EFFECTIVENESS OF COMMUNICATION CHANNELS AND SMALLHOLDER FARMERS' ADOPTION OF IMPROVED LEGUME TECHNOLOGIES: A CASE OF MOROGORO REGION, TANZANIA

CHARLES BYALUGABA LUGAMARA

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EXTENDED ABSTRACT

Legume crops play important roles economically, socially and environmentally by providing jobs, being a cheap source of protein, improving health and nutrition, improving soil fertility, weed suppression and nitrogen fixation. However, it is yet to be clearly determined as to which approach or a combination of approaches that are effective in ensuring legume technologies are disseminated across the various farming groups. The current study aimed at assessing the effectiveness of awareness creation approaches on level of knowledge, adoption and willingness of smallholder farmers to pay for improved legume technologies and explore other factors associated with adoption and willingness to pay for the technologies in Gairo and Mvomero districts. The study adopted a cross-sectional research design whereby data were collected once from Gairo and Mvomero Districts, Morogoro, Tanzania. The districts were purposively selected due to a number of multimedia approaches and other extension methods that had been used to raise farmers' awareness of improved legume technologies. A total of 400 respondents participated in this study of whom about two thirds were from the area of intervention and a third were from the area with no intervention. Primary data was collected through a questionnaire, key informant interviews and focus group discussions. Data was analysed using SPSS whereby descriptive and inferential statistics were determined. Results show that smallholder farmers were aware of all the technologies assessed and the level of awareness differed across the treatments. Factors significantly associated with smallholder farmers awareness were availability of legume technology intervention ($P<0.01$) and total revenue from income generating activities ($P<0.05$). In addition, the results also show that less than a quarter of respondents adopted/cultivated improved common bean seeds. Generally, factors significantly ($P<0.05$) associated with adoption of improved common bean seeds were availability of legume technology intervention, total area cultivated, total income

from other income generating activities (IGA), borrowing money from any financial source, visit by extension officer and household size. On the other hand, results show that overall, more than two thirds of the farmers were willing and ready to pay for at least one technology out of the six technologies assessed. Results also show that factors positively and significantly ($P<0.05$) associated with smallholder farmers willingness to pay for the technologies included availability of legume technology intervention, total revenue from IGA, being a member of a farmers' association and visit by extension officer. It can generally be concluded that, the surveyed farmers had moderate uptake for improved bean technologies which farmers' pinned to lack of knowledge on how to use the inputs and lack of capital or prevailing high input prices. Therefore, the study recommends that, awareness creation should continue and target those farmers who have not adopted improved bean technologies. In order to increase farmers' knowledge, adoption and willingness to pay for improved legume technologies there is a need for reduction of technology prices or provision of subsidies.

DECLARATION

I, Charles Byalugaba Lugamara, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor is concurrently being submitted in any other Institution.

Charles Byalugaba Lugamara **(MARD Candidate)**	Date

The above declaration is confirmed by;

Prof. Justin K. Urassa **(Supervisor)**	Date
Dr. Paul Dontsop **(Supervisor)**	Date

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DEDICATION

This work is dedicated to my daughter “Evana” who was born during the period of this study, my parents, my late father Philemon Lugamara and my late mother Christina Kagemulo who laid the foundation of my study and to my lovely wife Eveline Festo Kabitina and my sister Naomi Mbezi Lugamara for their inspiration during my study period.

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LIST OF ABBREVIATIONS AND ACRONYMS

AGDP	Agricultural Gross Domestic Product
ASARECA	Association for the Strengthening of Agricultural Research in Central and Eastern Africa
ASDP	Agricultural Sector Development Programme
ASR	Agricultural Sector Review
CBOs	Community Based Organisations
CIFSRF	Canadian International Food Security Research Fund
DAICO	District Agricultural, Irrigation and Cooperative Officer
FBOs	Faith Based Organisations
FGDs	Focus Group Discussions
ICT	Information and Communication Technologies
IDRC	International Development Research Centre
IGAs	Income Generating Activities
IITA	International Institute of Tropical Agriculture
KIT	Koninklijk Instituut voor de Tropen (Royal Tropical Institute)
MLE	Monitoring Learning and Evaluation Strategy
NGOs	Non-Governmental Organisations
PER	Public Expenditure Review
SDGs	Sustainable Development Goals
SILT	Scale up Improved Legume Technologies
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
SUA	Sokoine University of Agriculture

TDV	Tanzania Development Vision
UN	United Nations
URT	United Republic of Tanzania
VEO	Village Executive Officer
WEO	Ward Executive Officer

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Food legumes play an important and diverse role in the farming systems and in the diets of poor people around the world such as reducing poverty, improving human health and nutrition, and enhancing ecosystem resilience (Katungi *et al.*, 2010). In Sub-Saharan Africa (SSA), legume crops play important roles economically, socially and environmentally by providing jobs, being a source of cheap protein consumed at the household level, improving health and nutrition and improving soil fertility through weed suppression and nitrogen fixation (Akibode, 2011; Sanginga and Bergvinson, 2015).

In Tanzania, most smallholder farmers especially women participate in legume production. Generally, legumes act as a good and inexpensive protein source compared to meat and fish (Malema, 2006; ProFound and Mugenyi, 2012). Other significant roles of legumes in Tanzania include quick source of income as they can mature early compared to other staple crops and the fact that legumes can bring in cash at every stage of their growth such as green leaves, fresh pods and dry grains (Birachi, 2012). Moreover, legumes excel in human and livestock nutrition, soil fertility improvement and foreign currency earning through export.

Generally, due to the importance of legumes to rural households' livelihoods many interventions to raise their productivity have been tried. For example, financing agriculture and promoting research activities; improving extension services provided to smallholder farmers; training for updating skills and knowledge of farmers; improving agricultural mechanization, improving agricultural information systems, improving agricultural

markets and marketing (URT, 1997; URT, 2001; URT, 2008). Despite the efforts made to increase food productivity, the rate of legume production is low (i.e. below a ton per hectare) (Malema, 2006; URT, 2012). Moreover, the cost to obtain such crops for food is high (ProFound and Mugenyi, 2012). Common bean's poor productivity may either be due to use of ineffective awareness creation approaches or farmers unwillingness to adopt improved legume technologies.

According to the 2007/2008 Tanzanian agricultural sample survey it was revealed that in Morogoro Region, area planted with improved seeds (cereals, fruits and vegetables, oil seeds and oil nuts and pulses) for the short and long rains was 60 151 ha (12.6% of total planted area) while the rest of the area (87.4%) equivalent to 514 415 ha was planted without using improved seeds (URT, 2012). Amongst the different crop types, the total area planted with improved seeds for pulses (legumes) was 943 ha (2%). Similarly, a study conducted by the Agricultural Sector Review Committee/Public Expenditure Review Committee (ASR/PER) (2010/2011) cited in URT (2013) revealed that, the estimate of improved seeds of cereals, legumes and oil seeds in Tanzania is 120 000 tons. However, only 12 800 tones (10%) of improved seeds were used in crop production (URT, 2013).

Generally, legumes' low productivity could be a consequence of farmers' low access to the legume technologies due to shortfalls of awareness creation approaches. In Tanzania, food crops account for 65 per cent of the Agricultural Gross Domestic Product (AGDP) (URT, 2013). The performance of crops generally dictates the lifelines of rural communities which comprises mainly smallholder farmers. Generally, increased food crop (particularly legumes) productivity can have a positive impact on farmers since it helps in food and nutrition security of the households (ASARECA/KIT, 2014). Therefore, the

current study aimed at assessing the effectiveness of communication channels and farmers adoption of improved legume technologies.

1.2 Problem Statement

Despite efforts done by the government and other stakeholders in formulating good policies and strategies aimed at increasing legumes production and productivity, it has been shown that legumes' productivity in Tanzania, Morogoro included is low (below a ton per hectare) (URT, 2012). It is also projected that by the year 2030, Africa will be facing a deficit of 1.5 million tons of legumes (Sanginga and Bergvinson, 2015). According to Tanzania's 2007/2008 agricultural sample survey, it was revealed that the total area planted with improved legume seeds in Morogoro was 943 ha (2%) the rest was planted with unimproved seeds (URT, 2012).

Based on the above, a question remains as to why some smallholder farmers are not making good use of the available legume technologies. Probably, poor productivity may either be a result of the ineffective awareness creation approaches used or farmers' unwillingness to adopt improved legume technologies. In addition, problems could be small farm size, input and output marketing system, credit facilities, land tenure system, information and communication infrastructure, participation in other economic activities other than legumes, environment (land quality and soil type) and farmers' subjective perception of the new technologies. However, it is yet to be clearly determined as to which approach or a combination of approaches is effective in ensuring legume technologies are disseminated across the various farming groups particularly in the study area. The aim of the current study was to assess the effectiveness of awareness creation approaches on level of knowledge, adoption and willingness of smallholder farmers to pay for improved legume technologies in Gairo and Mvomero districts.

