EFFECTIVENESS OF EXTENSION METHODS FOR SCALING UP IMPROVED COMMON BEAN TECHNOLOGIES AMONG SMALL-SCALE FARMERS IN BABATI DISTRICT, TANZANIA

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ABSTRACT

Scaling up of Improved Legume Technologies (SILT) project had being promoting adoption of the improved common bean technologies (ICT[1]) among the farmers in Babati District, Tanzania. Yet it's not well known on its effectiveness of achieving its objectives of disseminating ICT[1]. Thus, this study determined the effectiveness of different extension methods used by SILT project in scaling up ICT[1] in Babati District. In this study adoption was conceptualized as an act in which farmers who were exposed to various sources of information were aware of, willing and using the ICT[1] in their own fields. A quasi experimental survey was used and household questionnaires were administered to 200 respondents selected through multi-stage sampling techniques. The Tobit regression model was used to assess the effectiveness of various extension methods in increasing smallholder farmers' awareness, willingness, and adoption of ICT[1], as well as the influence of farmers' socio-economic characteristics on the adoption ICT[1]. The results show that seven ICT[1]s were promoted by multiple extension methods in the study area and only 44.5% and 19.1%, 24.5% and 9.6% of the SILT and non-SILT household heads were aware and willing to adopt full package of ICT[1] respectively. But adoption levels remain very low at 2.6% and 1.5% for SILT and non-SILT household heads respectively. Demonstration plots, input suppliers and extension workers were more effective sources of information which led to adoption of the ICT[1]. Furthermore, household heads' level of education and marital status of the household head significantly influenced the adoption of the ICT[1] in the study area. It is concluded that households' agricultural technology adoption decisions depend on their socio-economic circumstances and institutional effectiveness. It is therefore recommended that, policies should be formulated to take advantage of the factors which positively influence farmers' adoption of modern agricultural production technologies and to mitigate the negative ones.

DECLARATION

1, AMINA MUSTAPHA, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

Amina Mustapha — Date

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The above declaration is confirmed by:

Prof. A. Z. Mattee — Date

(Supervisor)

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DEDICATION

This work is dedicated to my dearest father Mustapha Waziri Marusu, and my mother Mwajuma Selemani Irunga who put a lot of effort in laying down the foundation for my education.

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LIST OF ABBREVIATIONS

AFAP	African Fertilizer and Agribusiness Partnership
ASDP	Agricultural Sector Development Programme
BXW	Banana *Xanthomonas* Wilt
CABI	Centre for Agricultural Bioscience International
FFSs	Farmer Field Schools
FRI	Farm Radio International
ICT	Information and communication technology
ICT[1]	Improved common bean technologies.
IITA	International Institute of Tropical Agriculture
KCT	Kulika Charitable Trust
MAAF	Ministry of Agriculture, Animal Industry and Fisheries
NBS	National Bureau of Statistics
NGOs	Non-Governmental Organizations
PABRA	Pan-Africa Bean Research Alliance
SILT	Scaling up of Improved Legume Technologies
UNFFE	Uganda National Farmers' Federation
WV	World Vision

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Agricultural development implies a shift from traditional methods of production to new, science-based methods of production that include new practices (new varieties, cultural practices, commercial fertilizers and pesticides as well as new crops and new farming systems). This can be achieved if these practices are communicated to farmers through effective and efficient extension methods (Tura *et al*., 2010; Mignouna *et al*., 2011; Akpan *et al*., 2012). Masuki *et al.* (2014) argue that farmers decide to use the whole or part of package of newly recommended practices depending on whether the extension methods are able to raise farmers' awareness, stimulate willingness or influence their decision to adopt recommended scientific farming techniques in place of their traditional practices.

Likewise, Khatam *at el.* (2013) have expressed the view that for farmers of different agricultural zones to adopt a new technology, effective extension methods must be able to raise and stimulate awareness of the technologies, provide a valid and up-to-date information on the new technologies, the applicability of the technologies to their farming systems and to provide technical assistance necessary for the technology to the farmers. Thus, Mwangi and Kariuki (2015) have posited that successful adoption of improved farming techniques is predicated upon the effectiveness of dissemination methods to communicate new knowledge and understanding of these new technological practices to rural farmers. At the same time, effectiveness of a method depends upon selecting the right method, at the right time to the right people (Javadi *at el*., 2015). Different extension methods have been effective in different situations, types of technology, and at different stages in the adoption process.

In eastern and central African countries, governments, development partners and NGOs have been using various extension methods to popularize improved common bean technologies such as improved common bean varieties, chemical fertilizer, pesticides, fungicides and insecticides, proper planting and timely wedding, storage management, and marketing of the common bean produce (Msolla, 2015). For example, on-farm trials and demonstrations, use of visual aids and promotional materials which were given to farmers, use of trained extension staff and NGO staff, farmer-to-farmer exchange visits, and drama were used to communicate improved common bean technologies to farmers between 1992 and 1996 in Burundi, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Sudan, Tanzania, Uganda and Zaire (David, 1997).

In Tanzania the government has used demonstration plots to disseminate improved common bean technologies including improved common bean varieties (such as Lyamungu 85, Lyamungu 90, Selian 94, JESCA and Selian 97, Selian 05, Selian 06, and CHEUPE), proper spacing, fertilizer application, sorting, pest and disease control, and packing in the northern highlands of Tanzania including Tanga, Arusha, Kilimanjaro and Manyara Regions (ASDP, 2010). In the southern highlands improved common bean varieties have been disseminated to farmers through a combination of extension methods (e.g. posters, radio episodes, newspapers, leaflets, mobile-based systems, agricultural shows/field days, on farm research and community-based seed production) (Letaa *et al.*, 2015).

The “Scaling up of Improved Legume Technologies (SILT) through Sustainable Input Supply System” project is one of the projects dealing with scaling up improved common bean technologies and development of input supply system in northern, western and southern highlands of Tanzania. The overall objective of the project is to develop and use

innovative and complementary communication methods to scale-up improved legume technologies (improved common bean, soya bean and groundnuts) and establish sustainable input supply systems (Msolla, 2015).

The project is implemented by the International Institute of Tropical Agriculture (IITA) with Farm Radio International (FRI), Centre for Agricultural Bioscience International (CABI) and African Fertilizer and Agribusiness Partnership (AFAP) as partners. IITA plays a coordinating role to facilitate links with project partners and stakeholders to ensure that essential data are shared and any changes to the project plans are quickly communicated (Sonne, 2016).

African Fertilizer and Agribusiness Partnership (AFAP) played the role of establishing scaling up demonstration plots, training hub agro-dealers and extension staff and conducting farmer field days. Centre for Agricultural Bioscience International (CABI) is responsible for producing and translating printing materials in Kiswahili such as leaflets, flash cards, posters and *Shujaaz* comics into Kiswahili and distributing them directly to the farmers or through Fertilizer and Agribusiness Partnership (AFAP).

At the same time, Farm Radio International (FRI) is responsible for preparing weekly participatory agricultural radio series to promote a bundle of proven common bean technologies (Hampson, 2015) including improved common bean variety, post-harvest and storage management, application of chemicals such as pesticides and fungicides, using common beans as an intercrop and the use of blended fertilizer. FRI works closely with two selected regional radio stations and other partners (the more popular radio stations, Legume Alliances, district extension staff and local agro-dealers) to design, produce and

promote improved common bean technologies via these selected radio stations (Hampson, 2015).

In Manyara Region the project is being implemented in two districts, Mbulu and Babati Districts where in each district one demonstration plot was established in one of the selected villages. In Babati District, SILT partners employed a variety of extension methods in disseminating improved common bean technologies. These include district extension staff, demonstration plots, field days, radio (Radio Habari Njema and Five FM) and farmer to farmer extension methods (Msolla, 2015; ASDP, 2010).

1.4 Problem Statement

For many years in Tanzania, farmers have been accessing agricultural information from extension workers through interpersonal communication but the number of extension workers has not been adequate considering that the number of farm families has been increasing (Levi, 2015). On average in Tanzania, one extension agent is responsible for serving 1,000 farming households; in reality, it is hard for the extension agent to serve them all (Mattee, 1994). Also there is no single extension method that is appropriate for all situations but rather the use of a combination of methods (Kobero, 2010). Better understanding of farmers' agricultural information needs, preferred sources of information and methods could help to guide extension and other agricultural programmes to better target specific groups of farmers (Babu *et al.*, 2011). Different studies have been conducted in Tanzania on different methods used for scaling up agricultural technologies, including a study done by Mwamakimbula (2014) on assessment of the factors impacting agricultural extension training programs in Tanzania which has suggested further study on which extension methods can best be used to train farmers on the new agricultural technologies. Levi (2015) did a study on the effectiveness of ICT in disseminating

agriculture technologies in Kilolo and suggested further studies on the effectiveness of ICT in complementing the dissemination of agricultural technologies.

Another study was done in Babati District in which demonstration plots were used to train farmers on how to produce improved common bean seeds (ASDP, 2010), but could not establish whether the programme was effective in terms of the number of households reached, acknowledged ,who had being influenced to adopted and had adopted the improved common bean practices. All these studies have focused on single method of scaling up agricultural technologies but little is known about the relative effectiveness of the various methods used singly or in combination. Likewise since the implementation of the SILT project 2015, little is known on its effectiveness of achieving its objectives of disseminating improved common bean technologies. Therefore this study intends to fill this gap by assessing effectiveness of various extension methods used in the SILT project area to raise awareness and to stimulate willingness to adopt improved common bean technologies among small scale farmers for increased productivity in the study area.

1.5 Justification of the Study

Sustainability and productivity of the agricultural sector worldwide largely depends on effective extension methods that focus strongly on the dissemination and facilitation of the adoption of recommended technologies and practices by farmers (Ssemakula and Mutimba, 2011). The main challenge facing agricultural extension in the 21st century is how to develop low-cost sustainable extension methods for service provision that go beyond extending messages to playing a key role in promoting farmers as the principal agents of change in their communities (Lukuyu *et al.,* 2012).These methods need to enhance farmers' learning, innovation and improve their capacities to organize themselves for more efficient production and to demand extension services (Davis *et al.,* 2009). The

task is especially complex, given the need for extension methods to address the challenges of transforming farmers from using traditional farming practices to new scientific and recommended farming practices (Lukuyu *et al.,* 2012). Thus this study will be useful to agricultural planners and practitioners to adopt best extension methods to use in transferring improved common bean technologies to farmers. Furthermore, knowing the most effective methods will assist in designing effective agricultural extension programmes for increasing adoption of improved common bean technologies to the farmers. This study will also contribute to the national initiatives for improving extension services in line with the National Strategy for Growth and Reduction of Poverty that stipulates increasing communication and collaboration in the delivery of extension services to the farmers.

1.6 Objective

1.6.1 Overall objective

To determine the effectiveness of different extension methods used in scaling up improved common bean technologies in Babati District.

1.6.2 Specific objectives

i. To assess the effectiveness of various extension methods in increasing smallholder farmers' awareness about improved common bean technologies
ii. To assess the effectiveness of various extension methods in stimulating smallholder farmers' willingness to adopt improved common bean technologies.
iii. To assess the effectiveness of various extension methods in influencing smallholder farmers to adopt improved common bean technologies.
iv. To identify other determinants of adoption of improved common bean technologies by smallholder farmers.

1.7 Research Questions

i. What is the effectiveness of various extension methods on increasing smallholder farmers' awareness about improved common bean technologies?

ii. What is the effectiveness of various extension methods on stimulating willingness of smallholder farmers to adopt improved common bean technologies?

iii. How do the various extension methods differ in terms of their effectiveness in influencing small scale farmers to adopt improved common bean technologies?

iv. What are other determinants of the adoption of improved common bean technologies by smallholder farmers?

1.8 Research Hypothesis

The Government of Tanzania in collaboration with Development Partners has invested significant resources to strengthen agricultural research, extension services, and to create farmers' organizations. However, common bean productivity and household adoption of improved common bean technologies are still relatively low (Ronner and Giller, 2013). A number of studies have indicated that different sources of information have varied influence on the adoption of agricultural technologies and practices across the different adoption stages. Mass media (i.e. radio, newspapers, television, and magazines) play an important role during the initial stages of creating awareness on agricultural innovations, while interpersonal communication (e.g. crop consultants, extension agents, demonstrations, input suppliers, other growers, etc.) which typically involves face-to-face contact, plays an important role in promoting adoption Khatam *et al.* (2013) However, an effectively designed content of extension methods had potential to serve the roles of awareness creation as well as influencing the adoption processes.

Other factors (such as farmers socio-economic and the institutional factors) were found to have impacts on the adoption the improved farming practices among the farmers Botha and Atkins (2005). Based on the literature survey, the following three hypotheses have been formulated and empirically tested for analysing their association with household decision to adopt improved common bean technologies.

Ho_1: There no statistically significant difference in the influence of the extension methods in creating awareness of the improved common bean technologies among the small household heads.

$H0_2$: There no statistically significant difference in the influence of the extension methods in stimulating household heads willingness to adopt improved common bean technologies.

$H0_3$: There is no statistically significant difference in the influence of extension methods and the adoption of the improved common bean technologies.

$H0_4$; There is no statistically significant difference in socio-economic factors and institutional factors on the adoption of the improved common bean technologies.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework of Adoption

Adoption is a gradual and continuous process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation or not. In this study two theories had been used to explain the dependent and independent variables. These are diffusion of innovation theory and extension theory. Diffusion of innovation theory explains the influence of independent variables of the study while the extension theory explains the dependent variables (awareness, willingness and adoption) of the study as elaborated below.

2.1.1 Extension theory

According to Botha and Atkins (2005) awareness is an important precondition for adoption to occur. However, in most cases exposure to a technology is not random. Individuals may be exposed to new technologies because they are targeted by researchers or extension workers based on the prejudice of their higher probability of adoption. Individuals may also through their private or self-interests and efforts get exposed to a new technology. Further the theory assumes that, increased adoption rates would occur if information about the innovation (improved common bean technologies) is communicated through farmers 'social networks'. That means farmers' awareness of the improved common bean technologies will be induced by extension agents using a variety of extension methods.

The body of knowledge the individual accumulates about the innovation (improved common bean technology) is the determination of individual interest/experiment to adopt

the innovation at a small portion of his farm. After experimenting the innovation based on the risk and benefit observed about the new innovation, the individual will confirm the innovation in his farming practice. Thus farmers' full uptake of improved common bean technologies will require building confidence of the farmers about the technologies through the use of a variety of extension methods like farmer to farmer extension method and demonstration plot.

