choose effective methods to facilitate the dissemination of the technologies effectively. The best channel available for the interveners to popularizing and disseminating the technology is through farmers-to-farmers.

vi. Care should be given for the desirability of the technology characteristics of the crop-livestock intervention by the interveners.

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**Appendix 1: Minimum and Maximum values for the continuous variables**

| Districts | Age | | Family size | | Land owned(ha) | | Farm experience(yr) | |
|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| Lemo | 24 | 65 | 2 | 14 | 0.5 | 3 | 5 | 40 |
| Sinana | 27 | 72 | 2 | 15 | 1.25 | 15 | 10 | 40 |
| Basona | 27 | 70 | 2 | 10 | 0.5 | 3 | 10 | 43 |
| Endamehoni | 28 | 72 | 2 | 13 | 0.5 | 5.5 | 10 | 43 |
| Total | 24 | 72 | 2 | 15 | 0.5 | 15 | 5 | 43 |

**Appendix 2: Variance Inflation Factors and Tolerance of Continuous Variables**

| Variable | VIF | Tolerance |
|---|---|---|
| AGE | 2.19 | 0.457653 |
| EDUC | 1.50 | 0.667596 |
| FARMSIZE | 1.30 | 0.771897 |
| TOTINC | 1.28 | 0.779772 |
| TIME | 1.14 | 0.880215 |

**Appendix 3: Contingency Coefficients for Discrete Variable**

| | Constant | OFI (1) | LABAV (2) | PRICEY (3) | PERCY (4) | EXTCON (5) | PRICEX (6) | INFRA (7) | COMCHAN (8) | FWRISK (9) | TECIXS (10) | MKTAV (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Const | 1 | 0.402 | 0.302 | 0.077 | 0.316 | 0.253 | 0.476 | 0.005 | 0.268 | 0.286 | 0.074 | 0.025 |
| 1 | | 1 | 0.023 | 0.036 | 0.210 | 0.238 | 0.279 | 0.046 | 0.128 | 0.016 | 0.009 | 0.060 |
| 2 | | | 1 | 0.111 | 0.057 | 0.157 | 0.058 | 0.211 | 0.135 | 0.137 | 0.012 | 0.056 |
| 3 | | | | 1 | 0.431 | 0.012 | 0.218 | 0.200 | 0.023 | 0.015 | 0.738 | 0.071 |
| 4 | | | | | 1 | 0.145 | 0.306 | 0.039 | 0.017 | 0.215 | 0.027 | 0.106 |
| 5 | | | | | | 1 | 0.241 | 0.337 | 0.227 | 0.348 | 0.088 | 0.277 |
| 6 | | | | | | | 1 | 0.154 | 0.012 | 0.175 | 0.198 | 0.321 |
| 7 | | | | | | | | 1 | 0.019 | 0.273 | 0.159 | 0.324 |
| 8 | | | | | | | | | 1 | 0.065 | 0.049 | 0.286 |
| 9l | | | | | | | | | | 1 | 0.012 | 0.299 |
| 10 | | | | | | | | | | | 1 | 0.134 |
| 11 | | | | | | | | | | | | 1 |

**Appendix 4: Africa RISING Research Protocols**

| Year | Research Protocols |
|---|---|
| 2013 | 1. Participatory Variety Selection(PVS) on potato, wheat and faba bean at Lemo |
| 2014 | 2. Pilot study on supplemental irrigated fodder production for fattening sheep at Lemo<br>3. Irrigated fodder(oat and Vetch) production for Animal feed supplementation at Lemo<br>4. Participatory evaluation of techniques to improve the utilization of crop residues by farm households<br>5. Participatory variety selection of wheat, barley, faba bean and potato combined with double cropping of short duration crops<br>6. Stepwise intensification options for small-scale Faba Bean / forage production systems<br>7. Testing permanent raised bed systems for soil and water conservation and crop intensification<br>8. Bridging yield gaps through soil test-based nutrient amendments<br>9. Decentralized system for community-based seed production and extension provision<br>10. Design and pilot processes to enhance facilitation, communication and coordination of innovation platforms<br>11. Design and pilot processes and tools for monitoring and evaluating the impact of innovation platforms |
| 2015 | 12. Irrigated fodder (oat and Vetch) production for Animal feed supplementation at Lemo<br>13. Participatory evaluation of techniques to improve the utilization of crop residues by farm households<br>14. Sweet Lupine adaptation trial(PVS) at Lemo<br>15. Participatory variety selection of wheat, barley, faba bean and potato combined with double cropping of short duration crops<br>16. Chick pea participatory Variety selection<br>17. Stepwise intensification options for small-scale Faba Bean / forage production systems<br>18. Testing permanent raised bed systems for soil and water conservation and crop intensification<br>19. Bridging yield gaps through soil test-based nutrient amendments<br>20. Decentralized system for community-based seed production and extension provision<br>21. Promotion of diffused light storage for potato<br>22. Promotion of quality seed for potatoes |
| | 23. |
| 2014-2016 | 24. Integration of high value multipurpose trees with soil and water conservation measures for improved livelihood and reducing land degradation<br>25. Integrating tree lucerne in the crop-livestock farming systems of the Ethiopian highlands for multiple products and services<br>26. Enhancing the productivity of enset system through Integrated Disease and Pest Management (IPM) approaches |
| 2016 | 27. Stepwise intensification options for small-scale Faba Bean / forage production<br>28. Systems (Using irrigation)<br>29. Sweet Lupine adaptation trial(PVS) at Lemo (using irrigation) |