1.3 Justification for the Study

Currently, in Morogoro a multi-media approach is being used to scale up use of improved legume technologies. Such approaches include technological briefs (leaflets and brochures) and other extension methods including demonstrations and farmer field days. The approaches were implemented under the project known as Scale up Improved Legume Technologies (SILT) through Sustainable use of Input Supply and Information Systems supported by the International Development Research Centre (IDRC) and the Canadian International Food Security Research Fund (CIFSRF) (MLE, 2016). The project shared knowledge with smallholder farming families on the positive contribution of legumes to human and livestock nutrition, livelihoods, soil fertility and the environment. Other areas shared were land preparation; legume variety selection; use of quality seed; fertilizer application at planting; planting and spacing; weeding; control of insect and storage pests and diseases; harvesting and storage; and safe use of chemicals. It is therefore expected that findings from the study can contribute to enhancing the change of farmers' knowledge and adoption of innovative and comprehensive legume husbandry practices and hence increased legume production and productivity.

In addition to the above, the study is in line with the Sustainable Development Goal (SDG) 1 which aims at ending poverty in all its forms (absolute poverty and relative poverty) among communities through increased legume production. Similarly, in goal 2 which aims at ending hunger, achieving food security and improved nutrition and promote sustainable agriculture (UN, 2015). Moreover, Tanzania's Development Vision 2025 goal 1 also emphasises on high quality livelihoods for all Tanzanians through realizing food self-sufficiency and food security and absence of abject poverty among other things (URT, 1999). Therefore, through increased legume production and productivity, abject poverty among legume producers could be eradicated and people's nutrition will be improved and

high quality livelihood through food self-sufficiency. Generally, findings from this study could be of great use to policy makers, academia, research institutions and other stakeholders interested in improving food and nutritional security and reduction of poverty in rural areas.

1.4 Research Objectives

1.4.1 Overall objective

The general objective of this study was to assess the effectiveness of awareness creation approaches on level of knowledge, adoption and willingness of smallholder farmers to pay for improved legume technologies in Gairo and Mvomero districts.

1.4.2 Specific objectives

i. To assess smallholder farmers level of awareness on improved legume technologies.
ii. To assess determinants of smallholder farmers awareness on improved legume technologies.
iii. To determine the effectiveness of various awareness creation approaches on smallholder farmers understanding of improved legume technologies.
iv. To assess the determinants of smallholder farmers' adoption of improved legume technologies.
v. To assess the determinants of smallholder farmers' willingness to pay for improved legume technologies.

1.5 Research Questions

i. Are smallholder farmers aware of improved legume technologies?

ii. Which awareness creation approaches or combinations are most effective on smallholder farmers understanding of improved legume technologies?

iii. What drivers influence smallholder farmers' adoption of improved legume technologies?

iv. Is adoption of improved legume technologies linked to households socio-demographic factors?

v. How do household socio-demographic factors influence their willingness to pay for improved technologies?

1.6 Hypotheses

i. Smallholder farmers' knowledge on improved legume technologies does not differ based on awareness creation approaches used.

ii. Smallholder farmers' knowledge on improved legume technologies does not differ significantly between areas with and without intervention.

iii. Smallholder farmers' adoption level of improved legume technologies does not differ by awareness creation approach used.

iv. Smallholder farmers' willingness to pay for improved legume technologies does not differ by awareness creation approach used.

v. Smallholder farmers' adoption level of improved legume technologies does not differ between areas with and without intervention.

vi. Smallholder farmers' willingness to pay for improved legume technologies does not differ between areas with and without intervention.

1.7 Conceptual Framework

The study's conceptual framework has five major components: background variables/demographic factors such as age, sex, education, marital status, occupation and

household size. Generally, background variables can influence smallholder farmers' choice and use based on the preferred multi-media approach such as technological briefs (leaflets and brochures) and other extension approaches for example demonstration plots and farmer field days. In addition, awareness creation approaches used (multi-media and other extension methods) can change farmers knowledge and perception hence lead to farmers' decision to adopt or not to adopt improved legume technologies i.e. improved common bean varieties; new planting methods; type, rate and time to use fertilizers; weeding method (when and how often/number of times); harvesting method (stage and when); type, rate, time and safe use of chemicals; and post-harvest and storage management. Further to the above, external factors such as agricultural input supply and financial policies, rainfall and temperature can shape the perception of smallholder farmers towards adoption and willingness to pay for improved legume technologies.

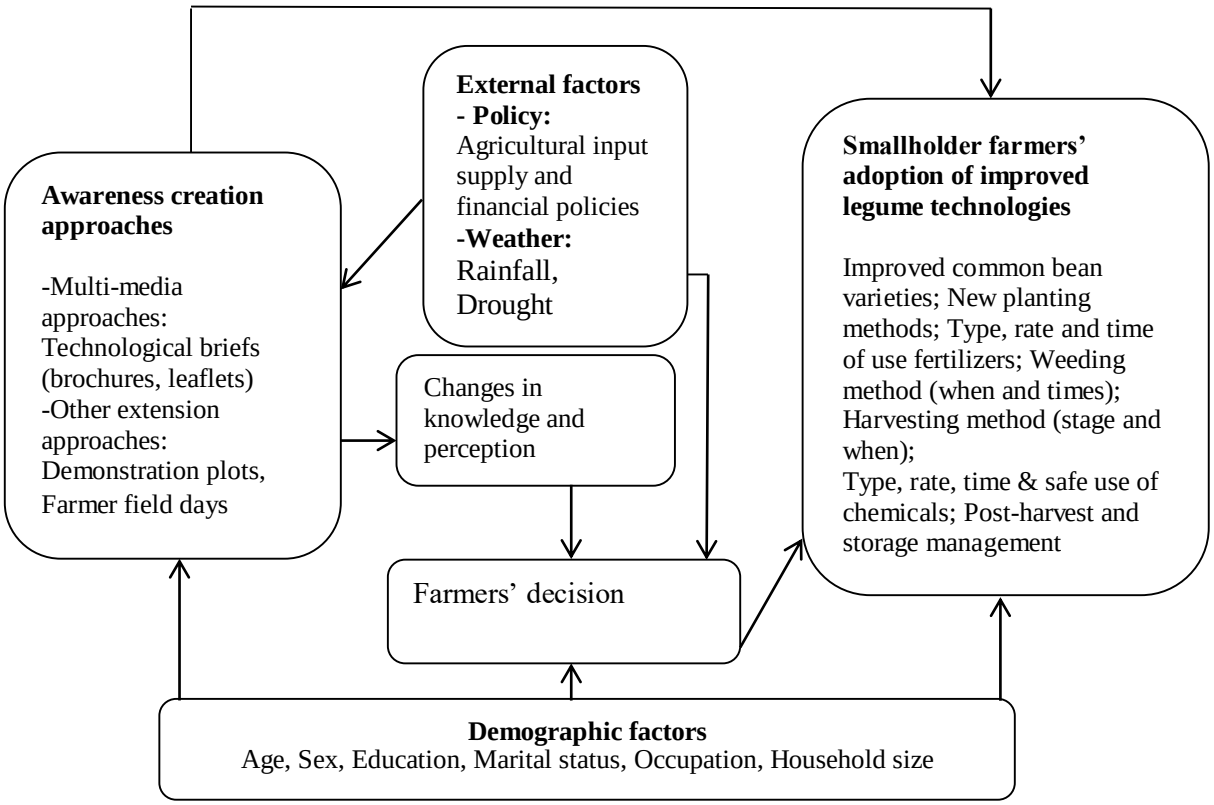

Figure 1.1: **Conceptual Framework for the assessment of effectiveness of awareness creation approaches and willingness of smallholder farmers to adopt improved legume technologies**

1.8 Organization of the Dissertation

This dissertation is organised in three chapters. The first chapter consists of the extended abstract and introduction of the overall theme studied. In addition, it offers a description of the commonality of concepts presented in the separate manuscripts. Chapter two contains publishable manuscript one which covers objectives i, ii, iii and provide answers for hypothesis i, ii and iii. Chapter three contains publishable manuscript two which covers objectives iv, v and provide answers for hypothesis iv, v and vi. Lastly, chapter four presents the study's general conclusions and recommendations.

1.9 Limitations of the Study

It was difficult to get some relevant information due to language barriers, because some villagers were not conversant with the national language (Swahili), they spoke native languages. This limitation was mitigated by requesting local agricultural extension officers who were experienced with the local languages to interpret the languages to the researcher. In addition, since data was collected during the rainy season, the majority of farmers were not around. Therefore, it became difficult to get them. However, due to assistance from extension officers and village executive officers the researcher was able to find them at some other pre-arranged time.