2.1.2 Diffusion of innovation theory

The theory assumes that adoption is the function of four factors as explained by Rogers (2003) below:

i. The innovation itself, which in the present study constitute the newly introduced technologies (improved common bean varieties, planting method, chemical fertilizer application, pesticide and herbicide application, and weeding method).

ii. The communication channels used to spread information about the innovation, which in this study are the extension methods (farmer to farmer extension method, field days, leaflets, demonstration plots, radio, the use of extension agent and input suppliers) used to disseminate information concerning the innovation.

iii. Time needed for the innovation to be adopted, since adoption is a gradual process which starts with low rate of adoption and which may increase or decrease depending on the prevailing circumstances.

iv. The nature of the society to whom it is introduced, which refers to the socio-economic characteristics of the farmers in the study area.

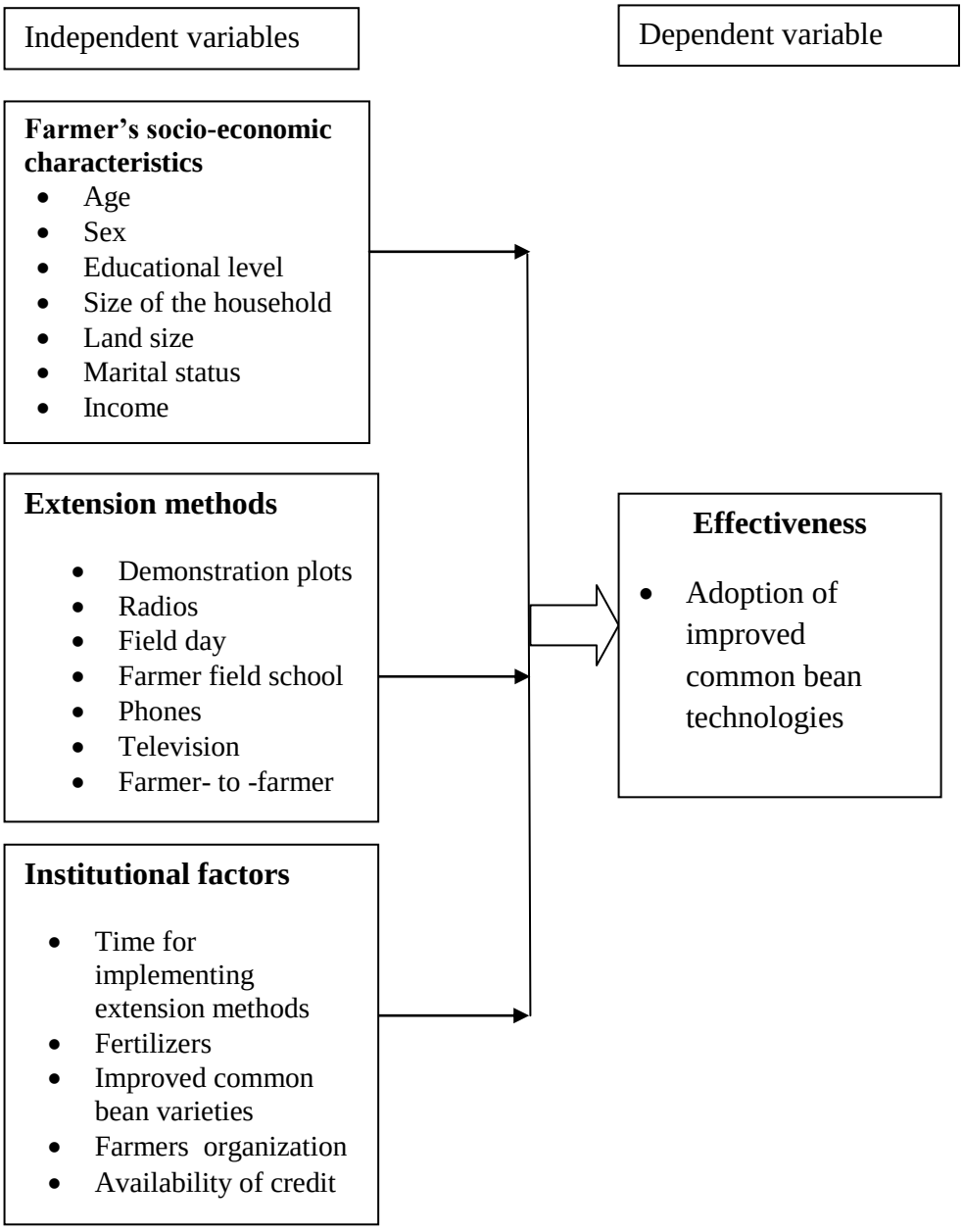

Figure 1: Diagrammatic illustration of the conceptual framework adopted and modified from Roger (2003) and Botha and Atkins (2005)

2.2 Factors Affecting Adoption

Many studies have concentrated on finding factors affecting adoption of new technologies, but most did not look at the factors which affect the level or strength of adoption of new agriculture technologies except a few studies by Akpan *et al.* (2012), Gregory and Sewando (2013), and Mignouna *et al.* (2011). Understanding factors affecting level of adoption and adoption decision for each individual farmer has serious implication in common bean production and farmers' development. Thus, this study will add into the body of knowledge by explaining factors which affect adoption decisions and level of adoption. The study has adopted Rogers' diffusion theory in explaining the factors affecting adoption of improved common bean technology and its level of adoption. These factors are farmers' socio-economic characteristics, extension methods and institutional factors.

2.2.1 Farmers' socio-economic characteristics

According to Roger (2003), Botha and Atkins (2005) and as seen in Figure 1, farmers' socio-economic characteristics include household heads' gender, age, marital status, education and number of the household members. Various studies have been conducted to explain the influence of these socio-economic factors in the adoption of agricultural technologies.

(a) Age of the household head

The influence of the household head's age has been explained differently by different researchers. Some researchers find that age positively influence adoption by saying that old farmers adopt the technology because they have accumulated capital or have greater access to credit, due to their age (Etoundi and Dia, 2008), while other studies explain that age is one of the hindrances to technology adoption by saying that age of the farmer

erodes confidence in adopting a new technology, or old farmers are more risk-averse than younger farmers (Cavane and Subed, 2009). A study done by Atibioke *et al*. (2012) found that age of the household head has a negative influence towards technology adoption. This implies that younger farmers are more likely to be risk takers than older farmers

(b) Marital status

Kenya *et al.* (2017) observed that the level of adoption of fertilizer was higher among the married members than those who were single (unmarried, widows and divorced). They pointed out that married members had more labour force which was needed for fertilizer application as compared to singles, widows and others. Married situation creates a room for sharing responsibilities. Just as pointed out by Mikwamba (2011) in a marriage situation, the work output that each person produced was much more than when each person worked independently.

(c) Education of the household head

Education of the household head has a positive influence on adoption of new technology. The reason behind is that more educated household heads are expected to be more efficient to understand and obtain new technologies in a shorter period of time than uneducated people. Also education level is assumed to increase a farmer's ability to obtain, process and use the information relevant to adoption (Kafle, 2010).

(d) Sex of the household head

Few studies report that the rate of technology adoption is higher among male-headed households, compared to female-headed households because of discrimination i.e. women have less access to external inputs, services, and information due to socio-cultural values (Lopes, 2010). For male-headed households adoption is positively influenced because men

in most societies are the ones who control productive resources such as land, labour and capital which are critical for the adoption of new technology (Abunga *et al.*, 2012). In contrast, female-headed households have a negative influence on technology adoption due to poor access of resources which are used in production (Matata *et al.*, 2010).

(e) Household labour

The number of household members who provide labour has a positive influence to technology adoption. Tura *et al*. (2010) argued that household size influenced adoption of the improved maize varieties positively due to the supply of family labour. A study done in Ethiopia which aimed at finding determinants of adoption using Probit and Tobit models showed that family labour was an important factor in adoption of the use of fertilizer on maize (Fufa, 2006).

(f) Land size

The size of the land holding by the household head can influence adoption both positively and negatively. For example, study done by Tura *et al*. (2010) found that land holding size returned a positive and significant result in influencing adoption of new technology. Households with larger land holdings allocated more land to improved common bean varieties. A study done by Kalinda *et al.* (2014) shows that farm size is often, one of the first factors measured when modeling adoption processes. Farm size does not always have the same effect on adoption; rather the literature shows that the effects of farm size vary depending on the type of technology being introduced, and the institutional setting of the local community.

(g) Income of the household head

Income may enhance labour and purchasing power, and therefore low level of income implies difficulties in buying farm inputs like improved seed, fertilizers and herbicides

(Diiro, 2013). Many studies report positive contributions of income to household's adoption of recommended agricultural practices like use of improved seed varieties, fertilizers application, spacing, weeding, and pest management. For instance, different recommended agricultural practices adoption studies conducted by Wekesa *at el.* (2003) indicated positive relationship between income and adoption of recommended agricultural practices. However not all technologies have shown positive relationship between income and their adoption. Some studies on technologies that are labor intensive have shown negative relationship between income and adoption. According to Goodwin and Mishra (2002) the pursuit of income by farmers may undermine their adoption of modern technology by reducing the amount of household labor allocated to farming enterprises.

2.2.2 Institutional factors

According to Roger (2003), Botha and Atkins (2005) and as seen in Figure 1, institutional factors like allocated time for implementing the programmes, inputs, farmers organization and credit availability increase the probabilities of the farmers to adopt the new innovation. Since technology adoption is accompanied with the use of inputs like fertilizer, pesticides and other associated inputs, if the farmer will have access to credit this will enable him/her to have access to various inputs, hence access to credit has a positive influence towards technology adoption. Mugisha and Diiro (2010) in their study on factors influencing adoption found that access to credit relaxes income constraints of famers hence enables them to have access to key inputs as well as in hiring of labour.

2.2.3 Extension methods

Extension methods have a positive influence on technology adoption because they can help in creating awareness about the technology and it's potential. Extension services play important role in the implementation and diffusion of innovation. For example, the

extension agent acts as a personal coach for change and as a communication medium who closes the gap between farmers and the innovation (Tura *et al*., 2010; Mignouna *et al*., 2011; Akpan *et al*., 2012). For this reason, extension officers must understand where and how to use various communication media and extension methods available to them to reach more clients more frequently, and to give extension efforts more impact (FAO, 2016).

2.2.3.1 Effectiveness of the extension methods

Extension methods are the methods of extending new knowledge and skills to the rural people by drawing their attention toward them, arousing interest and helping them to have successful experiences of the new practices. The effectiveness of a dissemination pathway depends not only on the number of farmers that receive information but also on how successful that pathway influences farmers' decision to adopt a given technology (Murage *et al.,* 2012). In this study, effectiveness of these extension methods is measured by increased number of individuals who are aware, willing and adopting improved common bean technologies and increased proved common bean technological uptake. Different technologies have different attributes of knowledge and information requirement sets. These sets are likely to objectively determine the types of dissemination pathways to use, if the adoption of the technology in question is to succeed.

For relatively 'knowledge-based' innovations like improved common bean technologies, the uptake is likely to depend on how extensive and intensive farmers are trained and the effectiveness of dissemination pathways used (Padel, 2001). If ineffective pathways are used, farmers are likely to spend more time searching for more relevant information thus increasing the information search costs. This, therefore, implies the need to evaluate the effectiveness of the pathways being used in order to isolate the ones which are not only effective but also efficient, contingent on resource availability.

Given that information is packaged and presented differently in different dissemination pathways, there is likelihood of variations on the effects these pathways could have on technology adoption (Mauceri *et al.,* 2005). There is therefore an additional need to determine these differences in order to optimize the use of those pathways that have greatest impact on adoption and within the realm of available resources. On this basis individual, group and mass contacts extension methods were assessed to get their relative effectiveness in dissemination of improved technologies to the farmers. Churi *et al.* (2012) and Suvedi and Kaplowitz, (2016) contended that the more an individual is exposed to different extension methods the more the individual changes his/her farming practices.

2.2.3.2 Individual methods

Individual methods are offered through landscape site visits, phone calls, personal letters, training and visit and farm-to-farm extension visits which make extension truly clientele-oriented by providing solutions to their problems at the local level (Donaldson *et al.,* 2006 and Khatam *et al.,* 2013). Individual extension methods are the methods most preferred by farmers. The reason that is given by farmers is the opportunity offered by these methods to ask questions and learn skills interactively on the farm (Kobero, 2010). This method produces results that include beneficial behavior changes, economic and environmental value for extension clients, and measureable impacts. Individual contact methods can be resource-intensive, considering the travel, diagnostic work, research, reporting, and follow-up activities they involve (Galindo-Gonzalez and Israel, 2010). A study done by Khatam *et al.* (2013) showed that individual methods such as farm visits, phone calls and home visits are effective in diffusing latest agricultural technologies among the farming community to increase production of crops and thus improve living standard of the people. Similarly, Nduru, (2011) concluded that individual contact methods were ranked highest in the effectiveness of dissemination of agricultural information to maize growers.

(a) Farmer to farmer extension method

A study done by Lwoga *et al.* (2011) and Churi *et al.* (2012) revealed that farmer to farmer extension method ranked as the first main source of agricultural information and knowledge in the local communities in Tanzania, despite the inadequate reliability of information and experience shared among them. A study done by Ssemakula and Mutimba (2011) indicated that farmer to farmer extension method created multiple effects in information sharing at several levels and increased technological uptake in Tororo and Masaka Districts. With decline of public extension services, NGOs such as Kulika Charitable Trust (KCT), the World Vision (WV), and Uganda National Farmers Federation (UNFFE) employed farmer to farmer extension method in promoting agricultural technological practice to the farmers (Swanson and Samy, 2002).

Franzel *et al.* (2015) revealed that farmer to farmer extension was more effective in terms of its reach, covering wide range of target groups including women, youth and the poor farmers. Furthermore, their study reveals that farmer to farmer extension method can work in combination with other extension methods like farmer field schools, demonstration plots, field days and training and visiting extension methods (Simpson *et al.,* 2015). On the other hand, farmer to farmer extension method proved inappropriate for high-risk and very technical enterprises and practices (e.g. certain crop spraying practices); innovations where cost of an error may be very high (e.g. treatment of livestock diseases); or for what are essentially permanent decisions (e.g. siting of water control structures) (Franzel *et al.*, 2015). Furthermore, farmer to farmer extension method has been reported not to work well in areas of low population density where transportation is a constraint (Franzel *et al.*, 2015).