Source: Africa RISING, 2016

**Appendix 5: Description of Explanatory Variables**

| Abbreviation used for Variables | Description | Status of variables | Expected Outcome |
|---|---|---|---|
| AGE | Age of HH head in years | Continous | - |
| EDUC | Education of HH head in schooling years | Continuous | + |
| FARMSIZE | Total farmland size in hectares | Countinuous | + |
| TOTINC | Total income in birr | Continuous | + |
| TIME | Time after the introduction of the interventions in years | Continuous | + |
| OFI | Off-farm income 1=if available, 0=otherwise | Dummy | + |
| LABAV | Labor availability 1= if available, 0= otherwise | Dummy | + |
| PRICEY | Perception of output price 1= high, 0= otherwise | Dummy | + |
| PERCY | Perception of yield 1= high, 0= otherwise | Dummy | + |
| EXTCON | Extension contact: 1= regular, 0= otherwise | Dummy | + |
| PRICEX | Perception of input price 1= affordable, 0= otherwise | Dummy | - |
| INFRA | Infrastructure availability 1= good, 0= otherwise | Dummy | + |
| COMCHAN | Communication effectiveness 1=effective, 0= otherwise | Dummy | + |
| FWRISK | Farmers willingness to accept risk 1= risk taker, 0= otherwise | Dummy | + |
| TECIXS | Technological characteristics 1= superior, 0= otherwise | Dummy | + |
| MKTAV | Market availability 1= available 0= otherwise | Dummy | + |

## Appendix 6: Survey Questionnaire

### Dilla University

### School of Graduate Studies

### Department of Agricultural Economics

**Mapping and Quantification of Dissemination of Crop-Livestock Interventions in Africa RISING Sites of Ethiopian Highlands**

### 1. General Information

| Classifying information | Response | Classifying information | Response |
|---|---|---|---|
| Region | | Name of Responndent | |
| Zone | | Mobile of Respondent | |
| Woreda(District) | | $N^0$ | |
| Kebele (PA) | | $E^0$ | |
| Name of the enumerator | | Date of interview | |
| Mobile(Enumerator) | | | |
| Name of Supervisor | | | |