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CHAPTER TWO

2.0 Effectiveness of Communication Channels on Knowledge and Adoption of Improved Common Bean Technologies among Smallholder Farmers' in Tanzania

Charles Byalugaba Lugamara[1*], Justin K. Urassa[2] and Paul Martin Dontsop Nguezet[3]

[1]Department of Development Studies, Sokoine University of Agriculture (SUA), P.O. Box 3024, Morogoro, Tanzania. E-mail: charleslugamara@gmail.com

[2]Department of Policy, Planning and Management, Sokoine University of Agriculture (SUA), P.O. Box 3035, Morogoro, Tanzania.
E-mail: jksurassa@yahoo.co.uk or urassa@suanet.ac.tz

[3]International Institute of Tropical Agriculture (IITA), Birava Road, Bukavu, DR Congo.
E-mail: P.Dontsop@cgiar.org

[*]Corresponding author: charleslugamara@gmail.com

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2.1 Abstract

Increased legume productivity is of paramount importance as this may highly contribute to nutritional security as they are a source of cheap protein. However, there is lack of enough information on smallholder farmers' understanding towards improved legume technologies in poor resource countries such as Tanzania. The study on which this manuscript is based aimed at assessing the effectiveness of communication channels on knowledge of smallholder farmers' adoption of improved common bean technologies in Tanzania. The study adopted a cross-sectional research design whereby data were collected once from Gairo and Mvomero districts, Tanzania. The districts were purposively selected due to a number of multimedia approaches that had been used to raise farmers' awareness and knowledge. A total of 400 respondents participated in the study whereby about two thirds were from the area of intervention and the rest from the area with no intervention. Primary data were collected through a questionnaire, key informant interviews and focus group discussions. Collected data was analysed using SPSS whereby descriptive and inferential statistics were determined. Generally, results show that, the level of awareness differed across the treatments. Availability of legume technology interventions was positively and significantly (P=0.000) associated with smallholder farmers awareness across all the technologies. In addition, the results show low a level of adoption of improved legume technologies among the surveyed households. Improved legume technologies highly practiced by farmers include weeding methods, new planting methods and use of improved common bean varieties. It can generally be concluded that, the surveyed farmers had a low uptake for improved bean technologies which farmers' pinned to lack of knowledge on how to use the inputs and lack of capital or high input prices. Therefore, there is need for reduction of their prices or provision of subsidies in addition to creation of awareness particularly in the areas with no intervention.

Key words: Effectiveness, Communication Channels, Smallholder farmers' knowledge, Improved common bean Technologies

2.2 Background Information

Food legumes play an important and diverse role in the farming systems and in the diets of poor people around the world such as reducing poverty, improving human health and nutrition, and enhancing ecosystem resilience (Katungi *et al.*, 2010). In Sub-Saharan Africa (SSA), legume crops play an important role economically, socially and environmentally by providing jobs, providing the cheap protein consumed mostly at the household level, improving health and nutrition and improving soil fertility through ground cover, weed suppression and nitrogen fixation (Akibode, 2011; Sanginga and Bergvinson, 2015).

In Tanzania, most small-scale farmers especially women participate in legume production. Generally, legumes act as a good and inexpensive protein source compared to meat and fish (Malema, 2006; ProFound and Mugenyi, 2012). Other significant roles of legumes in Tanzania include their early maturity compared to other staple food crops, being a quick source of income at every stage of their growth such as green leaves, fresh pods and dry grains (Birachi, 2012). Generally, legumes excel in human and livestock nutrition, soil fertility improvement and foreign currency earning through export.

The importance of legumes to communities has led to a need for development and dissemination of various improved technologies. As a result of the above, extension agents have used a variety of ways to reach farmers. Generally, a number of delivery approaches and communication channels exist in legume producing areas, these include but not limited to conventional approaches (agricultural extension officers visiting farmers), multimedia approaches (radio, television, mobile phones, newspapers, leaflets, brochures etc.), other extension methods like demonstration plots, farmer field days etc. However, the conventional agricultural extension service is commonly used in Tanzania Morogoro

included whereby extension officers visit farmers in order to disseminate agricultural technologies: this method is important since it helps extension workers to provide technical assistance directly to farmers. But the method faces a number of challenges which include insufficient numbers of extension officers, inadequate resources (finances and transport) to mention a few (Sanga *et al.,* 2013).

In Tanzania and beyond multimedia methods such as radio, television, mobile phones, newspapers, leaflets and brochures are also used in disseminating agricultural technologies. For example Farmer Voice Radio project which was launched in 2009 and implemented in some of the districts in Tanzania. The project linked extension officers and farmers with a radio based system. Generally, the multimedia method helps to reach many farmers within a short time in disseminating agricultural technologies (Sanga *et al.,* 2013). Other researches conducted in different parts of Africa found that multimedia methods are effective in awareness creation to smallholder farmers pertaining agricultural technologies because less time and costs can be incurred while covering large areas (Ango *et al.,* 2013; Ariyo *et al.*, 2013; Kakade, 2013; Chapota *et al.,* 2014; Sam and Dzandu, 2012). Despite of their importance, multimedia methods have limitations. For example, duration of the program tends to be short for farmer to capture all necessary information. Another limitation is that of language barrier because most facilitators are not fluent in local languages and there may be lack of communication skills to communicate with the audience (Sam and Dzandu, 2012).

Apart from the above extension methods, demonstration plots have been another avenue through which agricultural technologies are disseminated. Generally, demonstration plots help farmers to learn more by seeing and doing/practising. Also they are among the best methods to improve yield and help extension workers to effect desirable changes to

smallholder farmers. Demonstration plots are arranged at the best learning locations (rural setting); and they provide opportunities through which useful communication and interaction can take place between extension workers and smallholder farmers (Khan *et al.*, 2009). Nonetheless, the method also has limitations as few farmers can be made to learn at a time.

Tanzania has for a long time being making efforts to scale-up crop productivity (legumes included) under the Agricultural Sector Development Strategy I. For example, financing agriculture and promoting research activities; improving extension services provided to smallholder farmers; training for updating skills and knowledge of farmers; improving agricultural mechanization and improving agricultural information systems (URT, 2001). Despite the efforts made to increase food productivity, legume yields are low (below a ton per hectare) (Malema, 2006; URT, 2012). In addition, the cost to obtain such crops for food is high (ProFound and Mugenyi, 2012). Moreover, poor productivity may either be a result of the ineffective awareness creation approaches used or farmers' unwillingness to adopt improved legume technologies. Generally, the low productivity could be a consequence of farmers' low access to the legume technologies due to shortfalls of awareness creation approaches.

In the 2015/2016 cropping season a project on Scaling up Improved Legume Technologies (SILT) through Sustainable use of Input Supply and Information Systems was implemented in Morogoro Region through support from the International Development Research Centre (IDRC) and the Canadian International Food Security Research Fund. Through the project there was sharing of knowledge with smallholder farming families using multimedia approaches such as technological briefs (leaflets and brochures) and other extension approaches particularly demonstration plots and farmer field days (MLE,

2016). The knowledge disseminated included positive contribution of legumes to human and livestock nutrition, livelihoods, soil fertility and the environment, land preparation, legume variety selection, use of quality seed, fertilizer application at planting, planting, spacing and weeding. Others were control of insect and storage pests and diseases, harvesting and storage, and safe use of chemicals.

According to the Productivity Commission (2013), effectiveness is the extent to which stated objectives are met. Indicators of the effectiveness of programmes generally focus on measuring the changes in outcomes that reflect the objectives of the programme. According to SCRGSP (2006) cited in Productivity Commission (2013) performance of any program can be measured at two levels; whereby cost effectiveness performance indicators can be used to estimate unit cost of producing certain output, and program effectiveness performance indicators which look at agreed measures of access, appropriateness, and quality. But for the case of this study effectiveness means which one among the approaches (current/multimedia and other extension methods such as demonstration plots and farmer field days) are important in pushing smallholder farmers to achieve knowledge and change their practices towards adopting improved legume technologies for increased productivity, income and general well-being.

2.3 Methodology

The study was conducted in Gairo and Mvomero districts in Morogoro Region, Tanzania from February to March 2017. Morogoro Region lies between latitudes 5^0 58" and 10^0 0" South of the Equator, and longitudes 35^0 25" and 30^0 30" to the East. Its climate is highly influenced by the Indian Ocean. The Nguru, Uluguru and Udzungwa Mountains as well as the Mahenge Hills form part of the Eastern Arc Mountains.

Gairo District constitutes different agro-ecological zones with different climatic conditions. Generally, rainfall varies between 600 mm to 1200 mm and between altitudes of 1100 to 2200 metres above sea level (m.a.s.l). Land is characterised with moderately fertile well drained soil comprising sandy/clay loam soils. Agriculture is the mainstay of the District residents, employing 90% of the households. The main subsistence crops cultivated include maize and beans (URT, 2016a).

Mvomero District's climate varies from semi and warm tropical to cool high altitude. The district is characterised by high rainfall between March and May and from October to December. Annual rainfall is between 600 mm to 2000 mm and highest between the altitudes of 400 to 2000 m.a.s.l. The land is very fertile, about 90.1% of the district's total population are engaged in agriculture and agricultural related occupations for their livelihood (URT, 2016b). The above districts were purposively selected due to the fact that, multimedia approaches such as technological briefs (leaflets and brochures) and other extension approaches such as demonstration plots and field days were used to scale up improved legume technologies in the last cropping season in these particular areas.

2.4 Research Design

The study used a cross-sectional research design whereby data were collected at a single point in time. Two wards that received intervention on improved common bean technologies were purposively selected. The sampling units were households within the area with and without intervention. A structured questionnaire was administered to 400 respondents in this study, about two thirds (66.5%) were from the area of intervention, the rest were from the area with no intervention. Qualitative data was collected using focus group discussions (FGDs) and key informants interviews which were conducted at the ward level.