(b) The use of extension agents

A study done by Lwoga *et al.* (2011) revealed that the use of public extension officers ranked the second source of agricultural information and knowledge in the local

communities in Tanzania, though farmers were dissatisfied with the frequency of their interactions. According to Okwu and Daudu (2011), farmers prefer interpersonal communication with fellow farmers and extension workers because this method provides room for translating information on the new innovation for example climate forecast into their farm-level decision making processes. These studies did not clearly separate the impacts based on each pathway but chose to use the number of extension contacts or knowledge index as a proxy for access to information. Extension contact alone may not promote adoption if the information dissemination pathway being used is ineffective or inappropriate.

(c) The use of input suppliers

Godwin and Taylor (2013) in their study revealed that agricultural input suppliers were very effective sources of agricultural information of the farmers for obtaining information about the latest agricultural products. Another study done by Wekesa *et al.*, (2003) revealed that farmers may be aware and willing to adopt a new agricultural technology but the absence of an inputs supplier in the vicinity obstructs their adoption and the presence of the input suppliers in the vicinity motivates the farmers to adopt the proven technologies.

2.2.3.3 Group methods

Group contact methods are well suited to bringing specific information about practices, helping to move the individual through the desire for conviction and sometimes to taking action (FAO, 2016). Group methods are also more effective because of peer influence and competition among group members; close supervision of group members enables working with many farmers at the same time (Buyinza, 2015). Examples of these methods include:

(a) Demonstrations

According to Khan *at el*. (2009) demonstration plots are powerful delivery system of improved technologies in the farmer's field under farmers' conditions. Further, Khan *at el*.

(2009) showed that, the method was an effective means of communication to transmit knowledge and skills, and the interested may easily see, hear, and learn the things conveyed by the extension worker. On the other hand, demonstrations are not appropriate for promoting many technologies in a single event, they require considerable time and cost for implementation and the number of farmers reached is smaller (Nduru, 2011).

(b) Farmer Field Schools (FFSs)

A study done by Mwamakimbula (2014) showed that this method did well on content, skills acquisition and beneficiary participation. Research conducted by Davis *et al*. (2010) in Tanzania indicated that poor farmers are good participants in farmer field schools but farmers who are better off do not participate as they view it as a waste of time. The advantage of this method is that, through group interactive activities, farmers get a chance to improve their decision-making capacity as well as their leadership and communication skills. It is weakest on number of farmers reached and service provider participation and number of technologies covered as it is enterprise based (Nduru, 2011). Therefore, this study will add into body of knowledge on the number of farmers reached by farmer field schools and the number of technologies covered.

(c) Field days

Field day is usually a day-long event where farmers showcase new agricultural technologies, practices and products they have adopted, and they share information and their experiences with other participant farmers (Suvedi and Kaplowitz, 2016). A study carried out by Murage *et al.* (2012) has indicated that field days were more effective to women (53.2%) compared to men (46.8%) in Kenya, while in Uganda and Tanzania the method was more effective to male compared to female farmers (57.4% and 62.6% respectively of those who actively participated in field days). A previous study by Tegha,

(2014) found that farmers' propensity to seek new agricultural knowledge motivated them to attend field days and in the overall, they favorably rated its effectiveness in information dissemination.

Other extension methods like seminars, meetings and exhibitions had also been used to disseminate proven technology to the farmers (Ogunremi, 2013). For example in Tanzania, evaluation of the training activities for urban farmers in Dar es Salaam revealed that seminars on simple adaptive technologies are useful element in urban horticulture (Suzuki, 2000). Exhibitions involve a systematic display of information, actual specimens, models, posters, photographs, and charts in a logical sequence. Exhibitions are organized for arousing the interest of the visitors in the things displayed. It is one of the best media for reaching a large number of people, especially illiterate and semi-illiterate people. Exhibitions are used for a wide range of topics, such as planning a model village, demonstrating improved irrigation practices, soil conservation methods, showing high-yielding varieties of seeds and plants, new agricultural implements and the best products of village industries Likewise general meetings, usually are held for passing on certain information to the people for future action. Extension workers give lectures to the people on certain pre-selected topics related to their work.

2.2.3.4 Mass extension methods

Mass extension methods attract attention, stimulate interest and the desire for further information (Okunade, 2007). They are the methods used to reach quickly many people at the same time at different locations. These methods are particularly useful in making a large number of people aware of new ideas and practices, stimulate farmers' interest, or alerting them to sudden emergencies (Rogers, 2003). The effectiveness of these methods is measured by their ability to change a static situation into a dynamic one. This method

comprises both electronic and print media such as bulletins, leaflets, circular letters, posters exhibitions television, telephone, radio and newspapers, which play an important role in creating awareness about new agricultural technologies among farming communities across the world (Ali, 2011).

(a) Radio

Radio is an important vehicle for increasing agricultural productivity through provision of relevant and current agricultural information on time and in the right format to stakeholders. In a study carried out by Ariyo *et al.* (2013), radio was considered cost-effective due to the large geographical coverage and timeliness in the provision of information to farmers on improved agricultural technologies. According to other studies carried out by Sam and Dzendu (2015) and Levi (2015), radio is a one way communication of technologies to farmers and unable to disseminate agricultural technologies that need practical demonstration. Thus, this study will establish the best combination of extension methods which will work together with radio in disseminating agricultural technologies.

(b) Television

Television is another mass method commonly used and is one of the most powerful media of communication. It combines both audio and visual impact and is very suitable for the dissemination of agricultural information. It is more useful in teaching how to do a specific job. Nazari and Hassan (2011) in their study revealed that television offers effective channels for communicating agricultural messages, which can increase knowledge and influence behavior of audience members within short time and can reach a large number of people. However, Nyamba and Mlozi (2012) in their study revealed that television has been ineffective in disseminating agricultural information to the rural communities because of unavailability of electricity.

(c) Mobile phones

Though mobile phones have become a popular method of communication in Tanzania among small holder farmers, only 35.4% of agricultural information is communicated by phone in Tanzania according to Aluyu *et al.* (2016). Other studies indicated the use of mobile phones for communicating market information to farmers (Mokotjo and Kalusopa, 2010). However, the potential of mobile phones for communicating agricultural information is constrained by limited availability of electric power (Nyamba and Mlozi, 2012). This implies that efforts to benefit from mobile phones for communicating agricultural information should be linked with ensuring availability of power sources to rural communities.

(d) The use of printed material

A study done by Nazari and Hassan (2011) reveals that printed materials (magazines, newspapers, leaflets, bullets books/booklets, and pamphlets) were effective media of providing quality, timely information and arouse interest of using information to the farmers. On the other hand, printed materials, with the exception of books, had low use due to their unavailability and the absence of the reading habit (Lwoga *et al.,* 2011). Thus, there are still gaps in accessing information and knowledge which need to be filled.

2.3 Common Bean Technologies

Common bean is an important component of agricultural food crops for achieving food and nutritional security and for contributing to the improvement of soil fertility through nitrogen fixation in the soil (Akibode, 2011). Despite the importance of common bean, its productivity remains low in Tanzania (NBS, 2012). Common bean production in Tanzania and other developing countries relies on local cultivars which are highly constrained by diseases, pests, insects, poor seed quality, low soil fertility, drought and poor crop

management (Tryphone *et al.*, 2013). Limited access and utilization of information on the improved common bean varieties and fertilizers are considered the main reasons for low productivity of common bean varieties (Ministry of Agriculture, Food and Cooperatives, 2013). Based on these studies, appropriate method or combination of methods may solve this problem by linking the farmers to input suppliers and acknowledging good agronomic practices of improved common bean.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Area

This study was conducted in two Wards of Babati District namely Ari and Bashnet. The District was purposively selected based on the fact that the SILT project has been implemented in this District since 2015.

3.2 Research Design

Quasi experimental design was performed between two groups of common bean growers in this study. The first group was the group of common bean growers who accessed SILT demonstration plot, leaflets, or radio programmes, while the second group did not access any of the SILT interventions. The design demonstrates not only the output of the interventions but also encompass a broad range of non-randomized interventions in the area (Angrist and Pischke, (2009).

3.3 Study Population

The target population for this study consisted of all the farm households including those participating and those not participating in the SILT project and the key informants (extension workers, and SILT implementers) in Babati District.

3.4 Sampling Procedures and Sample Size

This study used multistage sampling technique in two stages.

Stage 1: First stage involved purposive selection of the wards and villages based on the fact that in one of the Wards the SILT project was implemented, while another Ward with almost the same socio-economic characteristics as the SILT Ward was selected.

Thus two Wards were selected, Arri, the only Ward with SILT interventions, and Bashnet, which was selected out of twenty wards without SILT project interventions in Babati District.

Purposive sampling technique was also used to select the one village from Arri Ward (with the SILT intervention) and four out of five villages from Bashnet Ward without SILT intervention). The selection of one village from SILT intervention Ward was done based on the fact that a demonstration plot was established there, while the selection of the four villages from non-SILT intervention was based on the similarities of socio-economic characteristics of the farmers with Arri. The selected villages were Bashnet, Long, Guse and Wallahu.

Stage 2: The second stage involved the selection of the respondents. A list of one hundred households that received intervention of the SILT project found in the Ward office was used as sample size of the SILT intervention ward while a simple random sampling procedure was used to select another 100 households, (i.e. 25 households from each village) from a list of 467 households who grow common bean found in the non-intervention Ward office. Where the household head could not be found a simple random sampling technique was used to get a replacement household head with the assumption that he/she can provide all the information of the household head. Thus a sample of 200 households growing common bean were interviewed using questionnaire.

Additionally five key informants including extension workers and the SILT implementers from SILT Ward were purposively selected based on their possibility of providing information on the implementation of the SILT project in the study area. Thus the distribution of the respondents used for this study is shown in the Table 1.

Table 1: Distribution of respondents involved in the study

	Wards		
	Arri	**Bashnet**	**Total**
Household heads	100	100	200
Extension workers	2	0	2
Key informants	3	0	3
Total	**103**	**102**	**205**

3.5 Data Collection

3.5.1 Data collection instruments

A structured questionnaire (Household Interview Schedule, Appendix 1) was used to collect primary data for the households that are in the SILT project and those not in the SILT project. Questionnaires which were used to collect the primary data had both open-ended questions for comments and opinions of the respondents, and closed-ended questions. Furthermore, an interview checklist for key informants (extension workers and the SILT implementers) was used to collect information on costs of implementing the extension methods in disseminating the improved common bean technologies to the farmers.

3.5.2 Pre testing of the questionnaire and interview checklist

The questionnaire and interview checklist were pre-tested before their actual use. This was necessary to check the validity and the reliability of the instruments. Eighteen randomly selected households and two extension staff from the villages which were not in the study area were used for pre-testing.

3.5.3 Primary data collection

Primary data were collected by administering a questionnaire to the respondents. Socio-economic characteristics of the household head such as sex, age, education level, land ownership, farming experiences and family size were gathered. Institutional variables

(credit availability, fertilizer and improved common bean seeds) and information on which extension methods used were also collected. The data collected also covered aspects of costs incurred by the project and the government to implement these extension methods in scaling up common bean technologies. These data were collected by the researcher in collaboration with well-trained enumerators. Enumerators were trained on the objective of the study, the contents of the interview and interviewing techniques. Proper training of enumerators and supervision during the data collection process boosted the reliability of the data.

3.6 Data Analysis

Data were verified, coded and summarized using the Statistical Package for Social Sciences (SPSS) statistical software before being transferred to STATA software for analysis. Simple descriptive statistical analyses mainly frequencies, percentages, cross tabulation and Chi-square test were used to describe socio-economic characteristics of the household, level of awareness, willingness and adoption of improved common bean technologies. Tobit regression model was used to analyze effectiveness of the extension methods in creating awareness, increasing willingness, adoption and determinants of adoption of improved common bean technologies. The model has the advantage that it provides both the influence of exogenous factors on the probability of the intensity of adoption (Masuki *et al*., 2014). The study could also have used probit and logit models since the decision to adopt ranges from 0 to 1. However, probit and logit models are used in instances where the choice of uptake is binary; either to adopt (1) or not to adopt (0). Knowledge acquisition, decision and uptake of the improved common bean technology disseminated by the SILT project was continuous; the farmer could be more knowledgeable, willing to adopt and uptake of 1 up to 7 technology packages or part of the packages or none at all, where each package constituted 0.142857 of the whole package. Therefore, Tobit model was most suited since it allows use of continuous decision variable (ranging from 0 to 1).

3.6.1 Objective one

Descriptive statistics such as percentages and chi-square test were used to assess the degree of awareness of the improved common bean technologies among the household heads. Farmers who were knowledgeable of the all improved common bean technologies disseminated by SILT were regarded as fully aware; knowledgeable of some of the improved common bean technologies were regarded as less aware and unaware for the farmers who did not have knowledge on the improved common bean technologies. In assessing the effectiveness of the extension methods in increasing household head awareness of the improved common bean technologies Tobit regression model were used. Thus, the sources of information which were found significant at 1% were considered as more effective, 10% were regarded as effective and with positive and negative coefficient were regarded as not effective in creating awareness of the improved common bean technologies. The household heads that were aware of the whole package technologies disseminated by SILT project had scored 1; the ones who were not aware of any of the elements of this technology got a score of 0. The rest of the farmers scored between 0 and 1; a household head that was aware of only one aspect of the SILT technology scored 0.142857.

The detailed model is explained below.

Awareness or $Y = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \beta 5x5 + \beta x6 + \beta x7 + \beta x8$

Where;

B0 = Intercept of the regression equation;

B1- β8 = Parameter to be estimated;

X1= Extension worker (1=yes, 0= No);

X2 = Farmer field school (1=yes, 0= No);

X3 = Input suppliers (1=yes, 0= No);

X4 = Radio habari njema/5FM (1=yes, 0= No);

X5 = SILT demonstration plot (1=yes, 0= No);

X6 = Farmer to farmer (1=yes, 0= No);

X7 = Field days (1=Yes, No=0) and

X8 = Leaflets (1=Yes, No=0).