### 2. Socio-economic characteristics

2.1 sex of the household head 1. Male 2. Female

2.2 Age of the household head_________________

2.3 Religion of the household head:

1. Orthodox(Christian) 2. Protestant(Christian) 3. Muslim 4. Other_________

2.4 Marital status: 1. Married 2. Single 3. Divorced 4. Widowed 5. Other____________

2.5 Education: 1. 1-4 2. 5-8 3. 9-12 4. >12

2.6 Family size: Male_______ Female__________ Total__________

2.7 What is the roofing material of the main house?

1. Grass 2. Iron sheet 3. Bamboo 4. Other _____________

2.8 What is the wall material of the main house?

1. Mud bricks 2. Stone 3. Wooden wall plastered with mud 4. Other______

2.9 What is the floor material of the main house?

1. Earth 2. Cement 3. Wood 4. Tiles 5. Other_____________

### 3. Household assets

| Asset types | Item name | Tick if own | Asset types | Item name | Tick if own |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Communication items | Radio | | Farm houses and structures | Main house | |
| | TV | | | Kitchen(kushina) | |
| | Tape recorder | | | Grain house | |
| | Mobile | | | Feed stores | |
| | Satellite dish | | | Livestock houses | |
| | Other__________ | | | Water troughs | |
| Transportation | Motor cycle | | | Feed troughs | |
| | Bicycle | | | Solar | |
| | Donkey/cart | | | Water harvesting pond | |
| | Horse/cart | | Household items | Bed | |
| Farm tools and machineries | Hoe/mattock | | | Table | |
| | Spade/shovel | | | Chair | |
| | Ox plough | | | Other____________ | |
| | Sickle | | Other assets | Mills | |
| | Mensh/ôforkĉ | | | Shops | |
| | Other____________ | | | Other_____________ | |

**4. Land size and ownership**

4.1 Size of total farm holding(timad)______________

4.2 Area under cultivation(timad)________________

4.3 Grazing area(timad)______________

4.4 Fallow land(timad)___________________

4.5 Shared in(timad)_____________

4.6 Shared out(timad)_________________

4.7 Rented in(timad)______________

4.8 Rented out(timad)_____________

4.9 Number of plots (parcels) of land____________

**5. Access to services and basic facilities (market, credit, and extension services)**

5.1 Do you have access to production and market information? 1. Yes 2. No

5.2 If yes, please indicate the source?

| Source of information | Tick if used | Frequency of use 1=never used, 2=rarely, 3=frequently | Distance (km) | Effectiveness 1=very good 2=good 3=Poor |
|---|---|---|---|---|
| Other farmers | | | | |
| Extension officer | | | | |
| Research institutions | | | | |
| Field days | | | | |
| Farmer Training Centers(FTC) | | | | |
| Agricultural shows | | | | |

| | | | | |
|---|---|---|---|---|
| Family and friends | | | | |
| Mass media(Radio/TV) | | | | |
| Farmer organizations | | | | |
| Traders | | | | |
| Market place | | | | |
| Print materials | | | | |
| Other source_______________ | | | | |

5.3 Access to basic facilities

| Types of facilities | Do you have an access? 1=yes, 2= no | Perception 1=good, 2=medium, 3=poor |
|---|---|---|
| Electricity | | |
| All weather road | | |
| Schools | | |
| Health services | | |
| Animal health service | | |
| Credit services | | |
| Telecom services | | |
| Piped water | | |
| Agri. Extension service | | |
| Market | | |

**6. Family labor availability and utilization**

6.1 Family member less than age 10: male________ female_________ total________

6.2 Age 10-14: male________ female_________ total__________

6.3 Age 15-60: male________ female_________ total__________

6.4 Age >60: male__________ female_________ total__________

6.5 How many family members are working full time on farm?___________________

6.6 How many of your family members are working off farm?____________________

6.7 For which farm activities do you allocate more working hours per day? Indicate below.

a) For livestock_____________hours per day

b) For crop________________ hours per day

6.8 Do you have labor shortage for farm activities? 1. Yes 2. No

6.9 If yes, for which activities do you face labor shortage?

1. Land preparation 2. Planting 3. Weeding 4. Harvesting 5. Livestock herding

6.10 If yes in 6.8, how do you fix the problem during the peak labor demand period?

1. Hiring 2. Labor exchange 3. Other________________

6.11 In the past years, was there your family movement to other areas? 1. Yes 2. No

6.12 If yes, duration of movement? 1. Seasonal 2. Permanent

6.13 If yes in 6.11, what was the purpose of the movement?

1. Employement 2. Education 3. Others___________________

6.14 If yes in 6.11, who was involved in such movement? 1. Son/daughter 2. Husband 3. Wife

6.15 If yes in 6.11, which season is of the major movement?

6.16 Provide information on the labor availability

| Labor availability | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surplus | | | | | | | | | | | | |
| Sufficient | | | | | | | | | | | | |
| Shortage | | | | | | | | | | | | |

## 7. Bio-physical and agro-ecological characteristics

7.1 Altitude______________

7.2 What is the agro-ecology of the area? 1. Dega 2. Weyna dega 3. Kola

7.3 How the rainfall of the area is characterized? 1. Monomodal 2. Bimodal

7.4 How was the rainfall distribution during the past five years? 1. Even 2. Uneven

7.5 How was the seasonal reliability of the rainfall? 1. Adequate 2. Inadequate

7.6 How was the timing of the rainfall during the past five years? 1. On time 2. Early 3. Late

7.7 How do you characterize the soil color of the area? 1. Black heavy soil 2. Medium light or loamy soil 3. Light soil 4. Sandy(poor) soil