2.5 Sample Size

In calculating the sample size it was assumed that 50% of smallholder farmers in both control and intervention arms are willing to adopt legume technology. Therefore, a random sample size calculation formula was used to calculate a representative sample size of smallholder farmers (Cochran, 1977).

n = Z2α/2 P (1-P)/ e2, where by: n= sample size; Z2α/2 = is the probability distribution with level of significance α = 5%; "P" = Proportion of smallholder farmers with knowledge or adopted legume technologies; (1-P) = Proportion of smallholder farmers with no knowledge or not adopted legume technologies; "e" = the level of marginal error.

Then calculation of the representative sample of the population of smallholders farmers is estimated considering the proportion of smallholder farmers in both control and intervention arms who have knowledge or adopted legume technologies=50%, a 95% confidence level or ά =0.05 and acceptable margin of error =0.063 with a complex sample design effect=5 and 10% non-response. Then the required sample size is 400.

n = (1.96x1.96x0.5x0.5)/0.0632 = 241.975x1.5 = 362.963/0.9 = 403.292

Table 2.1: **Number of respondents selected**

District	Ward	Village	Intervention	People received intervention	Sample
Mvomero	Kinda	1=Ndole	Farmer field days	82	47
			Farmer field days +Technological briefs	44	30
		2=Makate	No intervention (control village)	00	69
Gairo	Rubeho	1=Ikenge	Farmer field days	215	120
			Farmer field days +Technological briefs	120	68
		2=Rubeho	No intervention (control village)	00	66
			Total	**461**	**400**

2.6 Data Analysis

The primary data collected through the questionnaire was coded and entered into the SPSS software (version 20) for data cleaning and analysis. The Pearson Chi square statistics test was used to compare group differences for categorical variables. Crude and Adjusted odd ratios were used to ascertain strength of association between categorical variables and factors predicting adoption and willingness to pay for improved legume technologies among smallholder farmers. Tables and figures have been used for presentation of the results. Differences or association between variables were considered statistically significant if the p-value was ≤0.05.

The statistical model and the variables that were used are presented below.

The binary logistic regression model was specified as follows:

$$Logit(Pi) = \log(Pi/1 - Pi) = b_0 + b_1x_1 + b_2x_2 + b_1x_1 + \cdots b_kx_k \ldots\ldots\ldots\ldots (1)$$

Logit (Pi) = in odds (event) that is natural log of the odds of an event (use of technologies) occurring

Pi = Prob (event), that is the probability that the event will occur

1-Pi = Prob (no-event), that is the probability that the event will not occur

b_0 = Constant of the equation

b_1-b_k = Coefficient of the independent (predator, response) variables

k = Number of independent variable

x_1 to x_k = Independent variables entered in the model

x_1 = Household size (total number of people in a household)

x_2= Sex of household head (Male 1, 0 female)

x_3 = Age of household head measured in years

x_4 = Marital status of household head (married 1, 0 otherwise)

x_5 = Education level of household head (Primary and above 1, 0 otherwise)

x_6 = Type of intervention (With intervention 1, 0 otherwise)

x_7 = Total income from other income generating activities (IGA)

x_8 = Actual land in hectares cultivated

x_9 = Belonging to farmers association (1 Yes, 0 No)

x_{10} = Access to extension service (1 Yes, 0 No)

x_{11} = Access to credit (Ever received credit 1, 0 otherwise)

2.7 Results and Discussion

2.7.1 Socio-demographic characteristics of respondents

The results in Table 2.2 show that more than three quarters of the households were headed by males. The household head ages ranged from 18 to 79 years. Nevertheless, the majority of household heads were in the age range of 36-60 years (Middle aged household heads) and 18-35 years (Youthful heads), which means the majority of household heads were in the economic active group (URT, 2015). Study results further show that above three quarters of the household heads had attained primary school education. This means the level of literacy in the study areas was high to the extent that, programs intended to create awareness in the particular area can be easily delivered and understood by the smallholder farmers through use of different communication channels/methods. Study results also show that, almost all of household heads depend on agricultural production as their main occupation. The above is supported by Gairo and Mvomero districts socio-economic profiles which show that, agriculture employs over 90% of districts residents (URT, 2016a; URT, 2016b).

Table 2.2: Demographic and socio-economic characteristics and farmers knowledge on Improved Legume Technologies (n=400)

Variable	Category	Overall	Mvomero	Gairo
Household size	1- 6	343(85.8)	125(85.6)	218(85.6)
	>6	57(14.2)	21(14.4)	36(85.8)
Sex	Male	348(87)	123(84.2)	225(88.6)
	Female	52(13)	23(15.8)	29(11.4)
Age	18-35	171(42.8)	49(33.60	122(48)
	36-60	209(52.2)	87(59.6)	122(48)
	>60	20(5)	10(6.8)	10(3.9)
Education level	None	68(17)	20(13.7)	48(18.9)
	Primary education	326(81.5)	120(82.2)	206(81.1)
	Above primary ed	6(1.5)	6(4.1)	0(0)
Marital status	Single	11(2.8)	6(4.1)	5(2)
	Married	334(83.5)	114(78.1)	220(86.6)
	Divorced	26(6.5)	13(8.9)	13(5.1)
	Separated	10(2.5)	6(4.1)	4(1.6)
	Widow/er	19(4.8)	7(4.8)	12(4.7)
Main occupation	Crop production	394(98.5)	143(97.9)	251(98.8)
	Others	6(1.5)	3(2.1)	3(1.2)

NB: - Number in brackets indicate percentage

- Above primary includes secondary education; tertiary (certificate and diploma)
- Others refers to livestock production; salaried employment (government); casual labourer (off farm activities)

2.7.2 Levels of awareness of smallholder farmers on improved legume technologies

Study results (Table 2.3) show that more than three quarters of the respondents were aware of improved common bean technologies. Results also show that more than two thirds of the respondents were aware of new planting methods (time of planting and proper spacing). Table 2.3 further shows that more than a half of the respondents were aware of the type, rate and time of using fertilizers (basal and boosting fertilizers). In addition, the results show that under two thirds of the respondents were aware of the weeding methods (stage, when and number of times to weed).

The results in Table 2.3 also show that more than a half of the respondents were aware of harvesting methods (stage of maturity and proper time to harvest). In addition to the above, results in Table 2.3 show that more than a half of the respondents were aware of the type, rate, time and safe use of chemicals. Lastly, the results show that more than a half of the respondents were aware on post-harvest and storage management technologies. Generally, the results seem to suggest that there has been an impact of the interventions availed through the SILT project which is dealing with improved legume technologies. The above explanation is mainly based on the observation that the levels of respondents' awareness were high suggesting communication channels used were effective. Moreover, awareness was very high in areas with demonstration plots + farmer field days and demonstration plots + farmer field days + technological briefs (leaflets and brochures) while for the areas with no intervention there was low awareness. Further, the study results imply that, most of the smallholder farmers are in good position to raise their legume production and productivity based on the fact that, the level of awareness they have in particular to improved legume technologies is high but only if they will apply or use the same. The results in Table 2.3 conform to those reported by Ariyo *et al.* (2013) that, 90% of smallholder farmers confirmed multimedia methods to be effective in creating awareness of improved agricultural technologies. Based on results in Table 2.3 on the levels of awareness, the study rejects the null hypotheses which states that, "smallholder farmers' knowledge on improved legume technologies does not differ based on awareness creation approaches used".

Table 2.3: Awareness of improved legume technologies among smallholder farmers in the study area (n=313)

Technology	Aware of technology	No intervention	Demo/FFD	Demo/FFD/Tech. Briefs	Chi-squire	P-value
Improved common bean varieties	313(78)	57(43)	158(94)	98(100)	152.291	p<0.001
New planting methods	271(68)	26(19)	150(89)	95(97)	217.227	p<0.001
Type, rate and time of use fertilizers	231(58)	11(8)	132(79)	88(90)	205.887	p<0.001
Weeding method (when and times)	241(60)	13(10)	141(84)	87(89)	215.591	p<0.001
Harvesting method (stage and when)	219(55)	11(8)	124(74)	84(86)	179.719	p<0.001
Type, rate, time & Safe use of chemicals	224(56)	11(8)	126(75)	87(89)	191.549	p<0.001
Post-harvest and Storage management	217(54)	10(8)	125(74)	82(84)	179.867	p<0.001

NB: Number in bracket indicate percentage

2.7.3 Factors associated with awareness of improved legume technologies among smallholder farmers by type of intervention

Study results (Table 2.4 and Appendices 2.1-2.7) show that there was a significant (P=0.000) association between availability of legume technology interventions and levels of awareness of smallholder farmers of improved common bean seeds. Table 2.4 further shows there is a significant (P=0.000) association between availability of legume technology intervention and awareness of planting method (timely planting and proper spacing). Results (Table 2.4) also show a significant association between availability of legume technology intervention (P=0.000), visit by extension officer (P=0.044) and awareness of the type, rate and time to use fertilizer. The above observation is supported by Savaranan (2010) who found that, extension services (integrated and broad based extension), availability of agricultural technology intervention (integration of indigenous

knowledge systems with modern farm technology) and belonging to farmers association are the most determinants of smallholder farmers' awareness.