3.6.2 Objective two

Descriptive statistics such as percentages and chi-square test were used to assess the degree of willingness to adopt improved common bean technologies among the household heads. For those farmers who did not show any interest in any of the improved common bean technologies they were considered as unwilling; those interested in some of the improved common bean technologies were regarded less willing and those who were interested in all improved common bean technologies were regarded as willing to adopt. In assessing the effectiveness of the extension methods in increasing household head willingness to adopt the improved common bean technologies Tobit regression model was used. The source of information which were found significant at 1% were considered as more effective, 10% were regarded as effective and with positive and negative coefficient were regarded as not effective in stimulating household willingness to adopt improved common bean technologies. The household heads who were willing to use the whole package technologies disseminated by SILT project had scored 1; the ones who were not willing to adopt any of the elements of this technology got a score of 0. The rest of the farmers scored between 0 and 1; a household head who was willing to adopt only one aspect of the SILT technology scored 0.142857.

The detailed model is explained below.

Willingness to adopt or $Y= \beta0+ \beta1x1+ \beta2x2+ \beta3x3+ \beta4x4+ \beta5x5 + \beta x6 + \beta x7 + \beta x8$

Where;

B0 = Intercept of the regression equation;

B1- β8 = Parameter to be estimated;

X1= Extension worker (1=yes, 0= No);

X2 = Farmer field school (1=yes, 0= No);

X3 = Input suppliers (1=yes, 0= No);

X4 = Radio habari njema/5FM (1=yes, 0= No);

X5 = SILT demonstration plot (1=yes, 0= No);

X6 = Farmer to farmer (1=yes, 0= No);

X7 = Field days (1=yes, 0= No) and

X8 = Leaflets (1=yes, 0= No).

3.6.3 Objective three

Descriptive statistics such as percentages and chi-square test were used to assess the degree of adoption of improved common bean technologies among the household heads. In assessing the effectiveness of the extension methods in increasing household heads adoption of the improved common bean technologies Tobit regression model were used. The source of information which were found significant at 1% were considered as more effective, with positive coefficient were regarded as effective and with negative coefficient were regarded as not effective in influencing the adoption of the improved common bean technologies. Farmers who were growing common bean using improved seed of the recommended agronomic practices (improved seed, mineral fertilizer, spacing, post-harvest and storage management, harvesting method, application of herbicides and pesticides and weeding method) were considered as full adopters, non-adopters for those who did not use any of the technologies disseminated by SILT project and partial adopters for those who used less than seven technologies disseminated by the project. The farmers

who fully adopted the technologies disseminated by SILT project had scored 1; the ones who did not apply any of the elements of this technology got a score of 0. The rest of the farmers scored between 0 and 1; a farmer who has adopted only one aspect of the SILT technology scored 0.142857.

The detailed model is explained below.

Adoption or $Y = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \beta 5x5 + \beta x6 + \beta x7 + \beta x8$

Where;

B0 = Intercept of the regression equation;

B1- β8 = Parameter to be estimated;

X1= Extension worker (1=yes, 0= No);

X2 = Farmer field school (1=yes, 0= No);

X3 = Input suppliers (1=yes, 0= No);

X4 = Radio habari njema/5FM (1=yes, 0= No);

X5 = SILT demonstration plot (1=yes, 0= No);

X6 = Farmer to farmer (1=yes, 0= No);

X7 = Field days (1=Yes, No=0) and

X8 = Leaflets (1=Yes, No=0).

3.6.4 Objective four

Tobit regression model was used to determine the determinants of the household adoption of the improved common bean technologies. Thus household who were growing common bean using improved seed of the recommended agronomic practices (improved seed, mineral fertilizer, spacing, post-harvest and storage management, harvesting method, application of herbicides and pesticides and weeding method) were considered as full adopters, non-adopters for those who did not use any of the technologies disseminated by

SILT project and partial adopters for those who used less than seven technologies disseminated by the project. The farmers who fully adopted the technologies disseminated by SILT project had scored 1; the ones who did not apply any of the elements of this technology got a score of 0. The rest of the farmers scored between 0 and 1; a farmer who has adopted only one aspect of the SILT technology scored 0.142857.

This model is explained as follows

$yi*=\beta xi+\varepsilon i$…… (i)

yi =y* if y*>0……..……..… (ii)

yi =0 if y* ≤ 0…….…..……. (iii)

yi= β0+ β1x1+ β2x2+ β3x3+ β4x4+ β5x5……..…….+ βnxn……(iv)

yi* is the dependent variable describing the farmers adoption levels of the improved common bean technologies, taking numeric value ranging from 1 to 0 where 1 for those adopted the whole package of technological practices adopters, and 0 not applied any practice and the value between 1 to 0 for those applied any part of technological practices, xi is a vector of variables explaining whether a farmer adopts improved common bean technologies and εi is the error term. The hypothesized list of variables includes gender of the household head, age of the household head, education of the household head, household head years of formal schooling, and household head access to credit in the locality.

Detailed model with hypothesized variables is as follows,

Adoption or Yi = B0+β1AGE +β2HSX + β3EDU +β4HHL +β5INC +β6SDP +β7FFS+β8HMS+ β9HFS+ β10EXW+ β11FD+ β12HBF+ β13F2F + β14IPS + β15RH5 + β16LF ……..……(iv)

Where;

B0 = the intercept of the regression equation;

B1- β16 = the parameter to be estimated;

AGE = Age group of the household head (measured by the number of years individual has);

HSX= Sex of the household head (1= Male, 0=female);

EDU= Education of the household head measure in years of schooling;

HHL= Family labour (Number of individuals in the household who contribute their labour in the farming activities);

HMS= Marital status of the Household head (1=marriage, 0= otherwise);

HFS=Household head's farm size (measured in hectares);

EXW = Extension workers (1=Yes, No=0);

IPS= Input suppliers (1=Yes, No=0);

LF= Leaflets (1=Yes, No=0);

SDP=SILT demonstration plot (1=Yes, No=0);

FD=Field day (1=Yes, No=0);

F2F=Farmer to farmer (1=Yes, No=0);

FFS=Farmer field school (1=Yes, No=0);

RH5=Radio habari njema/5FM (1=Yes, No=0);

INC= Household head's income from other produce measured in Tanzanian shillings and

HBF= Household head's membership in a farmer group (1=Yes, No=0).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Description of the Household Heads' Socio-economic Characteristics

Table 2 presents the summary of respondents' socio-economic characteristics. The results show that 31.0% and 36.0% of the SILT and non-SILT household heads respectively, were smallholder farmers aged between 18 and 39 years. These results therefore imply that there were relatively fewer youth involved in farming activities compared to older persons. This is attributed mainly to the fact that most youth, after finishing school, migrate to urban areas looking for salaried employment or engaging in self-employment. Hence, the agricultural sector in rural areas is dominated by farmers aged 40 years and above, who for one reason or another, have not moved to urban areas. This is in line with the findings of Modibo *et al*. (2010) who concluded that the farming population in most developing countries is aging, thus hindering the agricultural sector in such places to advance to a more commercial level as the adoption rate among older farmers is lower.

Table 2: Socio-economic characteristics of the sample household heads in Babati District

	SILT farmers n=100		Non SILT farmers n =100		Statistical test.
	N	%	n	%	P-value
Age of household head					
18 - 29 years	4	4.0	7	7.0	0.133ns
30-39 years	27	27.0	29	29.0	
40- 49 years	36	36.0	35	35.0	
≥50 years	33	33.0	29	29.0	
Sex of household head					
Male	81	81.0	72	72.0	0.762ns
Female	19	19.0	28	28.0	
Marital status					
Monogamous	68	68.0	76	76.0	
Polygamous	15	15.0	7	7.0	0.341ns
Divorced	4	4.0	5	5.0	
Single	3	3.0	1	1.0	
Widower/widow	10	10.0	11	11.0	
Education level of HHH					
No formal education	18	18.0	17	17.0	
Primary education	75	75.0	78	78.0	
Secondary education	6	6.0	3	3.0	0.720ns
Two year college education	1	1.0	1	1.0	
Bachelor degree	0	0.0	1	1.0	
Main occupation of HHH					
Crop production	98	98.0	96	96.0	
Livestock production	0	0.0	2	2.0	
Self employment off farm	2	2.0	0	0.0	0.136ns
Causal laborer off-farm	0	0.0	2	2.0	
Membership of HHH in farmer group					
No	84	84.0	94	94.0	0.024****
Yes	16	16.0	6	6.0	
Total land owned by HHH					
< 5 Hectares	51	51.0	56	56.0	
5 -10 Hectares	29	29.0	30	30.0	0.697ns
> 10 Hectares	15	15.0	19	19.0	
Total land of HHH under common bean					
<1 Hectare	38	38.0	22	22.0	
1 – 5 Hectares	48	48.0	46	46.0	0.021***
>5Hectares	14	14.0	32	32.0	
Size of HHH labour size					
1 – 5 members	92	92.0	90	90.0	
>5 members	8	8.0	8	8.0	0.356ns
No one contributes	0	0.0	2	2.0	
Contact with extension worker					
No	78	78.0	89	89.0	0.052**
Yes	22	22.0	11	11.0	
HHH income per year from sale of crop produce					
< 500000 Tshs	32	32.0	66	66.0	
500000 to 1000000 Tshs	24	24.0	17	17.0	0.0000***
>1 000 000 Tshs	44	44.0	17	17.0	
HHH percentage of income from sale of common bean					
100%	5	5.0	3	3.0	
75 -99 %	19	19.0	4	4.0	
50-74%	23	23.0	5	5.0	0.000***
25-49%	28	28.0	9	9.0	
< 25%	25	25.0	79	79.0	

Key: HHH household head
ns =Not statistically significant; *** highly significant at (p< 0.01); * significant at (p<0.05)

The results also show that majority of the SILT and non-SILT household heads from the study area (75.0% and 78.0% respectively), had attained primary education. Similar results were found by Nyamba and Mlozi (2012) which means that majority of farmers in the study area as in many other areas have formal education thus they could read and understand instructions about the new improved common bean practices. In addition, such farmers can easily access information from various sources, and can create knowledge out of those sources.

Furthermore, the results in Table 2 reveal that 81.0% of the SILT and 72.0% of non-SILT household heads were males, which is consistent with the findings by Mwamakimbula (2014), in which 60.0% of the sampled participants interviewed in the same district were from male-headed households. This is to be expected given that most communities in Tanzania are patrilineal where males are always the heads of households. Incidentally, this is also reflected in the proportion of men taking part in extension education training where the number of men who had ever attended extension training outweighed that of women. This was attributed to women having less access to external inputs, services, and information due to socio-cultural values (Lopes, 2010).

There was significant difference in the income earned from sale of other crops between SILT household heads and non-SILT household heads at $P>0.01$. Thus more (44.0%) SILT household heads and fewer (17.0%) of the non-SILT household heads earned more than Tshs 1 000 000 from sale of other crops. This shows that, the SILT household heads had transferred training received in common bean production practices to other crops which enabled them to improve their farming practices and thus increasing the crop yields and income.

Also the results in Table 2 show that, there is significant difference in the income earned by the SILT and non-SILT household heads from sale of common bean at $P<0.01$. Thus more (24.0%) of the SILT household heads and fewer (7.0%) of the non-SILT households earn between 75.0% and 100% of their total income from sale of common bean. This implies that more SILT household heads depend largely on the sale of common bean for their livelihood compared to non-SILT household heads. Thus more effort should be made to encourage the households to apply the improved common bean practices in their common bean plots for more yields and income. By doing this it will improve households livelihoods. This result concurs with a study done by Diiro (2013) who argued that, adoption of any new innovation (improved common bean technologies) requires capital for purchasing inputs and hiring labour.

Apart from that, more than half (51.0% and 56.0%) of the SILT and non-SILT households respectively own less than five hectares of land, which confirms that more than half of the household heads in the study area are smallholder farmers. However, most of the farmers claimed to have larger areas that are left unutilized due to lack of improved farm inputs to enable them to cultivate larger areas. This was also noted by Mugabi (2013) who commented that Tanzania has a large area of arable land but estimated that only 23.0% of it is being utilized. However there is a statistically significant difference in the amount of land allocated to common bean production between SILT and non-SILT farmers with SILT farmers allocating significantly more land to bean production than non-SILT farmers.

The results show that majority (84.0% and 94.0% of the SILT and non-SILT) household heads were not belonging to any farmer group. This shows that the household heads in the study area were not well organized and coordinated. Since they are much dispersed, and

the extension worker cannot afford to visit all of them individually to disseminate useful information, establishment of farmer groups would help to strengthen extension services in most of the areas (Vargas-Lundius, 2009). This is because through farmer groups, communication among farmers and sharing of knowledge given through extension training programmes is expanded, helping to sharpen farmer decision making abilities (Mvuna, 2010).

This study revealed that about 68.0% and 76.0% of the SILT and non-SILT household heads were married to a single wife/husband and the rest were polygamous, single, widowed or divorced. It is known that married people have relatively higher likelihood of adopting improved farming practices since they are believed to have adequate labour for farming activities and can share new farming skills which any member of the household has acquired (Kingslay and Charles, 2013).

Also the study shows that, only 22.0% and 11.0% of the SILT and no-SILT household heads respectively, had contact with extension workers in the study area. Thus increase in household contact with the extension workers will provide opportunity for transfer of skills, knowledge and information which will facilitate adoption. For adoption to increase, the number of the household heads with access to extension services should be higher because the extension worker brings awareness of the new technologies and the benefits associated with those technologies. However there is significant difference in the contact with the extension workers between SILT and non-SILT household heads at $P< 0.05$. Thus SILT household heads had more contact with extension workers compared to non-SILT household heads.

The results in Table 3 reveal that majority, 75.0% and 85.0% of the SILT and non-SILT household heads had access to animal manure while facing limited access to fungicides.

This confirms the results of the Agriculture Sample Census report of 2007/08 which revealed that 95.0% of the farmers in Manyara Region had access to animal manure but were largely facing limited access to chemical fertilizer like Urea and DAP, and other inputs such as herbicides, fungicides and certified seeds. Additionally, only 10.0% and 41.0% of the SILT and non-SILT household heads had access to credit from various sources such as relatives, friends, informal saving and credit, and the government (Table 3). The results are consistent with those of Kiplimo *et al*. (2015) who found that 57.4% had no access to credit from any financial services due to the inability of formal institutions to lend to smallholder farmers for lack of farm records, tangible collateral such as titles to land, and valuable assets.