7.8 Land slope of the area: 1. Steep or hilly (>13%) 2. Gently slopping or rolling (2-13%) 3. Flat (0-2%)

7.9 How do you rate the fertility of soil? 1. Fertile 2. Medium 3. Less fertile 4. Infertile

7.10 What soil erosion control mechanisms do you use? 1. Contour (terracing) 2. Trees 3. Grazing patch 4. Others_________________

## 8. Livelihood activities

8.1 What is/are the most important source of livelihoods in order of importance?

1. ____________________ 2.______________________ 3. _______________

8.2 What is/are the most important income generating activities?

1. ___________________ 2. ______________________ 3. ________________________

8.3 Indicate the relative importance of the each farming system to your livelihoods

1. Crop _____________(%) 2. Livestock_______________ 3. Non-farm___________(%)

8.4 Indicate the relative importance of each farming system for income generation

1.Crop _____________(%) 2. Livestock_______________ 3. Non-farm___________(%)

**9. Farm characteristics**

9.1 **Crop production**

9.1.1 Do you practice intercropping? 1. Yes 2. No

9.1.2 If yes, indicate the intercropped crops?

1. ___________&_________ 2. _________&___________ 3. ________&_________

9.1.3 Do you practice crop rotation? 1. Yes 2. No

9.1.4 Do you practice relay cropping? 1. Yes 2. No

9.1.5 If yes, indicate main and relay crops

1. ___________&__________ 2. _________&___________

3.__________&_________

9.1.6 Crops grown

| No | Crop | Total yield(qt) | Amount consumed(qt) | Amount sold(qt) | Average sale price/qt(birr) | |
|---|---|---|---|---|---|---|
| 1 | Maize | | | | | |
| 2 | Wheat | | | | | |
| 3 | Teff | | | | | |
| 4 | Food barley | | | | | |
| 5 | Sorghum | | | | | |
| 6 | Potato | | | | | |
| 7 | Faba bean | | | | | |
| 8 | Field peas | | | | | |
| 9 | Chick pea | | | | | |
| 10 | Haricot beans | | | | | |
| 11 | Lentil | | | | | |
| 12 | Ground nut | | | | | |
| 13 | Sesame | | | | | |
| 14 | Linseed | | | | | |
| 15 | Rapeseed | | | | | |
| 16 | Noug | | | | | |
| 17 | Safflower/sunflower | | | | | |
| 18 | Tomato | | | | | |
| 19 | Carrot | | | | | |
| 20 | Beetroot | | | | | |
| 21 | Cabbage | | | | | |
| 22 | Onion | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 23 | Garlic | | | | | | |
| 24 | Shallot | | | | | | |
| 25 | Fruit | | | | | | |
| 26 | Cassava | | | | | | |
| 27 | Taro | | | | | | |
| 28 | Enset | | | | | | |
| 29 | | | | | | | |

9.2 Livestock production

9.2.1 Please indicate in details the livestock inventory

| Types of livestock | Number currently owned | | | Purpose of keeping the animals(codes*) |
|---|---|---|---|---|
| | Improved | Local | Total | |
| Cows | | | | |
| Breeding bulls | | | | |
| Oxen | | | | |
| Heifers | | | | |
| Calves | | | | |
| Sheep | | | | |
| Goats | | | | |
| Poultry | | | | |
| Bees | | | | |
| Donkey | | | | |
| Horses | | | | |
| Mule | | | | |

*Purpose of keeping: 1= Store of wealth, 2= finance future expenditure, 3= insurance, 4= prestige, 5= Replacing stock, 6= manure production, 7= milk production, 8=animal draft