Study results (Table 2.4) further show that there was a significant (P=0.000) association between availability of legume technology intervention and awareness of weeding methods (when to weed and number of times to weed). Table 2.4 further shows there was a significant association between availability of legume technology intervention (P=0.000), total revenue from income generating activities (IGA) (P=0.012) and awareness of harvesting methods (stage of harvesting and proper time of harvesting). In addition to the above, the study found that there was significant (P=0.000) association between availability of legume technology intervention and awareness of the type, rate, time and safe use of chemicals. Lastly, study results (Table 2.4) show that there was a significant association between availability of legume technology intervention (P=0.000), total revenue from IGA (P=0.000) and awareness of post-harvest and storage management. The study's finding is supported by Khan and Akram (2012) who reported that, field visits, farmer practical know-how gained through demonstration (legume technology interventions) and discussion by extension workers (regular visits by extension officer) determines the level of smallholder farmers' awareness.

Generally, the study findings suggest that there has been an impact of the interventions made through the SILT project promotion of improved legume technologies amongst smallholder farmers. The above explanation is mainly based on the significances observed and high values of Wald statistic (Table 2.4 and Appendices 2.1-2.7) which implies that availability of legume technology intervention, total revenue from IGA and visit by extension officers has a higher contribution to the level of awareness of smallholder farmers pertaining to improved legume technologies.

Table 2.4: Factors associated with awareness of improved legume technologies on smallholders farmers in the study area (n=400)

Factors/determinants	Improved common bean varieties	New planting method	Type, rate and time of use fertilizer	Weeding method	Harvesting method	Type, rate, time & safe use of chemical	Post-harvest and storage management
Household size	-0.065 (0.394)	0.026 (0.066)	0.148 (2.326)	0.056 (0.333)	0.138 (2.387)	0.13 (2.038)	0.15* (2.785)
Sex	0.842 (1.312)	-0.239 (0.091)	-0.569 (0.502)	0.123 (0.025)	-0.709 (0.971)	-0.898 (1.485)	-0.586 (0.649)
Age	-0.016 (1.380)	-0.005 (0.118)	-0.002 (0.012)	0.006 (0.178)	0.003 (0.060)	0.009 (0.494)	-0.010 (0.610)
Marital status	-0.084 (0.018)	0.532 (0.565)	-0.016 (0.000)	-0.218 (0.097)	0.149 (0.054)	0.221 (0.116)	0.221 (0.115)
Education	-0.085 (0.037)	-0.343 (0.574)	-0.252 (0.341)	0.108 (0.066)	0.048 (0.015)	0.064 (0.025)	-0.115 (0.084)
Availability of technology intervention (Yes)	3.63*** (90.281)	3.885*** (141.38)	4.034*** (116.79)	4.01*** (131.58)	3.712*** (104.584)	3.836*** (110.83)	3.759*** (103.024)
Total income from IGA	0.000 (0.037)	0.000 (0.050)	0.000 (1.817)	0.000 (2.207)	0.000** (6.279)	0.000* (3.768)	0.000** (4.764)
Total area cultivated	-0.002 (0.000)	-0.163 (1.626)	0.077 (0.302)	0.007 (0.002)	-0.042 (0.127)	-0.043 (0.129)	-0.085 (0.555)
Being member of farmers association (Yes)	0.931 (2.533)	0.217 (0.145)	-0.039 (0.006)	0.498 (0.751)	0.499 (0.91)	-0.122 (0.060)	0.221 (0.184)
Visit by extension officer (Yes)	1.262 (2.152)	1.373* (3.393)	1.363** (4.075)	0.605 (0.907)	0.487 (0.79)	0.373 (0.443)	0.588 (1.142)
Borrowing money for farming (Yes)	-0.202 (0.288)	-0.206 (0.278)	-0.433 (1.398)	-0.076 (0.041)	-0.341 (0.969)	-0.168 (0.223)	-0.254 (0.535)
Constant	-0.099 (0.014)	-1.089 (1.623)	-2.176** (6.543)	-2.041** (5.737)	-2.188*** (7.389)	-2.41*** (8.647)	-1.853** (5.362)
-2 Log likelihood	258.126	272.478	308.733	299.024	340.245	330.487	340.87
Cox& Snell R^2	0.331	0.438	0.446	0.449	0.409	0.421	0.41
Nagelkerke R^2	0.510	0.612	0.599	0.608	0.548	0.563	0.547
Chi-square	7.045	11.054	8.699	9.337	13.39	5.887	4.255
P-value	0.532	0.199	0.368	0.315	0.099	0.66	0.833

NB: Number outside the bracket refers to B values while number in bracket indicate Wald statistics

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

The specific logistic regression model results are presented as Appendices 2.1-2.7

2.7.4 Usefulness of the source of information for improved legume technologies

The study results (Fig. 2.1) show that, about three quarters of respondents perceived farmer field days and demonstration plots to be useful in disseminating improved legume technologies. The study results conform to those reported by Woomer *et al.* (2014) that, field days in the rural settings are the useful platform in disseminating improved legume technologies. The study results further show that, about a quarter of the respondents interviewed said district council extension officers are useful in disseminating improved legume technologies. According to Ango *et al.* (2013), 24.4% of the farmers obtained agricultural information through the extension workers, 14.4% obtained agricultural information through market agents while 8.9% obtained agricultural information through their neighbours. Further, results (Fig. 2.1) show that, below a quarter of respondents interviewed said reading technological briefs is useful in disseminating improved legume technologies.

Generally, sources of information were ranked and farmer field days were found to be the first, followed by demonstration plots. Others are District Council Extension Officer, reading technological briefs, neighbours and relatives. The last was Radio (SUA FM). It was also pointed out in the FGDs that farmer field days and demonstration plots are the two most important and useful methods of technology dissemination.

The quote below emphasises the above:

> *"...despite the bad weather (drought) which occurred in the last cropping season (2015/2016), common beans planted in the demonstration plot continued to be good, the seeds were of high quality and we saw the required spacing practically and the yields were high. Generally, it was encouraging"* (FGD participant, Ikenge village, Gairo, 18th March, 2017).

The above views are supported by the feedback from the project implementers, African Fertilizer Agrobusiness Partnership (AFAP) who said that farmer field days take less time to deliver information, demonstration plots lessons are easily understood and the Centre for Agricultural Biosciences International (CABI) who said that technological briefs are less expensive and take less time to prepare. Similarly, the results from key informants (District Council Extension Officers) who said farmer field days and demonstration plots take less time to deliver information and lessons are easily understood, also many people are taught at a time through technological briefs. Moreover, a study by Khan and Akram (2012) ranked extension methods used in disseminating agricultural technologies according to the order of importance/effectiveness (the top three) as farm/home visit, farmer field days and demonstration plots. Generally, results of the study imply that farmer field days + demonstration plots + technological briefs if combined with district council extension officers could be effective in disseminating improved legume technologies.

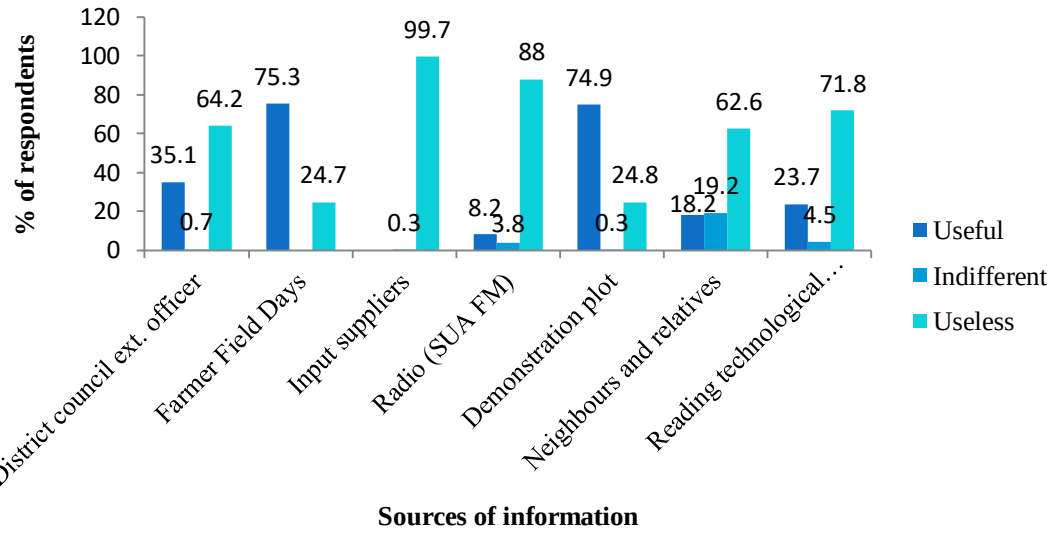

Figure 2.1: Usefulness of the sources of information of improved legume technologies

2.7.5 Farmers use of improved legume technologies

The study results (Table 2.5) show that only a few farmers were using improved legume technologies. Generally, it was revealed that improved legume technologies mostly used were weeding methods (proper time and number of weedings) (7.5%) and new planting methods (proper spacing and timely planting) (6.2%). Though the figure seems to be low of the respondents using the technologies, but this can be because the intervention was in its initial stage of implementation. Therefore, the figure may increase with time of knowledge diffusion. According to Ngwira *et al*. (2012), adoption/practices of the best legume technologies requires well established innovation platform with multiple stakeholder involvement, sufficient supply of high quality legume seeds together with farmer training or access to extension services, otherwise adoption or actual use of the technology is likely to remain low. Based on the results in Table 2.5 on the use of new planting methods (proper spacing and timely planting) and proper post-harvest and storage management, the study rejects the null hypothesis which states that, "smallholder farmers' knowledge on improved legume technology does not differ significantly between the area with and without intervention".