Table 3: Household distribution of the use of inputs and source of credit among the household heads in Babati District

Inputs and sources of credits	Respondents			
	SILT farmers n=100		Non-SILT farmers n =100	
	n	%	n	%
Inputs				
DAP	19	19.0	7	7.0
Urea	20	20.0	5	5.0
Certified seeds	26	26.0	16	16.0
Herbicides	13	13.0	6	6.0
Fungicides	29	29.0	13	13.0
Pesticides	66	66.0	32	32.0
Animal manure	75	75.0	85	85.0
Source of Credit				
Relatives	9	9.0	2	2.0
Friends	1	1.0	0	0.0
Government	2	2.0	0	0.0
Church/NGOs	7	7.0	0	0.0
Informal saving and credit	21	21.0	7	7.0
Bank and other micro finance institute	1	1.0	1	1.0
Total from multiple sources	10	10.0	41	41.0

4.2 Level of Awareness of the Improved Common Bean Technologies Among the Household Heads in Babati District

A synthesis of farmer responses presented in Table 4 indicates that the level of awareness of the improved common bean technologies varies across the study area. The results show

that about 44.3.% of the SILT household heads had acquired knowledge of the whole package of the improved common bean technologies while for the non-SILT household heads, only 19.1% were aware of all the seven technologies. There is a statistically significant difference at 1.0% in the level of awareness among the SILT and non-SILT household heads. Thus the level of awareness of the improved common bean technologies was higher among the household heads who were participating in SILT activities.

Thus there is need for the SILT implementers to expand their scope of intervention to the non-SILT area for the purpose of increasing and creating more awareness of the improved common bean technologies among the farmers in non-SILT area. Also more participatory training programmes focusing on adult education curriculum if applied will highly motivate the farmers to participate in the training programmes and hence increase the level of understanding and knowledge among the farmers about the improved common bean technologies in the study area. This finding is in line with a study done by Kenya *et al*,. (2017) who also found that, FFS participants were more aware of the improved rice practices than non-participants.

Table 4: Level of awareness of the improved common bean technologies among the farmers in Babati District

Total number of improved common bean technologies farmers were aware of	Respondents				Statistical test
	SILT household heads		Non-SILT household heads		
	N	%	n	%	P-Value
1	10	10.3	27	30.3	
2	4	4.1	3	3.4	
3	2	2.1	12	13.5	
4	8	8.2	5	5.6	0.0000***
5	11	11.3	12	13.5	
6	19	19.6	13	14.6	
7	43	44.3	17	19.1	

Key: n- Number of the household heads, *** means statistically significant at1%.

4.3 Effectiveness of Extension Methods in Creating Awareness of Improved Common Bean Technologies

The results in Table 5 show that the use of interpersonal contact by the extension workers with farmers through farm visits and training was more effective in creating awareness of the improved common bean technologies. The interaction between the extension workers and the farmers provide room for sharing information, knowledge and skills of the newly improved common bean practices. Furthermore, this finding is in line with the study done by Lwoga *et al.* (2011) who noted that new agricultural technologies from the research centers were introduced by the extension workers to the farmers through interpersonal contact with farmers, though farmers were dissatisfied with the frequency of their interaction.

SILT use of demonstration plots was found more effective in creating awareness of the improved common bean technologies among the farmers due to the practical nature of the training whereby interested persons are able to see, hear and practice during the method or result demonstrations. These results are in line with a study done by Khan (2009), who found that demonstrations were more effective in creating awareness of the new improved wheat, maize and vegetable crop farming practices in Chitra District.

Table 5: Tobit regression results for effectiveness of extension methods in creating awareness of the improved common bean technologies in Babati district

Awareness of the ICT[1]	Coef.	Std. Err.	t	P>t
The use of extension worker	1.126855***	0.437229	2.58	0.011
Farmer field school	1.001767*	0.551986	1.81	0.071
Input suppliers	1.263637***	0.421814	3.00	0.003
Radio (5FM/habari njema)	0.775338*	0.496957	1.56	0.120
SILT demonstration plot	1.408412***	0.494503	2.85	0.005
Farmer to farmer	0.834632*	0.433241	1.93	0.056
Leaflets	0.345372ns	1.086694	0.32	0.751
Field day	0.864494ns	1.638641	0.53	0.598
_Constant	2.337995	0.371583	6.29	0.000

Key: *** means statistically significant at1%, * at 10% level of significance, while ns = not statistically significant; [1]ICT- improved common bean technologies.

Ho: There no statistically significant difference of the influence of the extension methods in creating awareness of the improved common bean technologies among the small household heads.

At the same time, the results also show that input suppliers were also more effective in creating awareness of the improved common bean technologies in the study area through visits of the farmers to the shops of the input suppliers. The interaction of the inputs suppliers with farmers provided room for sharing new information, knowledge and skills of the new improved common bean technologies. The technologies on which farmers had acquired knowledge from the input suppliers were improved bean varieties, chemical fertilizer, herbicides and pesticides. Thus the input suppliers were more effective in creating awareness of the technologies which were in their possession. This is in line with the findings of Godwin and Taylor (2013) who found that input suppliers (agro-dealers) were the main source of the improved inputs, though they had little practical information on dealing with plant health problems or on interacting with farmers.

Furthermore, results in Table 5 show that radio was effective but not as effective as demonstration plots in creating awareness of the improved common bean technologies among the household heads in the study area. This may be attributed by poor accessibility of the radio programme among the households in the study area. Mtega (2012) argued that most rural areas in Africa are not electrified, reducing access in most rural communities to information and communication technologies from multiple sources such as radios, cellphone and the internet. However, these results contradict those obtained by Ariyo *et al.* (2013), who found that radio was more effective in creating awareness of the new farming practices among the farmers since it covers a large area and reaches many people at one point in time.

On top of that, farmer field schools were effective in creating awareness of the improved common bean technologies in the study area, but were less effective compared to the demonstration plots, interactions with extension workers and with inputs suppliers.

This can largely be due to the higher costs of establishing and running the farmer field schools. Harris *et al.* (2013) for example, show that the high cost of running the famer field school reduces its effectiveness in disseminating agricultural information to the farmers. Further the results contradict those obtained by Kenya *et al.* (2017), in which farmer field schools were found more effective in creating awareness of the improved rice production practices in Mvomero District.

At the same time, leaflets and field days were not effective in creating awareness about the improved common bean technologies in the study area. Unavailability of the leaflets to the farmers largely lowered its effectiveness in creating awareness of the improved common bean technologies among the farmers in the study area. These results are consistent with the findings by Lwoga *et al.* (2011) who found low effectiveness of leaflets in creating awareness about the new innovation due to their unavailability and the absence of reading culture among the farmers.

However Tobit regression results in Table 5 rejected the Null hypothesis ($H0_1$) as some of this information sources (such as home and field visits of the extension workers, input suppliers, demonstration plots, farmer field schools, farmer to farmer and radio habari njema/5FM) influenced household awareness of the improved common bean at $P<0.01$ and 0.001. On the other side, field day and the use of leaflets had no influence on creating awareness of the improved common bean technologies among the household heads in the study area.

4.4 Extent of Willingness to Adopt the Improved Common Bean Technologies Among the Household Heads

The results presented in Table 6 show that willingness to use one improved common bean technology was low at 4.1% among the SILT household heads compared to a quarter of the non-SILT household heads. At the same time, 71.4% and 65.5% of the SILT and

non-SILT household heads respectively were more willing to adopt between two and six improved technologies in their farm plots. This implies that the SILT household heads were interested to use two to six improved common bean practices in their farm plots.

Table 6: Extent of farmers' willingness to adopt the improved common bean technologies in Babati District

Number of improved common bean technologies farmers were willing to adopt	Respondents				Statistical test
	SILT household heads		Non-SILT household heads		
	n	%	n	%	P-Value
1	4	4.1	24	25.5	
2	10	10.2	14	14.9	
3	6	6.1	14	14.9	
4	15	15.3	5	5.3	0.0000***
5	21	21.4	14	14.9	
6	18	18.4	14	14.9	
7	24	24.5	9	9.6	

Key: n- Number of the household heads, *** means statistically significant at1%.

Furthermore, the findings in Table 6 show that only a quarter 24.5% and 9.6% of the SILT and non-SILT household heads were willing to use the whole package of the improved common bean technologies while the rest were not. This was attributed to the low level of knowledge and skills farmers had attained from the extension to enable them to identify and analyze their agricultural problems and be able to make the right decisions on the adoption of the improved common bean technologies.

However the results in Table 6 show that there is statistical difference at 1% in the level of willingness to adopt the improved common bean technologies between the household heads who participated in SILT activities and those who did not participate. This implies that the level of willingness to adopt the improved common bean technologies was higher among the SILT household heads than among non-SILT households. Household heads willingness to adopt the improved common bean technologies largely depend on the extent

they had acquired knowledge about these technologies. As pointed out by Umrani and Jain (2010), the central task of extension is to assist rural families to be able to help themselves through application of science in their daily lives of farming and home-making and that it uses communication of valuable information which helps people to make sound decisions.

Thus, rigorous education and community awareness programmes on the improved common bean technologies should be expanded beyond the SILT sites to persuade all stakeholders including the SILT implementers and the government. Also farmers with low access to information should be encouraged to interact with other farmers and leaders within the communities in order to increase their access to information.

4.5 Effectiveness of Extension Methods in Stimulating Farmers' Willingness to Adopt the Improved Common Bean Technologies in Babati District

The results in Table 7 reveal the role played by extension methods in stimulating farmers' willingness to use the improved common bean technologies in the study area. The findings indicate that SILT demonstration plot was more effective in persuading farmers to use the improved common bean technologies in their farm plots. The SILT demonstration plot being practical, participatory and interactive, gives room for the farmers to acquire both practical and technical skills about the improved common bean technologies. This gives farmers the confidence to test the improved common bean practices in their farm plots. This finding concurs with a study done by Khan *et al.* (2009), where the demonstration plot was found effective in motivating the farmers to use improved maize varieties in Chitra District in Pakistan.

Table 7: Tobit regression results for sources of information for willingness to adopt improved common bean technologies in Babati District

Willingness to adopt ICT[1]	Coef.	Std. Err.	t	P>t
The use of extension worker	0.404476ns	0.382773	1.06	0.292
Farmer field school	0.528338ns	0.483025	1.09	0.275
Input suppliers	1.040564***	0.369462	2.82	0.005
Radio 5FM/habari njema	0.671576*	0.435859	1.54	0.125
SILT Demonstration plot	1.312335***	0.43366	3.03	0.003
Farmer to farmer	0.400518ns	0.371831	1.08	0.283
Leaflets	-1.048917	0.951021	-1.1	0.271
Field day	1.87281ns	1.514434	1.24	0.218
_Constant	2.852001	0.315572	9.04	0.00

Key: *** means statistically significant at1%, * at 10% level of significance, while ns = not statistically significant; [1]ICT- improved common bean technologies.

H02: There no statistically significance difference of the influence of the extension methods in stimulating household heads willingness to adopt improved common bean technologies.

The input suppliers were more effective in motivating farmers to use the improved common bean technologies in their farms (Table 7). Thus not only the instructions given by the input suppliers to the farmers give them the confidence to use the improved common bean technologies but also the suppliers facilitate inputs availability to the farmers at the required time.

Further the results indicate that radio habari njema/5FM was less effective in stimulating famers to test the improved common bean technologies when compared to the demonstration plots and the input suppliers. This implies that radio was effective in motivating the farmers to test those technologies which demand technical knowledge rather practical demonstrations. This confirms the assertion by Sam and Dzendu (2015) and Levi (2015) that radio was a one way communication of technologies to farmers and is unable to disseminate agricultural technologies that need practical demonstration.

The results show that farmer to farmer extension method was not effective in increasing farmers' willingness to use the improved common bean technologies. This was largely attributed to inadequate knowledge of the improved common bean technologies farmers had attained which would allow them to practice and provide convenient proof for other farmers to test these practices in their own plots. These findings were supported by Lwoga *et al.* (2011) and Churi *et al.* (2012), who found that famers were willing to adopt the improved farming practices as they get proof of performance of the new practices over the traditional farming practices from their fellow farmers. Further the results contradict Franzel *et al.* (2015) who asserted that farmer to farmer extension method was effective in terms of its reach, covering wide range of target groups including women, youth and the poor farmers.

Although the use of extension agents was effective in influencing household heads willingness to adopt the improved common bean technologies, they were not as effective as SILT demonstration plots or the input suppliers. This could be due their being fewer in number with many responsibilities which reduce their interaction with common bean producers. This observation was similar to the findings of Mvuna (2010) who found the number of extension agents in Tanzania does not correlate with the need. Furthermore, Mvuna (2010) pointed out that the lack of prioritizing crops in specific areas leads to extension agents providing services to many crops, which reduces their efficiency.

According to the result in Table 7, farmer field schools were not effective in stimulating farmers' willingness to adopt the improved common bean technologies. This may be due to the high costs of administering the farmer field schools and the small number of farmers enrolled in the farmer field schools. Thus to increase the effectiveness of the farmer field schools in accelerating farmers' willingness to use the improved common bean

technologies, the FFS members would need to be trained to be the role models for non FFs farmers by utilizing their knowledge acquired in improving their farming practices. By doing so, non-FFS farmers in turn will be motivated to test the newly improved farming practices on their plots.

Additionally the results presented in Table 7 show that, field days were not effective in increasing farmers' willingness to adopt the improved common bean technologies in the study area. This might have been due to poor logistic arrangements of the field days organized by extension workers which include setting up of demonstration plots, time allocation to activities and interactive learning of farmers. This finding is contrary to the findings of a study by Tegha (2014) which showed that field days were more effective in stimulating farmers to adopt improved maize varieties in Lilongwe District in Malawi.

Lastly the results in Table 7 show that decrease in household heads accessibility to leaflets decrease households willingness to adopt improved common bean technologies. This was largely attributed to unavailability of leaflets to the farmer or to lack of a reading habit among the farmers in the study area. Thus increasing accessibility of leaflets to the famers can easily increase households' access to improved common bean technologies which could in turn increase household heads' willingness to adopt improved common bean technologies in the study area.

However in determining if there is significant influence of the extension methods on the household willingness to adopt the improved common bean technologies Tobit regression was used. Thus, Tobit regression results in Table 7 rejected the Null hypothesis ($H0_2$) as some of this information sources such as (input suppliers, demonstration plots, and radio habari njema/5FM) influenced household willingness to adopt improved common bean at

P<0.01 and 0.001. On the other side, field day, farmer field schools home, field visit of the extension workers, farmer to farmer and the use of leaflets had no influence on willingness to adopt improved common bean technologies among the household heads in the study area.