9.2.2 Will you keep crossbreed animals if you get an access? 1. Yes 2. No

9.2.3 If no, why_______________________________________________________________

9.2.4 What are the most important source of animal feed?

1. Green grass 2. Crop residue 3. Hay 4. Tree leaf fodder 5. Silage 6. Other_____

9.2.5 Is there series problems in feed? 1. Yes 2. No

9.2.6 What feeding practices do you practice? 1. Cut and carry 2. Stall feeding 3. Open grazing 4. Mixed feeding

9.2.7 How do you get animal feed? 1. Own grazing land 2. Purchased feed 3. Communal grazing land

9.2.8 Do you think that your animals have an adequate feed throughout the year?

1. Yes 2. No

9.2.9 If no, which months are of acute shortage of animal feed?__________________________________

9.2.10 Do you have cross breed cows/heifers? 1. Yes 2. No

9.2.11 If yes, is/are there specific problems related to cross breed animal management? 1. Yes 2. No

9.2.12 If yes, what problems?

1.______________________________

2. ______________________________

3. ______________________________

9.2.13 Have you ever faced livestock disease outbreak? 1. Yes 2. No

9.2.14 If yes, name the diseases

1__________________ 2.__________________ 3.________________

4.______________________

9.2.15 Are there veterinary medicine facilities in your locality? 1. Yes 2. No

9.2.16 If yes, who is the supplier of the facilities? 1. BoA 2. Private Vet clinics

**10. Participation in Africa RISING crop-livestock interventions**

1. In how many Africa RISING interventions you have participated in?

| AR interventions | | Variety name | Year 1 | Year 2 | Year 3 | Year 4 |
|---|---|---|---|---|---|---|
| Potato | Ware(food) | | | | | |
| | Seed | | | | | |
| Wheat | | | | | | |
| Barley | | | | | | |
| Faba bean | | | | | | |
| Apple | | | | | | |
| Avocado | | | | | | |
| Oat /vetch mixture | | | | | | |
| Tree lucern | | | | | | |
| Feed trough | | | | | | |
| Feed storage | | | | | | |

2. Which intervention(s) attracted you most?

   i. ________________ Why? ___________________________________

   ii. _______________Why_____________________________________

   iii. ________________ Why? ___________________________________

   iv. ________________ Why? ___________________________________

3. How did you become interested in Africa RISING intervention/s?

10.1 First informed and selected by DAĉs/Experts

10.2 Impressed after seeing the difference at the beneficiary farmers

10.3 Informed and motivated by the participating farmers

4. Which of the following sources of information are helpful for adoption and dissemination of Africa RISING interventions?

| **Source of information** | **Tick if used** | **Distance (km)** |
|---|---|---|
| Farmers | | |
| Extension officer | | |
| Field days | | |
| Farmer Training Centers(FTC) | | |
| Agricultural shows | | |
| Family and friends | | |
| Mass media(Radio/TV) | | |
| Farmer organizations | | |
| Traders | | |
| Market place | | |
| Print materials | | |

5. Which of the Africa RISING intervention(s) engaged women and children?

_______________________________________________________________

6. How many farmers replicated the intervention from you? Which intervention is replicated?

| AR interventions | | Variety | Within your kebele | | Outside of your kebele/woreda | | Distance of furthest farmer in km or hr |
|---|---|---|---|---|---|---|---|
| | | | Numbe of farmers | Seed transferred in Qt. | Number of farmers | Seed transferred in Qt. | |
| Potato | Food | | | | | | |
| | Seed | | | | | | |
| Wheat | | | | | | | |
| Barley | | | | | | | |
| Faba bean | | | | | | | |
| Apple | | | | | | | |
| Avocado | | | | | | | |
| Oat/vetch mixture | | | | | | | |
| Tree lucern | | | | | | | |
| Feed trough | | | | | | | |
| Feed storage | | | | | | | |

7. Please indicate the kebele/s and woreda/s of farmers who replicated AR internentions from you?

| | Intervention type | No. of replicator farmers | village/kebele | Woreda |
|---|---|---|---|---|
| a. | __________________ | __________________ | ______________ | ___________ |
| b. | ___________________ | _________________ | ______________ | ___________ |
| c. | ___________________ | __________________ | ______________ | ___________ |
| d. | ___________________ | __________________ | ______________ | ___________ |

8. How did you maintain seeds?

_____________________________________________________________________________

9. What challenges did you face in maintaining seeds?

_____________________________________________________________________________

10. How was the pattern of the seed transfer to other farmers over seasons?

1. Increasing   2. Decreasing   3. Same across the season

**11. Farmers' perception on Africa RISING interventions**

11.1 Did your participation in Africa RISING interventions bring behavioral changes with regard to your willingness to adopt improved agricultural technologies?

1. Yes   2. No

11.2 Did adoption of Africa RISING interventions have increased your income or enabled you to produce more or diversify crop and livestock production?