Table 2.5: Smallholder farmers' use of improved legume technologies (n=18)

Technology	Total practicing	without intervention	With demo/FFD	With demo/FFD/Tech. Briefs	Chi-squire	P-value
Improved common bean varieties	11(3.5)	2(3.5)	5(3.2)	4(4.1)	0.150	0.928
New planting methods	17(6.2)	2(7.7)	2(1.3)	13(13.7)	15.305	0.000
Type, rate and time of use fertilizers	7(3)	1(8.3)	4(3)	2(2.3)	1.326	0.515
Weeding method (when and times)	18(7.5)	2(15.4)	9(6.4)	7(8)	1.461	0.482
Harvesting method (stage and when)	9(4.1)	1(8.3)	3(2.4)	5(6)	2.175	0.337
Type, rate, time & safe use of chemicals	7(3.1)	0(0)	4(3.2)	3(3.4)	0.42	0.811
Post-harvest and storage management	8(3.7)	0(0)	2(1.6)	6(7.3)	5.020	0.081

NB: Numbers in bracket indicates percentages

2.7.6 Factors associated with smallholder farmers' adoption of improved legume technologies by type of intervention

Study results (Table 2.6 and Appendices 2.8-2.14) show that there was a significant (P=0.032) association between visits by extension officer and smallholder farmers use of improved common bean seeds. Similarly, the results show there was a significant association between visit by extension officer (P=0.001), age of household head (P=0.021) and smallholder farmers' proper use of planting method (timely planting and proper spacing). Study results further show existence of a significant association between visits by extension officers (P=0.011) and farmers' proper use of the type, rate and time to use

fertilizer. The results above conform to those of FAO (2015) and Pan *et al.* (2015) that, access or visits by extension services influences the use of improved crop technologies or modern inputs. The results in Table 2.6 further show that there was a significant (P=0.033) association between being a member to a farmer's association, revenue from IGA (p=0.034) and smallholder farmers' use of proper harvesting methods (stage of harvesting and proper time of harvesting). In addition to the above, the study results (Table 2.6) show that there was a significant association between age of household head (P=0.007), household size (P=0.031) and proper use of post-harvest and storage management. The results in Table 2.5 conform to those reported by Ainembabazi *et al.* (2017) that, smallholder farmers' membership to associations and extension services provided significantly influence smallholder farmers' use of improved legume technologies. The study's observation conforms with Uaiene *et al.* (2009), Abate *et al.* (2011) and Katengeza *et al.* (2015) who have reported that farmers' membership to associations has an impact on their use of improved technologies. The results in Table 2.5 further conform to those reported by Kasirye (2013) that, low education and land holding or small area cultivated does not influence smallholder farmers' use of improved agricultural technologies (especially improved seeds and fertilizers).

Table 2.6: Factors associated with smallholders farmers' practices of improved legume technologies by type of intervention

Factor/determinants	Improved common bean varieties	New planting methods	Type, rate and time of use fertilizers	Weeding method (when and times)	Harvesting method (stage and when)	Type, rate, time & safe use of chemicals	Post-harvest and storage management
Household size	0.085 (0.205)	-0.356* (0.208)	-0.052 (0.029)	-0.203 (0.182)	-0.487* (2.850)	-0.522 (2.348)	-0.756** (4.660)
Sex of household head	0.957 (1.389)	-1.868 (2.033)	-	0.797 (1.538)	-1.845 (0.578)	-1.22 (0.313)	-2.542 (1.057)
Age of household head	-0.027 (0.035)	0.060** (0.026)	0.027 (0.457)	0.012 (0.025)	0.033 (0.995)	-0.004* (0.01)	0.110*** (7.314)
Marital status	-0.925 (1.094)	2.110 (2.056)	-	0.074 (1.236)	1.232 (0.247)	1.933 (0.739)	1.095 (0.193)
Education	0.542 (1.093)	1.690 (1.171)	-	1.122 (1.088)	-	-	1.992 (1.882)
Availability of technology intervention (Yes)	-0.093 (0.816)	0.451 (0.937)	0.280 (0.026)	-0.528 (0.886)	-0.07 (0.003)	-	-
Total income from IGA	-0.000 (0.000)	0.000 (0.000)	0.000* (3.227)	0.000 (0.000)	0** (4.477)	0.000** (4.940)	0.000 (1.848)
Total area cultivated	0.199 (0.190)	0.091 (0.205)	0.248 (0.392)	-0.052 (0.219)	0.141 (0.244)	-0.335 (0.478)	-0.765 (0.715)
Being member farmers association	-0.307 (1.102)	0.804 (0.822)	0.784 (0.418)	0.434 (0.724)	1.926** (4.528)	-	-
Visit by extension officer (Yes)	1.680** (0.784)	1.955*** (0.609)	2.413** (6.525)	1.241* (0.646)	0.299 (0.086)	-	-
Borrowing money for farming (Yes)	0.330 (0.730)	0.005 (0.657)	-0.923 (0.543)	0.383 (0.585)	-0.045 (0.002)	-	-0.104* (0.011)
Constant	-3.366 (2.660)	-6.663*** (9.778)	-6.397** (6.131)	-3.733* (3.703)	-3.097 (2.104)	-2.094 (1.549)	-5.304** (4.288)
-2 Log likelihood	88.753	102.903	46.948	117.009	61.310	54.234	50.250
Number of observations	313	272	232	241	220	225	218
Cox& Snell R^2	0.021	0.085	0.066	0.045	0.061	0.035	0.081
Nagelkerke R^2	0.079	0.229	0.278	0.108	0.211	0.147	0.299
Chi-square	6.969	4.011	5.698	8.562	25.804	10.405	8.133
P-value	0.54	0.856	0.681	0.381	0.001	0.238	0.421

NB: Number outside the bracket refers to B values while number in bracket indicate Wald statistics

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

The '-'are omitted because of collinearity.

The specific logistic regression model results are presented as Appendices 2.8-2.14

2.7.7 Constraints faced by smallholder farmers in accessing inputs for their legume production

Study results show that smallholder farmers in the study area face a number of constraints in accessing legume inputs. On average the mostly reported constraints were lack of knowledge on how to use the inputs (62%) followed by lack of capital/expensiveness of inputs (30%). The study results in Table 2.7 conform to those of Akudugu *et al.* (2012) that, high costs associated on accessing modern agricultural technologies constrains farmers on the use of particular technology. In addition, during the FGDs participants pointed out that access to improved technologies in particular seeds was difficult due to the associated high costs. It was also pointed out in other FGDs that improved seeds were not available and there were no seed dealers nearby their villages, hence their dependence on local seeds. The quote below emphasises the above:

> *"Local seeds are very cheap hence most farmers rely on these. Moreover, nowadays farming is like gambling you may incur huge costs and end up harvesting nothing like what happened in the last cropping season (2015/2016) to most of us because of unreliable rains"* (FGD participant, Ndole village, Mvomero, 20th March, 2017).

Table 2.7: Constraints facing farmers in accessing inputs for improved common bean production (n=400)

Constraints	Basal fertilizer (DAP)	Top dress Fertilizer (UREA)	Certified Seed	Herbicide	Fungicide	Pesticide	Animal Manure
Too far from household	14(5.5)	16(4)	30(7.5)	5(1.3)	6(1.5)	14(3.5)	88(22)
Unsuitable packaging (large)	1(0.3)	1(0.3)	1(0.3)	1(0.3)	2(0.5)	1(0.3)	2(0.5)
No knowledge of how to use	248(62)	248 (62)	202 (50.5)	291(72.8)	297(74.3)	291(72.8)	214 (53.5)
No transport	1(0.3)	1(0.3)	2(0.5)	1(0.3)	1(0.3)	1(0.3)	18 (4.5)
Lack of capital/expensive	131 (32.8)	128(32)	161 (40.3)	102(25.5)	81(20.3)	81(20.3)	78 (19.5)
Lack of market information	0(0)	0(0)	4(1)	0(0)	0(0)	0(0)	0(0)
Soil fertility	5(1.3)	6(1.5)	0(0)	0(0)	0(0)	0(0)	0(0)
No diseases/ pests	0(0)	0(0)	0(0)	0(0)	13(3.3)	12(3)	0(0)

NB: Number in bracket is percentages

2.8 Conclusions and Recommendations

2.8.1 Conclusions

The manuscript has assessed the effectiveness of communication channels on knowledge and adoption of improved common bean technologies among smallholder farmers in Gairo and Mvomero districts, Morogoro Region. Based on the findings it can be concluded that people in the study area are generally aware of all the improved legume technologies assessed. Nevertheless, the level of awareness was high in areas with the intervention and low in the area with no intervention. It is also concluded that, sources of information as ranked based on usefulness shows that the most effective/useful chronologically were farmer field days, demonstration plots, village council extension officer, technological briefs and neighbours and relatives. It is further concluded that smallholder farmers' knowledge level in terms of using improved legume technologies is low in both the areas

with and without intervention. This is because, despite availability of the interventions, smallholder farmers' still lack knowledge on how to use improved legume technologies properly. In addition, costs associated with access to improved common bean seeds, fertilizers and chemicals are high to the extent of limiting the farmers' use of the same.