4.6 Level of Adoption of the Improved Common Bean Technologies Among the Farmers in Babati District

Table 8 provides a summary of the degree of uptake of the package of the improved common bean technologies by the household heads in the study area. The results show that about 35.5% and 40.9% of the SILT and non-SILT household heads respectively had adopted one improved common bean technology in their farm plots. Furthermore, more (61.9%) SILT household heads were using two to six improved common bean practices on their plots compared to 57.6% non-SILT household heads. However, full adoption was relatively low, 2.6% and 1.5% among SILT and non-SILT household heads respectively in the study area. A study by Tura *et al.* (2010) evidenced that, extension services are important in provision of information to farmers and influence the ability to make sound decisions in the uptake of farming technologies. However in order to increase adoption of the improved common bean practices SILT implementers and other stakeholders need to extend the duration of intervention instead intervening for one season only. By doing this famers will have enough time to learn and experience the advantages and disadvantages of the new innovation and to make sound decisions on whether or not to adopt the practice.

Also SILT implementers need to intensify the scope of intervention to non-SILT areas by establishing more demonstration pots and making good logistic organization of the demonstration plots (i.e. selection of the site for the demonstration plot and participatory training focusing on adult education training). SILT implementers should have a known schedule for training so as to help farmers allocate time for such training. This will help to

alert farmers of the trainings coming up, instead of bringing it to them as an ad hoc activity. Also the extension system should provide and distribute a list of events or training programs well in advance to assist farmers in planning to participate in the training activities.

Table 8: Level of adoption of the improved common bean technologies in Babati District

Number of improved common bean technologies farmers had adopted	Respondents				Statistical test
	Intervention ward		Non-intervention ward		
	n	%	n	%	P-Value
1	27	35.5	27	40.9	
2	9	11.8	6	9.1	
3	8	10.5	14	21.2	
4	7	9.2	9	13.6	0.860ns
5	11	14.5	9	13.6	
6	12	15.8	13	19.7	
7	2	2.6	1	1.5	

Key: n- Number of the household heads, ns means not statistically significant.

Overall, the statistical test shows that there is no significant difference in degree/intensity of adoption between the SILT and non-SILT household heads, which means that the intensity of adoption of the improved common bean technologies was the same for SILT and non-SILT household heads in the study area. This can be attributed to the fact that, farmers had not yet experienced the benefits associated with those innovations from their fellow farmers by the time this survey were conducted due to the short duration of the project implementation. This is in line with Asfawl *et al.* (2011) who reported that farmers who were aware of advantages of new technologies were more likely to adopt such technologies and allocate more land in the subsequent year.

4.7 Effectiveness of the Extension Methods in Influencing Adoption of the Improved Common Bean Technologies in Babati District

Results from in Table 9 show that, the extension workers were a more effective source of information for adoption of the improved common bean technologies among the household heads in the study area. This was largely due the interaction between the famers and the extension workers which gave famers the opportunity to ask questions and learn skills interactively on the farm. Thus, this makes extension truly clientele oriented by providing solution to their problems at their local level (Khatam *et al.,* 2013). The results are in line with a study done by Okwu and Daudi (2011) who found that farmers prefer interpersonal communication with extension workers because this provides room for translating information including improved common bean practices into their farm-level decision making processes.

Table 9: Tobit regression results for effectiveness of the extension methods in influencing adoption of improved common bean technologies among the farmers in Babati District

Adoption of [1]ICT	Coef.	Std. Err.	t	P>t
The use of extension worker	1.34658***	0.482802	2.79	0.006
Farmer field school	-0.3823	0.614595	-0.62	0.535
Input supplier	1.317122***	0.466252	2.82	0.005
Radio (5FM/habari njema	0.899049	0.547932	1.64	0.402
SILT Demonstration plot	0.1897	0.549387	0.35	0.73
Farmer to farmer	0.388591	0.480675	0.81	0.42
Leaflets	-3.73688	1.486908	-2.51	0.013
Field day	3.63731	2.002785	1.82	0.771
Cons.	1.226511	0.41644	2.95	0.004

Key: *** means statistically significant at1%; [1]ICT- improved common bean technologies.
H03: There is no statistically significance different on the influence of extension methods and the adoption of the improved common bean technologies.

The findings also show that input suppliers were more effective in influencing farmers to adopt the improved common bean technologies like the improved common bean varieties, chemical fertilizers, herbicides and pesticides in the study area. The input suppliers provided not only the skills on how to use the inputs on their farms but also facilitated accessibility of the inputs to the farmers. On the other hand, radio habari njema/5FM was effective in influencing famers' decision to use improved common bean technologies which require technical knowledge like proper time for planting and weeding rather than those which require practical (how to) demonstration.

SILT demonstration plot was less influential in the adoption of the improved common bean technologies compared to extension and input suppliers. This finding is contrary to the results of Khan *at el.* (2009) where demonstration plots were found very effective in increasing adoption of various crops in Chitral District in Pakistan, as the demonstration plots give proof of performance of the new practices being superior to the one being used, thus inducing the farmers to replace their traditional practices.

Furthermore, the farmer to farmer extension method was effective though not as effective as the input suppliers and the extension workers in influencing farmers to adopt the improved common bean practices. Lwoga *et al*. (2011) for instance stressed that interpersonal sources such as friends, family members and neighbours are all the time the main providers of the agriculture information due to their credibility, reliability and most of all, they are trusted by the rural community.

Likewise, field days were less effective than input suppliers and extension workers in influencing famers to adopt the improved common bean technologies in the study area. This could be due to poor organization of the field days. Tegha (2014) recommended that

in achieving effectiveness of the field days in increasing adoption of the improved maize varieties, a well organized demonstration plot and site should be clearly identified, and the timing should be convenient to the target group.

Finally, farmer field schools and the use of leaflets were not effective in increasing the adoption of the improved common bean technologies among the farmers in the study area as shown in Table 9. These results were most likely due to few farmer field schools which were established so could not cover many farmers, while unavailability and lack of interest of reading leaflets among the farmers made the leaflets ineffective in influencing farmers to adopt the improved common bean varieties. This finding concurs with the findings of Lwoga *et al.* (2011) and Harris *et al.* (2013), that inaccessibility of the leaflets and high cost of administering farmer field schools were the liming factors of their performance in influencing farmers to use the improved farming practices.

However in determining if there is significant influence of the extension methods on the household adoption of the improved common bean technologies Tobit regression was used. Thus, Tobit regression results in Table 9 rejected the Null hypothesis ($H0_3$) as some of this information sources (such as input suppliers and field visit and training of the extension workers,) influenced household adoption of the improved common bean at $P<0.01$. On the other side, field day, farmer field schools, demonstration plots, radio habari njema/5FM, farmer to farmer and the use of leaflets had little influence on adopt improved common bean technologies among the household heads in the study area.

4.8 Determinants of the Level of Adoption of Improved Common Bean Technology in Babati District

Results of Tobit regression show that out of sixteen estimated coefficients of adoption of improved common bean technologies, twelve exhibited positive sign, six out of those were

significant at 1% and one at 10%. The coefficients of input suppliers, extension workers, SILT demonstration plot, farmer to farmer extension method, total owned land by the household heads and the marital status of the household are positively and highly significant (P<0.01) and (P<0.1)for the adoption of improved common bean technologies.

Table 10: Tobit regression results showing determinants of adoption of improved common bean technologies in Babati District

Determinants of adoption of the improved common bean technologies	Coef.	Std. Err.	t	P>t
The use of extension worker	0.2041136	0.061881	3.3	0.001***
Farmer field school	-0.05603	0.076623	-0.73	0.466
Input supplier	0.1981689	0.059507	3.33	0.001***
Radio (5FM/habari njema	0.0238687	0.068818	0.35	0.729
SILT Demonstration plot	0.1675746	0.068869	2.43	0.016***
Farmer to farmer	0.1032449	0.059721	1.73	0.086*
Field day	-0.191566	0.154186	-1.24	0.216
Leaflets	-0.673657	0.243402	-2.77	0.006
Gender of the HHH	0.117507	0.066191	1.78	0.278
Age of the HHH	0.0375153	0.026647	1.41	0.161
Education level of the HHH	0.016768	0.032304	0.52	0.604
Marital status of the HHH	0.1025912	0.044935	2.28	0.024***
Membership of HHH in farmer organization	0.0047384	0.021333	0.22	0.824
Income from sale of other crops produce	-0.024546	0.028673	-0.86	0.393
Labour size of HHH	0.000167	0.00039	0.43	0.669
Total land owned by HHH	0.0474758	0.029544	1.61	0.11*
Constant	-0.024881	0.150057	-0.17	0.868

HHH- Household head *means significant at ***=1%, * = 10% level of significance
H04; There is no statistically significance different of Socio-economic factors on the adoption of the improved common bean technologies.

The findings in Table 10 show that, the use of extension workers through home and farm visiting and training, farmer visits to the input suppliers' shops, the interaction between the farmers themselves and the SILT demonstration plot is best combination of extension methods for scaling up improved common bean farming practices. Thus, increasing of the household interaction with the extension workers, input suppliers and accessibility to the demonstration plot increases the degree of the household adoption of the improved common bean technologies. Further the results reveal that, farmers with frequent contact with extension workers, access to input suppliers and the demonstration plot had highly

shared information, skills and experiences with their fellow farmers who had no access to these extension services. On the other, hand the results reveal that demonstration plot can work with other extension methods like farmer to farmer extension, the use of the extension worker and the use of the input supplies.

These findings concur with those of Simpson *et al.* (2015) in which farmer to farmer extension method worked together with demonstration plot, home visit and training by the extension workers. Also the results in Table 10 show farmers who had access to radio habari njema/five FM were more likely to adopt the improved farming technologies in their farm plots. On the other hand, decrease of farmers' accessibility to the farmer field school, field day and leaflets decreases farmers' rate of adoption of the improved common bean technologies in the study area shown in Table 10.

Apart from the sources of the information, other factors like marital status of the household significantly influenced the adoption of the improved common bean technologies. Thus the married couples were more likely to adopt improved common bean technologies for increased common bean production for family consumption and income generation for the improvement of their livelihood compared to singles and widows/widowers. As also pointed out by Mikwamba (2011) in a marriage situation the work output that each person produced is much more than when each person worked independently.

Further the results in Table 10 show that total land owned by the household significantly influenced the adoption of the improved common bean technologies. Thus the larger the farm size the household has the higher the probability of the household heads to allocate more land for growing common bean as shown in Table 10. These findings are in line with

a study by Kalinda *et al*. (2014) which revealed that households with large land allocate more land for implementing the new innovation thus increasing the adoption of the improved common bean technologies.

The findings show that the higher the level of the education of the household head, the higher the level of adoption of improved common bean technologies. Thus more educated farmers can easily access information from various sources, and can create knowledge out of those sources. This is in line with Kafle (2010) who asserted that education catalyzes the process of information flow and leads the farmer to different sources of getting information about a technology.

Further the results presented in Table 10 show that membership of the household head in an organization influences adoption decision. This is likely due to the fact that affiliation to any group or organization is a social capital. Also group membership is an indication of the farmer's extent of networks and contacts with organized and informal groups. Organization enables farmers to learn about agricultural technologies, share experiences and exchange ideas about agricultural technologies with other farmers. Networking enables farmers to assess and understand the risks and benefits associated with the use of an innovation thus high probability of adopting improved common bean technologies (Nkamleu, 2007).

The results show that the gender of the household head influenced adoption of improved common bean technologies. Male-headed households are more likely to adopt improved common bean technologies than the female-headed household heads. This can be attributed to inaccessibility of information on improved common bean technologies among the female household heads. These results are consistent with Lopes (2010) in his study on adoption of improved maize and common bean varieties in Mozambique, and Abunga *et al.* (2012) both of who found that the rate of adoption for female-headed households is low

because women have less access and control to external inputs, services, and information due to socio-cultural values.

Likewise, the results in Table 10 show that, the larger the labour size the household has, the higher the probability of adoption of the improved common bean technologies. Since most of these improved common bean practices like weeding, harvesting, planting, post harvest and storage management practices are labor intensive, availability of labour increases the probability of adoption of the improved common bean technologies. According to Tura *et al*. (2010), household size positively influenced adoption of the improved maize varieties due to the supply of family labour.

Additionally, the results show that the low income earned by the households from sale of other crops decreases the adoption of the improved common bean technologies. This was attributed to the fact that adoption of improved common bean technologies requires capital for purchasing herbicides, pesticides, fertilizers as well as hiring labour. The results further reveal negative association between age of the household head and the adoption of the improved common bean technologies. The results indicate that the younger farmers were less likely to adopt improved common bean technologies in the study area compared to the older ones. This may be due to the fact that younger farmers have less farming experiences and capital for purchasing inputs, compared to the older farmers. These results conform to a study by Atibioke *et al*. (2012) who found that age of the household head has a negative influence towards technology adoption.

On top of that, the regression results in Table 10, lead to rejection of the null hypothesis $H0_{4.}$ As some of these extension methods (such as source of information like input suppliers, extension workers, SILT demonstration plot, farmer to farmer extension method) and

socio-economic factors (such as total owned land by the household heads and the marital status of the household) had influence on the household heads adoption of the improved common bean technologies in the study area.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The main objectives of this study was to determine the effectiveness of different extension methods used in scaling up improved common bean technologies in Babati District. In achieving this objective specifically the study assessed the effectiveness of these extension methods in creating awareness, stimulating willingness to adopt and increasing adoption of improved common bean technologies together with the determinants of the adoption of the improved common bean technologies. Based on the findings of the study, it can be concluded that:

i. The SILT demonstration plot, the use of extension workers and the input supplies were the most effective sources of information (at $P<0.001$) in creating awareness and stimulating willingness to adopt improved common bean technologies among the SILT than the non-SILT household heads. Demonstration plots provide sufficient visual confirmation to the farmers, whereas extension worker visits and input suppliers provide interactive learning environment to the farmers.

ii. Input suppliers and the extension workers should be considered as most important source of information for the household adoption of the improved common bean technologies though the adoption level for the full package of the SILT and non-SILT household remain relatively low and the same.

iii. Other than the sources of information, the level of education, marital status and total land owned by the household head were the most important determinants of adoption of improved common bean technologies.