1. Yes   2. No

11.3 Have you seen any difference between the technologies provided by the Africa RISING and the one which you were using before?   1. Yes   2. No

11.4 What makes Africa RISING interventions different from other interventions?

**i. Crop**

| Crop interventions | | Preferable attributes | If not preferred, why? |
|---|---|---|---|
| Potato | Food | | |
| | Seed | | |
| Wheat | | | |
| Barley | | | |
| Faba bean | | | |

| | | |
|---|---|---|
| Apple | | |
| Avocado | | |

**ii. Livestock**

| Livestock interventions | Preferable attributes | If not preferred, why? |
|---|---|---|
| Oat/vetch mixture | | |
| Tree lucern | | |
| Feed trough | | |
| Feed storage | | |

**12. Quantification of inputs and outputs**

12.1 Give details on inputs used and outputs gained from the Africa RISING crop-livestock interventions?

| Africa RISING Interventions you are involved in | | Area cultivatd (timad)* | Amount of seed used per timad (Qt) | Output produced per timad (Qt)** | Amount of output sold (Qt) | Amount of output comsumed (Qt) | Amount of output kept for seed (Qt) |
|---|---|---|---|---|---|---|---|
| Potato | Food | | | | | | |
| | Seed | | | | | | |
| Wheat | | | | | | | |
| Barley | | | | | | | |
| Faba bean | | | | | | | |

**13. Cost-Benefit Analysis**

**i. Crop interventions- input**

| | | **Input comparison per timad*** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AR Crop interventions | | Amount of input/ timad (AR) | | | Input cost/timad (AR) | | | Amout of inputs/ timad (local) | | | Input cost/timad (Local) | | | Difference in input/ timad (AR-Local) |
| | | Seed | Fertliz | Labor | Seed | Fertli | Labor | seed | Fertli | Labor | Seed | Fertliz | Labor | Seed |
| Potato | Food | | | | | | | | | | | | | |
| | Seed | | | | | | | | | | | | | |
| Wheat | | | | | | | | | | | | | | |
| Barley | | | | | | | | | | | | | | |
| Faba bean | | | | | | | | | | | | | | |

***timad = ¼ hectare (0.25ha)**

**ii. crop interventions- output**

| AR Intervention | | Output comparison per timad |
|---|---|---|

| | | Amount of output/timad (AR) | Price of output per Kg (AR) | Amount of output/timad (local) | Price of output per Kg (local) | Difference in output/timad (AR-Local) |
|---|---|---|---|---|---|---|
| Potato | Food | | | | | |
| | Seed | | | | | |
| Wheat | | | | | | |
| Barley | | | | | | |
| Faba bean | | | | | | |

**14. Factors affecting the dissemination of the crop-livestock interventions and challenges**

14.1 Age of the household head in years_______________

14.2 Education of the household head in years of schooling______________

14.3 Gender of the household head? 0= female 1= male

14.4 Involvement t in off-farm activities? 0= No 1= yes

14.5 Farm experience of the household head in years? _____________

14.6 Labor availability 0= unavailable 1= available

14.7 Total farm size in hectare__________________

14.8 Perception on price of the output from Africa RISING interventions? 0= low 1= high

14.9 Farmersô perception of the yield of Africa RISING interventions?
0= not superior 1= superior to local

14.10 Do you have regular contact with extension agents or facilitators? 0= no 1= yes

14.11 Distance to research centers in km________________

14.12 Distance to Farmers Training Centers(FTC)____________

14.13 Total income of the farmers_________________

14.14 Time after the introduction of the intervention?___________________

14.15 Perception on the price of the input of Africa RISING interventions? 0= low 1= high

14.16 Infrastructure availability 0= not available 1= available

14.17 Communication channels 0= not effective 1= effective

14.18 How is the farmersô willingness to adopt the interventions?
0= not willing 1= willing

14.19 How do you perceive the technology characteristics of the Africa RISING interventions? 0= not superior 1= superior to local

14.20 How you have observed the suitability agro-ecologies to the Africa RISING interventions? 0= not favourable 1= favourable

14.21 What challenges did you face when you use the Africa RISING interventions

i. Challenges for crop interventions

________________________ ______________________

________________________ ________________________

_____________________ ________________________

ii. Challenges for livestock interventions

________________________ _____________________

_______________________ ________________________ _____________________

_______________________