2.8.2 Recommendations

Based on the study findings and conclusions the following are recommended:

i. The government and non-governmental organisations should invest more on awareness creation approaches in order to make sure that all smallholder farmers are sensitised on the improved legume technologies.

ii. The government and non-governmental organisations should insist more on farmers group (association) formation because, farmer associations can enhance awareness creation with regard to improved legume technologies and easy access to improved common bean seeds, fertilizers and chemicals.

iii. Lastly, the study recommends that in order for the intervention to have a great impact, the government needs to create a conducive environment that will allow smallholder farmers to access cheap quality improved common bean seeds, fertilizers and chemicals.

2.9 References

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2.10 Appendices

Appendix 2.1: Factors associated with awareness of improved common bean seeds

Factor/determinants	B	Std. Err.	Wald	Df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-.065	.103	.394	1	.530	.937	.766	1.147
Sex	.842	.735	1.312	1	.252	2.321	.550	9.803
Age	-.016	.014	1.380	1	.240	.984	.957	1.011
Marital status	-.084	.628	.018	1	.894	.920	.268	3.149
Education	-.085	.440	.037	1	.848	.919	.388	2.178
Availability of technology intervention (Yes)	3.630	.382	90.281	1	.000	37.728	17.842	79.781
Total income from IGA	.000	.000	.037	1	.848	1.000	1.000	1.000
Total area cultivated	-.002	.182	.000	1	.992	.998	.698	1.427
Being member of farmers association (Yes)	.931	.585	2.533	1	.112	2.537	.806	7.986
Visit by extension officer (Yes)	1.262	.860	2.152	1	.142	3.533	.654	19.075
Borrowing money for farming (Yes)	-.202	.376	.288	1	.592	.817	.391	1.707
Constant	-.099	.831	.014	1	.906	.906		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.2: Factors associated with awareness of planting method (timely planting and proper spacing)

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.026	.103	.066	1	.797	1.027	.839	1.257
Sex	-.239	.794	.091	1	.763	.787	.166	3.734
Age	-.005	.014	.118	1	.731	.995	.967	1.024
Marital status	.532	.708	.565	1	.452	1.703	.425	6.827
Education	-.343	.453	.574	1	.449	.710	.292	1.724
Availability of technology intervention (Yes)	3.885	.327	141.379	1	.000	48.648	25.643	92.289
Total income from IGA	.000	.000	.050	1	.823	1.000	1.000	1.000
Total area cultivated	-.163	.128	1.626	1	.202	.850	.661	1.091
Being member of farmers association (Yes)	.217	.570	.145	1	.703	1.243	.407	3.796
Visit by extension officer (Yes)	1.373	.746	3.393	1	.065	3.949	.916	17.029
Borrowing money for farming (Yes)	-.206	.391	.278	1	.598	.814	.378	1.751
Constant	-1.089	.855	1.623	1	.203	.337		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.3: Factors associated with awareness of the type, rate and time to apply fertilizer

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.148	.097	2.326	1	.127	1.159	.959	1.401
Sex	-.569	.803	.502	1	.478	.566	.117	2.730
Age	-.002	.014	.012	1	.914	.998	.972	1.026
Marital status	-.016	.719	.000	1	.983	.984	.241	4.028
Education	-.252	.432	.341	1	.559	.777	.333	1.812
Availability of technology intervention (Yes)	4.034	.373	116.789	1	.000	56.473	27.172	117.371
Total income from IGA	.000	.000	1.817	1	.178	1.000	1.000	1.000
Total area cultivated	.077	.139	.302	1	.582	1.080	.822	1.418
Being member of farmers association (Yes)	-.039	.515	.006	1	.939	.961	.351	2.636
Visit by extension officer (Yes)	1.363	.675	4.075	1	.044	3.909	1.040	14.685
Borrowing money for farming (Yes)	-.433	.366	1.398	1	.237	.649	.316	1.329
Constant	-2.176	.851	6.543	1	.011	.113		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.4: Factors associated with awareness of weeding methods (when to weed and number of times of weeding)

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.056	.096	.333	1	.564	1.057	.875	1.277
Sex	.123	.777	.025	1	.874	1.131	.246	5.190
Age	-.006	.014	.178	1	.673	.994	.967	1.022
Marital status	-.218	.700	.097	1	.755	.804	.204	3.170
Education	.108	.421	.066	1	.798	1.114	.488	2.542
Availability of technology intervention (Yes)	4.012	.350	131.575	1	.000	55.251	27.838	109.661
Total income from IGA	.000	.000	2.207	1	.137	1.000	1.000	1.000
Total area cultivated	.007	.139	.002	1	.960	1.007	.766	1.323
Being member of farmers association (Yes)	.498	.575	.751	1	.386	1.646	.533	5.083
Visit by extension officer (Yes)	.605	.635	.907	1	.341	1.831	.527	6.360
Borrowing money for farming (Yes)	-.076	.379	.041	1	.840	.926	.440	1.949
Constant	-2.041	.852	5.737	1	.017	.130		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.5: Factors associated with awareness of harvesting methods (stage of harvesting and proper time of harvesting)

Factor/determinants	B	Std. Err.	Wald	Df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.138	.089	2.387	1	.122	1.148	.964	1.367
Sex	-.709	.720	.971	1	.324	.492	.120	2.017
Age	.003	.013	.060	1	.807	1.003	.978	1.029
Marital status	.149	.641	.054	1	.816	1.160	.331	4.074
Education	.048	.392	.015	1	.903	1.049	.486	2.262
Availability of technology intervention (Yes)	3.712	.363	104.584	1	.000	40.954	20.105	83.425
Total income from IGA	.000	.000	6.279	1	.012	1.000	1.000	1.000
Total area cultivated	-.042	.117	.127	1	.721	.959	.762	1.207
Being member of farmers association (Yes)	.499	.523	.910	1	.340	1.647	.591	4.589
Visit by extension officer (Yes)	.487	.547	.790	1	.374	1.627	.556	4.757
Borrowing money for farming (Yes)	-.341	.347	.969	1	.325	.711	.360	1.402
Constant	-2.188	.805	7.389	1	.007	.112		

Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.6: Factors associated with awareness of the type, rate, time and safe use of chemicals

Factor/determinants	B	Std. Err.	Wald	Df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.130	.091	2.038	1	.153	1.139	.953	1.363
Sex	-.898	.737	1.485	1	.223	.407	.096	1.727
Age	.009	.013	.494	1	.482	1.009	.983	1.036
Marital status	.221	.648	.116	1	.733	1.247	.350	4.441
Education	.064	.404	.025	1	.874	1.066	.483	2.355
Availability of technology intervention (Yes)	3.836	.364	110.829	1	.000	46.326	22.682	94.614
Total income from IGA	.000	.000	3.768	1	.052	1.000	1.000	1.000
Total area cultivated	-.043	.120	.129	1	.720	.958	.756	1.212
Being member of farmers association (Yes)	-.122	.498	.060	1	.807	.885	.334	2.350
Visit by extension officer (Yes)	.373	.560	.443	1	.506	1.452	.485	4.349
Borrowing money for farming (Yes)	-.168	.357	.223	1	.637	.845	.420	1.700
Constant	-2.411	.820	8.647	1	.003	.090		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.7: Factors associated with awareness of post-harvest and storage management

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.150	.090	2.785	1	.095	1.162	.974	1.385
Sex	-.586	.728	.649	1	.421	.556	.134	2.317
Age	-.010	.013	.610	1	.435	.990	.965	1.015
Marital status	.221	.651	.115	1	.734	1.247	.348	4.466
Education	-.115	.395	.084	1	.772	.892	.411	1.934
Availability of technology intervention (Yes)	3.759	.370	103.024	1	.000	42.913	20.765	88.682
Total income from IGA	.000	.000	4.764	1	.029	1.000	1.000	1.000
Total area cultivated	-.085	.114	.555	1	.456	.919	.735	1.148
Being member of farmers association (Yes)	.221	.516	.184	1	.668	1.248	.454	3.428
Visit by extension officer (Yes)	.588	.550	1.142	1	.285	1.800	.612	5.293
Borrowing money for farming (Yes)	-.254	.347	.535	1	.465	.776	.393	1.532
Constant	-1.853	.800	5.362	1	.021	.157		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.8: Factors associated with uses of improved common bean seeds

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.085	.205	.171	1	.679	1.089	.728	1.627
Sex	.957	1.389	.475	1	.491	2.604	.171	39.648
Age	-.027	.035	.599	1	.439	.974	.910	1.042
Marital status	-.925	1.094	.715	1	.398	.396	.046	3.385
Education	.542	1.093	.246	1	.620	1.720	.202	14.659
Availability of technology intervention (Yes)	-.093	.816	.013	1	.910	.911	.184	4.516
Total income from IGA	.000	.000	.485	1	.486	1.000	1.000	1.000
Total area cultivated	.199	.190	1.092	1	.296	1.220	.840	1.771
Being member of farmers association (Yes)	-.307	1.102	.078	1	.780	.736	.085	6.376
Visit by extension officer (Yes)	1.680	.784	4.598	1	.032	5.367	1.155	24.930
Borrowing money for farming (Yes)	.330	.730	.205	1	.651	1.392	.333	5.822
Constant	-3.366	2.064	2.660	1	.103	.035		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.9: Factors associated with planting method (timely planting and proper spacing)