5.2 Recommendations

In increasing household heads' awareness, willingness to adopt and to actual adoption of the improved common bean technologies the following recommendations to policymakers district council, extension workers and SILT implementers emerge for dissemination of improved common bean technologies information;

(a) Policy makers should

- Promote agro inputs uptake through private sector engagement in agricultural extension service delivery. Using demonstration plots and involving agro dealers in running extension plots will be an effective approach to enhance access, distribution and correct application of inputs in rural areas.

(b) SILT implementers should:

- Expand their scope of the intervention to the non-SILT areas by establishing more demo plots.
- Make good logistic arrangements of the demonstration plot (i.e. resetting the site for demo plot instead of using the same site where other project implementers have being using)
- New sources of the information like radio and leaflets should be promoted to make information more accessible to the farmers.
- Extend the duration of intervention. This will give the farmers enough time to learn, practice and acquiring knowledge of the new improved farming practices.

(c)District Council should:

- Set-up of district information centers and Ward Resource Centers where publications of the research findings can be displayed and consulted.
- Conduct frequent training of the extension workers on proper on extension teaching methods to bring out the desired result. Extension workers must have adequate knowledge of the characteristics of each of the extension teaching

methods as well as know the characteristics of the respondents. These will enable them to use appropriate methods for appropriate group of farmers.

(c) Extension workers should:

- Create farmers groups and networks in which training can be easily conducted. This would also help in the dissemination and sharing of necessary information among famers and minimize their tasks, such as visiting each farmer to give information about the new innovation and training programs. In addition, this approach would help to strengthen adoption decision making abilities of farmers and, hence, increase the participation rate in extension education programs being conducted.
- Have a known schedule for training so as to help farmers allocate time for such training. This will help to alert farmers of the trainings coming up, so that they can plan to attend. The extension workers should provide and distribute a list of events or training programs well in advance to assist farmers in participating in training programs.

REFERENCES

Abunga, M., Emelia, A., Samuel, G. and Dadzie, K. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions? *Journal of Biology Agriculture and Health Care* 2(3): 1–14.

Agricultural Sector Development Program (2010). *NZARDI - ZARDEF and Strategic Research Annual Progress Reports for Northern Zone*, Tanzania. 191pp.

Akibode, S. C. (2011). Trends in the production, trade, and consumption of food-legume crops in sub-Saharan Africa. Dissertation for Award of MSc degree at Michigan State University. 85pp.

Akpan, S. B., Nkanta, V. S. and Essien, U. A. (2012). A double hurdle model of fertilizer adoption and optimum use among farmers of Southern Nigeria. *Journal of Tropicultura* 30(4): 249 – 253.

Ali-Olubandwa, A. M., Kathuri, N. J. and Wesonga, T. E. O. (2011). Effective extension methods for increased food production in Kakamega District, Nairobi, Kenya. *Journal of Agricultural Extension and Rural Development* 3(5): 95 – 101.

Aluyu, A. J. (2016). Effectiveness of mobile phone supported market information dissemination in promoting agricultural marketing: the case of Amuru district of Uganda in Africa. Dissertation for Award of MSc Degree at Haramaya University, Haramaya, Ethiopia. 79pp.

Ariyo, O. C, Ariyo, M. O, Okelola, O., Aasa, O. S., Awotide, O. G., Aaron, A. J. and Oni, O. B. (2013). Assessment of the role of mass media in the dissemination of agricultural technologies among farmers in Kaduna North, Local Government Area of Kaduna State, Nigeria. *Journal of Biology, Agriculture and Healthcare* 3(6): 2224 – 3208.

Asfaw, S., Shiferaw, B., Simtowe, F. and Haile, M. G. (2011). Agricultural technology adoption, seed access constraints and commercialization in Ethiopia. *Journal of Development and Agricultural Economics* 3 (9): 436 – 447.

Atibioke, O. A., Ogunlade, I., Abiodun, A. A., Ogundele, B. A., Omodara, M. A. and Ade, A. R. (2012). Effects of farmers' demographic factors on the adoption of grain storage technologies developed by Nigerian Stored Products Research Institute: A case study of selected villages in Ilorin West LGA of Kwara State. *Journal of Research on Humanities and Social Science* 2(6): 56 – 64.

Babu, S. C., Glendenning, C. J., Asenso-Okyere, K. and Govindarajan, S. K. (2011). *Farmers' Information Needs and Search Behaviors: Case Study in Tamil Nadu, India*. International Food Policy Research Institute, Washington DC. 56pp.

Botha, N. and Atkin, K. (2005). An assessment of five theoretical frameworks to study the uptake of innovation. *Paper Presented at New Zealand Agricultural and Resource Conference in New Zealand*, 26 – 27 August 2005. pp. 1 – 18.

Buyinza, J., Sekatuba, J., Agaba, H., Kinuthia, R. and Kiptot, E. (2015). *Analysis of Extension Systems in Uganda for Identification of Suitable Extension Approaches for Scaling-up Trees for Food Security Project in Eastern Uganda*. National Forestry Resources Research Institute Kampala, Uganda. 64pp.

Cavane, E. and Subedi, M. (2009). *Setting the Stage: A Note on Farmers' Attitudes and Adoption of Improved Maize in Mozambique*. Proceedings of the 25th Annual Meeting, Inter-continental San Juan Resort, Puerto Rico. pp. 35 – 67.

Churi, A. J., Mlozi, M. R. S., Tumbo, S. D. and Casmir, R. (2012). Understanding farmers' information communication strategies for managing climate risks in rural semi-arid areas, Tanzania. *International Journal of Information and Communication Technology Research* 2(11): 838 – 845.

David, S. (1997). *Dissemination and Adoption of New Technology: A Review of Experiences in Bean Research in Eastern and Central Africa, 1992-1996*. Network on Bean Research in Africa, Occasional Publications Series, No. 21. International Centre for Tropical Agriculture, Kampala, Uganda. 37pp.

Davis, K., Nkonya, E., Kato, E., Mekonnen, D., Odendo, M., Miiro, R., and Nkuba, J. (2010*). Impact of Farmer Field Schools on Agricultural Productivity and Poverty in East Africa*. International Food Policy Research Institute, Washington DC. 56pp.

Diiro, G. (2013). *Impact of Off-Farm Income on Technology Adoption Intensity and Productivity: Evidence from Rural Maize Farmers in Uganda*. International Food Policy Research Institute, Uganda. 19pp.

Donaldson, J. L., Hale, F. A., Bost, S. C., Windham, A. S., Stebbins, T. C. and Cook, D. L. (2006). Assessing an Extension plant pest diagnostic center for commercial clients: Satisfaction, savings, and success. [http://www.joe.org/joe/2006august/rb7.php] site visited on 20/1/2017.

Doss, C. R., Mwangi, W., Verkuijl, H. and deGroote, H. (2003). Adoption of Maize and Wheat Technology in East Africa: Synthesis of East African Adoption Studies. *Economics Working Paper No. 4.* CIMMYT, Mexico. 89pp.

Drechsel, P., Olaleya, A., Adeoti, A., Thiombiano, L., Barry, B. and Vohland, K. (2005). Adoption drivers and constraints of resource conservation technologies in sub-Sahara Africa. [http//www.iwmi.cgiar.org/Africa/west/pdf/Adoption const raints-overview.pdf] site visited on 23/04/2017.

Etoundi, S. M. N. and Dia, B. K. (2008). *Determinants of the Adoption of Improved Varieties of Maize.* Proceedings of the African Economic Conference, 2008, Cameroon. pp. 397 – 413.

FAO (2016). Guide to extension training. [www.fao.org/docrep/t0060e/T0060E01.htm# Foreword] site visited on 17/3 2017.

Franzel, S., Degrande, A., Kiptot, E., Kirui, J., Kugonza, J., Preissing, J. and Simpson, B. (2015). *Farmer-to-Farmer Extension.* Good Practice Notes for Extension and Advisory Services, Lindau, Switzerland. 4pp.

Fufa, B. (2006). Determinants of fertilizer use on maize in Eastern Ethiopia: A weighted endogenous sampling analysis of the extent and intensity of adoption. *Journal of Agriculture Economics* 45(1): 38 – 49.

Galindo-Gonzalez, S. and Israel, G. D. (2010). The influence of type of contact with Extension on client satisfaction. [http://www.joe.org/joe/2010february/a4.php] site visited on 23/04/2017.

Goodwin, B. and Mishra, A. (2002). Farming Efficiency and the Determinants of Multiple Job Holding by Farm Operators. *American Journal of Agricultural Economics* 86 (3): 722 – 729.

Gregory, T. and Sewando, P. (2013). Determinants of the probability of adopting quality protein maize technology in Tanzania: A logistic regression analysis. *International Journal of Development and Sustainability* 2(2): 1 – 18.

Hampson, K. (2015). Bean thinking. Using interactive radio to scale up production of common beans in Tanzania. [http;www.farmradio.org/portfolio] site visited on 23/07/2016.

Harris, L. M., Norton, G. W., Rezaul-Karim, A. N. M., Alwang, J. and Taylor, B. D. (2013). Bridging the information gap with cost-effective dissemination strategies: The Case of Integrated Pest Management in Bangladesh. *Journal of Agricultural and Applied Economics* 45(4): 639 – 654.

Javadi, E., Sheybani, H. and Soleimanpour, M. R. (2015). Factors affecting extension-education media effectiveness in agriculture information transmission to farmers in Tehran province. *Journal of Scientific Research and Development* 2 (2): 211 – 215.

Kafle, B. (2010). Determinants of adoption of improved maize varieties in developing countries. *International Research Journal of Applied and Basic Science* 1(1): 1 – 7.

Kalinda, T., Tembo, G. and Kuntashula, E. (2014). Adoption of improved maize seed varieties in Southern Zambia. *Asian Journal of Agricultural Sciences* 6(1): 33 – 39.

Kenya, N., Masangano, C., Kambewa, D. and Mlozi, M. R. S. (2017). Role of farmer field school in adoption of improved rice production practices in Mvomero District, Tanzania. *Africa Journal of Rural Development* 2(1): 21 – 32.

Khan, A., Pervaiz, U., Khan, N. M., Ahmad, S. and Nigar, S. (2009). Effectiveness of demonstration plots as extension method adopted by AKRSP for agricultural technology dissemination in Chitral District. *Sarhad Journal of Agriculture* 25(2): 313 – 319.

Khatam, A., Muhammad, S. and Ashraf, I. (2013). Role of individual contact methods in dissemination of agricultural technologies. Central region of Khyber Pakhtunkhwa, Pakistan. *Journal of Agriculture Research* 26(1): 40 – 44.

Kimaro, W. H., Mukandiwa, L. and Mario, E. Z. J. (Eds) (2010). Towards improving agricultural extension service delivery in the SADC Region. *Proceedings of the Workshop on Information Sharing among Extension Players in the SADC Region*, Dar es Salaam, Tanzania. 148pp.

Kingsley, M. and Charles, M. (2013). Mitigating HIV and AIDS impacts through agro-forestry practices. Lilongwe, Malawi. *International Journal of Agricultural Extension* 1(1): 1-7.

Kiplimo, J., Ngenoh, E. and Bett, J. (2015). Evaluation of Factors influencing access to credit financial services: Evidence from small holder farmers in Eastern Region of Kenya. *Journal of Economics and Sustainable Development* 6 (7): 97 – 106.

Kobero, H. (2010). Factors influencing the use of a certain agricultural extension on teaching methods for increased adoption of innovation in Mvomero and Morogoro District, Morogoro, Tanzania. Dissertation for Award of MSc Degree at Sokoine University, Tanzania. 119pp.

Letaa, E., Kabungo, C., Katungi, E., Ojara, M. and Nduguru, A. (2015). Farm level adoption and spatial diffusion of improved common bean varieties in southern highlands of Tanzania. *African Crop Science Journal* 23(3): 261 – 277.

Levi, C. (2015). Effectiveness of information communication technologies in dissemination of agricultural information to smallholder farmers in Kilosa District, Tanzania. Dissertation for Award of MSc Degree at Makerere University, Uganda. 81pp.

Lopes, H. (2010). Adoption of improved maize and common bean varieties in Mozambique. Thesis for Award of PhD Degree at Michigan State University, 104pp.

Lukuyu, B., Place, F., Franzel, S. and Kiptot, E. (2012). Disseminating improved practices: Are Volunteer Farmer Trainers effective? *The Journal of Agricultural Education and Extension* 18(5): 525 – 540.

Lwoga, E. T., Stilwell, C. and Ngulube, P. (2011). Access and use of agricultural information and knowledge in Tanzania. *Library Review* 60(5): 383 – 395.

Masuki, K. F. G., Mutabazi, K. D., Mattee, A. Z., Tumbo, S. D. and Rwehumbiza, F. B. (2014). Determinants of intensity of adoption of water systems innovations in Makanya Watershed, North-eastern, Tanzania. *International Journal of Environmental Engineering and Natural Resources* 1(5): 227 – 234.

Matata, P. Z., Gama, B. M., Mbwaga, A., Mpanda, M. and Byamungu, D. A. (2011). Effect of *Sesbania sesban* fallows on Striga infestation and maize yield in Tabora Region of Western Tanzania. *Journal of Soil Science and Environmental Management* 2(10): 311 – 317.

Mattee, A. Z. (1994). Reforming Tanzania's agricultural extension system: The challenges ahead. *African Study Monographs* 15(4): 177–188.

Mauceri, M., Alwang, J., Norton, G. and Barrera, V. (2005). *Adoption of Integrated Pest Management Technologies: A Case Study of Potato Farmers in Carchi, Ecuador.* AAEA Annual Meeting, Providence. Rhode Island. 27pp.

Mignouna, D. B., Manyong, V. M., Mutabazi, K. D. S. and Senkondo, E. M. (2011). Determinants of adopting imazapyr-resistant maize for Striga control in Western Kenya: A double-hurdle approach. *Journal of Development and Agricultural Economics* 3(11): 572 – 580.

Modibo, K., Nthoiwa, G. P. and Tsalaesele, N. (2010). An evaluation of factors that hinder subsistence farmers from diverting to profitable farming in Botswana: A lesson for extension officers. In: (Edited by Kimaro, W. H., Mukandiwa, L. and Mario, E. Z. J.), *Towards Improving Agricultural Extension Service Delivery in the SADC Region. Proceedings of the Workshop on Information Sharing Among Extension Players in the SADC Region*, Dar es Salaam, Tanzania. pp. 12 – 14.

Mokotjo, W. and Kalusopa, T. (2010). Evaluation of the agricultural information service (AIS) in Lesotho. *International Journal of Information Management* 30(4): 350 – 356.

Msolla, M. M. (2015). Increasing Investment in the Fertilizer Value Chain - The AFAP Model in Tanzania. [https://www.ipipotash.org/.../5-increasing-investment-in-the-fertilizer-value-chain-ms...] site visited on 20/08/2016.

Mugabi, C. (2013). *Challenges Facing Land Ownership in Rural Tanzania: What Needs to be Done.* Economic and Social Research Foundation, Dar es Salaam, Tanzania. 4pp.

Mugisha, J. and Diiro, G. (2010). Explaining the adoption of improved maize varieties and its effects on yields among smallholder maize farmers in Eastern and Central Uganda. *Journal of Scientific Research* 5(1): 6 – 13.

Murage, A. W., Obare, G., Chianu, J., Amudavi, D. M., Midega, C. A. O., Pickett, J. A., and Khan, Z. R. (2012). The effectiveness of dissemination pathways on adoption of "Push-Pull" technology in Western Kenya. *Quarterly Journal of International Agriculture* 51(1): 51 – 71.

Mtega, W. P. and Msungu, A. C. (2012). Using information and communication technologies for enhancing the accessibility of agricultural information for improved agricultural production in Tanzania. *The Electronic Journal of Information Systems in Developing Countries* 56(1): 1 – 14.

Mvuna, J. K. (2010). Agricultural extension services delivery in Tanzania. In: (Edited by Kimaro, W. H., Mukandiwa, L. and Mario, E. Z. J.), *Towards Improving Agricultural Extension Service Delivery in the SADC Region*. Proceedings of the Workshop on Information Sharing Among Extension Players in The SADC Region, Dar es Salaam, Tanzania. pp. 114 – 121.

Mwangi, M. and Kariuki. (2015). Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries. *Journal of Economics and Sustainable Development* 6: 1-10.

Mwamakimbula, M. A. (2014). Assessment of factors impacting agricultural extension training programs in Tanzania. Dissertation for Award of MSc Degree at Iowa State University. 108pp.

National Bureau of Statistics (2012). *Population and Housing Census.* Government Printers, Tanzania. 264pp.

Nazari, M. R. and Hassan, M. S. B. H. (2011). The role of television in the enhancement of farmers' agricultural knowledge. *Africa Journal of Agriculture Research* 6(4): 931 – 936.

Nduru, M. (2011). *A guide to Effective Extension Methods for Different Situation*. National Agricultural Extension Programme, Nairobi, Kenya.10pp.

Nkamleu, G. B. (2007). Modelling Farmers' Decisions on Integrated Soil Nutrient Management in sub-Saharan Africa: A Multinomial Logit Analysis in Cameroon. In: Bationo, A., Waswa, B., Kihara, J. and Kimetu, J. (Eds), *Advances in Integrated Soil Fertility Management in Sub-Saharan Africa. Challenges and Opportunities*. Springer Publishers, Netherlands. pp. 891 – 903.

Nyamba, S. Y. and Mlozi, M. R. S. (2012). Factors influencing the use of mobile phones in communicating agricultural information: A Case of Kilolo District, Iringa, Tanzania. *International Journal of Information and Communication Technology* 2(7): 2223 – 4985.

Ogunremi, J. B. (2013). Assessment of extension agents' use of communication methods and its impact on aquaculture linkage activities in Lagos state, Nigeria. *Journal of Agriculture and Social Research* 13(1): 15 – 20.

Okunade, E. O. (2007). Effectiveness of extension teaching methods in acquiring knowledge, skill and attitude by women farmers in Osun State. *Journal of Applied Sciences Research* 3(4): 282 – 286.

Okwu, O. J. and Daudu, S. (2011). Extension communication channels' usage and preference by farmers in Benue State, Nigeria. *Journal of Agricultural Extension and Rural Development* 3(5): 88 – 94.

Padel, S. (2001). Conversion to organic farming: A typical example of the diffusion of an innovation. *Sociologia Ruralis* 41(1): 49 – 61.

Rogers, E. M. (1995). *Diffusion of Innovation*. Free Press, New York. 518pp.

Rogers, E. M. (2003). *Diffusion of Innovations*. (5th Ed.), Free Press, New York. 541pp.

Ronner, E. and Giller, K. E. (2013). *Background Information on Agronomy, Farming Systems and Ongoing Projects on Grain Legumes in Tanzania*. N2Africa, Tanzania. 33pp.

Salasya, B., Mwangi, W., Mwabu, D. and Diallo, A. (2007). Factors influencing adoption of stress-tolerant maize hybrid (WH 502) in Western Kenya. *African Journal of Agricultural Research* 2(10): 544 – 551.

Sam, J. and Dzandu, L. (2015). *The Use of Radio to Disseminate Agricultural Information to the Farmers.* The Ghana Agricultural Network System Experience. Agricultural Information Worldwide, Johannesburg, South Africa. 23pp.

Sone, D. (2015). Tanzania legume complaints. Africa health consortium. [Africahealth. cabi.org] site visited on 23/07/2017.

Subedi, W., Hocking, T.J., Fullen, M.A., McCrea, A.R., Milne, E., Bo-zhi, W.U. and Mitchell, D. J. 2009. An awareness-adoption matrix for strategic decision making in agricultural development projects: A case study in Yunnan Province, China. Journal of Agricultural Sciences 8 (1): 1112-1119.

Ssemakula, E. and Mutimba, K. J. (2011). Effectiveness of the farmer-to-farmer extension model in increasing technology uptake Mbarara, Uganda. *South African Journal of Agricultural Extension* 40(3)*:* 339 – 365.

Sserunkuma, D. (2005). The adoption and impact of improved maize and land management technologies in Uganda. *Journal of Agricultural and Development Economics* 2: 67 – 84.

Suvedi, M. and Kaplowitz, M. (2016). *What Every Extension Worker Should Know*. MEAS Handbook. Michigan State University, USA. 188pp.

Suzuki, S. O. (2000). Attitude of smallholder farmers towards extension officers: A case of Kinondoni District, Dar es Salaam Region. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 74pp.

Tegha, Y. C. Z. (2014). Effectiveness of field days on promoting the adoption of the recommended improved maize varieties by small holder farmers in Lilongwe District, Malawi. Dissertation for award of MSc degree at Purdue University West Lafayette, Indiana. 121pp.

Tryphone, K. J., Chilagane, A. L., Protas, D. Kusolwa, M. P. and Msola, N. S. (2013). *Markers-assisted Selection for Common Bean Disease Improvement.* Prospects and Future Needs, INTECH, Morogoro, Tanzania. 28pp.

Tura, M., Aredo, D., Tsegaye, W., La Rovere, R., Girma, R., Tesfahen, G., Mwangu, W. and Mwabu, G. (2010). Adoption and continued use of improved maize seeds: Case study of Central Ethiopia. *African Journal of Agricultural Research* 5(17): 2350 – 2358.

Umrani, R. and Jain, C. K. (2010). *Agricultural Extension: Worldwide Innovations*. Oxford Book Company. 310pp.

Vargas-Lundius, R. (2009). *Smallholder Agriculture and Food Security in the 21st Century*. International Fund for Agricultural Development, Rome, Italy. 76pp.

Wekesa, E., Mwangi, W., Verkuijl, H., Danda, K. and De Groote, H. (2003). *Adoption of Maize Technologies in the Coastal Lowlands of Kenya*. International Maize and Wheat Improvement Center, Mexico. 34pp.

APPENDIX

Appendix 1: Interview schedule for the farmers

A study of effectiveness of extension methods for scaling up improved common bean technologies among small-scale farmers in Babati district, Tanzania.

General Instructions to Enumerators

Make brief introduction to each respondent before starting any question. That is, first introduce yourself to the respondents (greet them in the local way) and let them introduce themselves to you; tell them the institution you are working for and make clear the purpose and objective of the study (build rapport). Please fill up the questionnaire according to the respondents reply (do not put your own reply/ feeling). Please ask each question so clearly and patiently until the respondent understands clearly (get your points). Please do not try to use technical terms while discussing with the respondents (use local language for better communication). During the process put the answer of each respondent both on the space provided.

Research objectives

1. To assess the effectiveness of various extension methods on increasing smallholder farmers' awareness about improved common bean technologies
2. To assess the effectiveness of various extension methods on stimulating willingness of smallholder farmers to adopt improved common bean technologies
3. To assess the effectiveness of various extension methods in influencing smallholder farmer to adopt improved common bean technologies
4. To identify the determinant of the adoption of the improved common bean technologies to the small holder farmers

Module A. General Information

A01. Questionnaire No……..…..
A02. Name of enumerator…….
A03. Date of interview……
A04. Respondent's name…… ……...
A05. Respondent's gender…….
A06. Respondent's age……
A07. Respondent's mobile phone number……..…
A08. Is respondent the household head? …….…….. 1=Yes 0=No
A09. If no, what is the name of the household head……
A10. District…….
A11. Ward……
A12. Village…….
A13. Household GPS coordinates: A13.1 Altitude_____
A13.2. Latitude_____
A13.3. Longitude_____

MODULE B. Household's Information

B01. Household head's gender……1=Female 0=Male
B02. Household head's age…… years
B03. Main occupation of the household head (circle the one that applies)
1. Crop production
2. Livestock production
3. Salaried employment- government
4. Salaried employment-private sector
5. Self-employed off-farm
6. Casual laborer on-farm
7. Casual laborer off-farm
8. Herding
9. Fishing
10. Household chores
11. Other (specify)……....

B04. What is the highest formal education level attained by the household head?
1. No formal education
2. Primary school
3. Secondary school
4. Two-years college - Diploma
5. Four-years college – Bachelor Degree
6. Advanced education (M.Sc. . or PhD)
7. Other (specify)……

B05. What is the marital status of the household head?
1. Monogamous
2. Polygamous
3. Divorced
4. Never married
5. Other (specify)……..

B06. Is the household head a member of farmer organizations?

1. Yes
0. No

MODULE C. Household Income

C01.How much income did you earn in the past one year preceding the survey (2015/2016)?
Note to enumerator: Please assure that the information is used for research purpose only

No	Source of income	Actual amount in TZS
C01.1	Income from sale of crop produce	
C01.2	Income from sale of livestock	
C01.3	Income from business/petty trade	
C01.4	Remittances (cash transfer from relative/son/ daughter)	
C01.5	Income from land rent	
C01.6	Income from building rent	
C01.7	Employment income	
C01.8	Others (specify)	

C02. What percentage of the household income comes from sale of common beans?
1. 100%
2. 75-99%
3. 50-74%
4. 25-49%
5. Less than 25%

MODULE D: Common Bean Plots Cultivated during the Last Cropping Season, 2015/2016

Plot No	D01. Plot size (acres)	D02. Type of common bean variety planted	D03. Who manages the plot?	D04. Plot tenure	D05. Distance from home to the plot in kilometers	D06. Is the plot inter-cropped?	D07. Type of intercropping
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Code for D02: Type of common bean variety planted: 1= Improved common bean; 0= Local common bean
Code for D03: Who manages the plot? 1=women; 0=men
Code for D04: Plot tenure? 1= Owned; 2= Rented in; 3= Share-cropped
Code for D06: Is the plot inter-cropped? 1=Yes; 0=No
Code for D07: Type of intercropping: 1= Inter-cropping with maize only 2=Inter-cropping with maize and other legume such as cow peas, ground nuts, soya bean 3= Mono- cropping 4=other (specify)

MODULE E: Awareness, Willingness and the adoption about Common Bean Production Technologies

No.	Common bean technologies	E01. Are you aware of? 1= Yes. 0=No	E02. If yes, where did you get the information (source of information)?	E03. If you are aware, are you currently using them?)	E04: If you are not currently using them, will you be willing to use them in the future?
1.	Improved common bean varieties				
2	New planting methods – (when to plant and what spacing to use during planting)?				
3	Type, rate and time of application of chemical fertilizers				
4	Weeding method (when to weed and how many times to weed)				
5	Harvesting method (at what stage and when to harvest, moisture in the seeds)				
6	Type, rate and time and safe use of chemicals – herbicides, pesticides				
7	Post-harvest and storage management – to prevent production loss due to storage pests				

Code for E01: Are you aware of? 1= Yes; 0=No
Code for E02: for source of information: 1. District council extension staff; 2. FFS group; 3. Input suppliers; 4. Radios; 5. Demonstration; 6. Neighbors and relatives; 7. others (specify)
Code for E03: Are you currently using them? 1= Yes; 0=No
Code for E04: Will you be willing to use them? 1= Yes; 0=No

MODULE G: Access to Extension Services

G01. Are there extension workers in your farming areas? (May be inspectors)

1. Yes
0. No

G02.If yes, how many times did they visit your farms in the past two production seasons of the year 2015/16? ---------- (number of visits per year)

G03. If you were visited by extension workers in the past two production seasons, did they advise you on use of improved varieties of common beans or other common bean technologies?

1. Yes
0. No

G04. If yes, have you been applying the advice? _____

1. Yes
0. No

G05. If no, why not?

……
……

G06.Main source of improved common bean information (tick all those apply):

1. District council extension staff
2. FFS group
3. Input suppliers
4. Radios
5. Demonstration
6. Neighbors and relatives
7. Others'_____

MODULE H: Access to Inputs in the Past Two Production Seasons of the Year 2015/16

Type of Inputs	**H01. Did you get access to? 1=yes 0=no**
Chemical fertilizer at planting (DAP)	
Top dress Fertilizer (UREA)	
Certified seed	
Herbicides	
Fungicides	
Pesticides	
Animal Manure	

MODULE I: Access to Credit

I01. Did you borrow money from any of the following sources in the past two production seasons of the year 2015/16?

Source of borrowed Money	**Borrowed? 1=Yes 0=No**
Relative1	
Relative2	
Relative3	
Relative4	
Friend1	
Friend2	
Friend3	
Friend4	
Government	
NGO/Church	
Informal savings and credit group	
Bank or microfinance institution	
Others (specify)	

MODULE J: Access to Market

J01. How do you obtain improved common bean seeds? _____

1. Purchase
2. Gift from friends/relatives
3. Saved from previous seasons
4. Given free by AFAP/ NGOs
5. Research institutes
6. Extension departments
7. Other (specify)……

J02. If you purchase, where do you buy it from? _____

1. Pass on program
2. Local market
3. City market
4. Extension department
5. NGOs
6. Other (specify)……

J03.What is the distance from home to where you sale you common bean produce? …… (Kilometers).

Thank you for your cooperation