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-.356	.208	2.926	1	.087	.701	.466	1.053
Sex	-1.868	2.033	.844	1	.358	.154	.003	8.300
Age	.060	.026	5.294	1	.021	1.062	1.009	1.118
Marital status	2.110	2.056	1.053	1	.305	8.244	.147	463.767
Education	1.690	1.171	2.084	1	.149	5.419	.546	53.749
Availability of technology intervention (Yes)	.451	.937	.231	1	.631	1.569	.250	9.850
Total income from IGA	.000	.000	1.015	1	.314	1.000	1.000	1.000
Total area cultivated	.091	.205	.196	1	.658	1.095	.732	1.638
Being member of farmers association (Yes)	.804	.822	.958	1	.328	2.235	.447	11.191
Visit by extension officer (Yes)	1.955	.609	10.303	1	.001	7.064	2.141	23.306
Borrowing money for farming (Yes)	.005	.657	.000	1	.993	1.005	.278	3.641
Constant	-6.663	2.131	9.778	1	.002	.001		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.10: Factors associated with use of proper type, rate and time to apply fertilizer

Factor/determinants	B	Std. Err.	Wald	Df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-0.052	0.302	0.029	1	0.865	0.95	0.525	1.718
Age	0.027	0.04	0.457	1	0.499	1.028	0.95	1.112
Marital status	0.28	1.74	0.026	1	0.872	1.323	0.044	40.073
Total income from IGA	0	0	3.227	1	0.072	1	1	1
Total area cultivated	0.248	0.257	0.932	1	0.334	1.282	0.774	2.123
Being member of farmers association (Yes)	0.784	1.213	0.418	1	0.518	2.191	0.203	23.633
Visit by extension officer (Yes)	2.413	0.945	6.525	1	0.011	11.168	1.754	71.131
Borrowing money for farming (Yes)	-0.923	1.252	0.543	1	0.461	0.397	0.034	4.626
Constant	-6.397	2.584	6.131	1	0.013	0.002		

a Variable(s) entered on step 1: V1_QNB1, V3_QNB2IC, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.11: Factors associated with weeding methods (when to weed and number of times to weed)

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-.203	.182	1.248	1	.264	.816	.571	1.166
Sex	.797	1.538	.269	1	.604	2.219	.109	45.201
Age	.012	.025	.218	1	.640	1.012	.963	1.063
Marital status	.074	1.236	.004	1	.952	1.077	.096	12.139
Education	1.122	1.088	1.063	1	.303	3.070	.364	25.904
Availability of technology intervention (Yes)	-.528	.886	.355	1	.551	.590	.104	3.347
Total income from IGA	.000	.000	.104	1	.747	1.000	1.000	1.000
Total area cultivated	-.052	.219	.057	1	.812	.949	.618	1.457
Being member of farmers association (Yes)	.434	.724	.359	1	.549	1.543	.373	6.372
Visit by extension officer (Yes)	1.241	.644	3.715	1	.054	3.458	.979	12.210
Borrowing money for farming (Yes)	.383	.585	.429	1	.513	1.467	.466	4.621
Constant	-3.733	1.940	3.703	1	.054	.024		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.12: Factors associated with harvesting methods (stage of harvesting and proper time of harvesting)

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-0.487	0.288	2.850	1	0.091	0.615	0.349	1.081
Sex	-1.845	2.428	0.578	1	0.447	0.158	0.001	18.407
Age	0.033	0.033	0.995	1	0.319	1.033	0.969	1.102
Marital status	1.232	2.481	0.247	1	0.620	3.428	0.026	443.431
Availability of technology intervention (Yes)	-0.070	1.398	0.003	1	0.960	0.932	0.060	14.440
Total income from IGA	0.000	0.000	4.477	1	0.034	1.000	1.000	1.000
Total area cultivated	0.141	0.285	0.244	1	0.622	1.151	0.658	2.012
Being member of farmers association (Yes)	1.926	0.905	4.528	1	0.033	6.865	1.164	40.478
Visit by extension officer (Yes)	0.299	1.020	0.086	1	0.769	1.349	0.183	9.958
Borrowing money for farming (Yes)	-0.045	0.928	0.002	1	0.962	0.956	0.155	5.893
Constant	-3.097	2.135	2.104	1	0.147	0.045		

a Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 2.13: Factors associated with use of the type, rate, time and safe use of chemicals

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-0.522	0.340	2.348	1	0.125	0.594	0.305	1.157
Sex	-1.220	2.180	0.313	1	0.576	0.295	0.004	21.190
Age	-0.004	0.039	0.010	1	0.922	0.996	0.923	1.076
Marital status	1.933	2.248	0.739	1	0.390	6.907	0.084	565.961
Total income from IGA	0.000	0.000	4.940	1	0.026	1.000	1.000	1.000
Total area cultivated	-0.335	0.484	0.478	1	0.489	0.716	0.277	1.848
Constant	-2.094	1.683	1.549	1	0.213	0.123		

a Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V7_TOTALINCOME, V8_TOTAREACULT.

Appendix 2.14: Factors associated with post-harvest and storage management

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-0.756	0.350	4.660	1	0.031	0.470	0.237	0.933
Sex	-2.542	2.472	1.057	1	0.304	0.079	0.001	10.003
Age	0.110	0.041	7.314	1	0.007	1.117	1.031	1.210
Marital status	1.095	2.494	0.193	1	0.661	2.989	0.023	396.496
Education	1.992	1.452	1.882	1	0.170	7.327	0.426	126.057
Total income from IGA	0.000	0.000	1.848	1	0.174	1.000	1.000	1.000
Total area cultivated	-0.765	0.905	0.715	1	0.398	0.465	0.079	2.741
Borrowing money for farming (Yes)	-0.104	0.975	0.011	1	0.915	0.902	0.133	6.095
Constant	-5.304	2.562	4.288	1	0.038	0.005		

a Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V7_TOTALINCOME, V8_TOTAREACULT, V11_L01.

CHAPTER THREE

3.0 Determinants of Smallholder Farmers' Adoption and Willingness to Pay for Improved Legume Technologies in Tanzania

Charles Byalugaba Lugamara[1*], Justin K. Urassa[2] and Paul Martin Dontsop Nguezet[3]

[1]Department of Development Studies, Sokoine University of Agriculture (SUA), P.O. Box 3024, Morogoro, Tanzania. E-mail: charleslugamara@gmail.com

[2]Department of Policy, Planning and Management, Sokoine University of Agriculture (SUA), P.O. Box 3035, Morogoro, Tanzania.
E-mail: jksurassa@yahoo.co.uk or urassa@suanet.ac.tz

[3]International Institute of Tropical Agriculture (IITA), Birava Road, Bukavu, DR Congo.
E-mail: P.Dontsop@cgiar.org

[*]Corresponding author: charleslugamara@gmail.com

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3.1 Abstract

Globally food legumes play an important and diverse role in the farming systems and in the diets of poor people. Legumes help to reduce poverty, improve human health and nutrition, and enhance ecosystem resilience. However, limited information is in place on smallholder farmers' adoption and willingness to pay for improved legume technologies in poor resource countries such as Tanzania. The study on which the manuscript is based aimed at assessing the determinants of smallholder farmers' adoption and willingness to pay for improved legume technologies. The study adopted a cross-sectional research design whereby data were collected once from Gairo and Mvomero Districts, Tanzania. The districts were purposively selected due to the number of multimedia approaches that had been used to raise farmers' awareness and knowledge on increased legume productivity. A total of 400 respondents participated in the study, a third were from the non-intervention area. Primary data were collected through a questionnaire, key informant interviews and focus group discussions. Data was analysed using SPSS whereby descriptive and inferential statistics were determined. Generally, 23.8% of the farmers adopted improved common bean seeds. Factors significantly associated with adoption of improved common bean seeds were availability of legume technology intervention (P=0.000), total area cultivated (P=0.000), revenue from other income generating activities (P=0.005), household size (P=0.022), borrowing money for farming (P=0.024). In addition, farmers' willingness to pay for improved legume technologies differed across the six technologies assessed. On overall, more than half of the farmers were willing and ready to pay for at least one or more of the technologies. It can generally be concluded that the surveyed farmers had moderate uptake for improved bean technologies which farmers' pinned to prevailing high input prices. Therefore, to improve farmers willingness and adoption of improved legume technologies there is need for a reduction of their prices or provision of subsidies.

Key words: Smallholder farmers, willingness to adopt/pay, Improved legume technologies

3.2 Background Information

Legume crops play important roles economically, socially and environmentally by providing jobs, providing the cheap protein consumed mostly at the household level, improving health and nutrition and improving soil fertility through ground cover, weed suppression and nitrogen fixation (Akibode, 2011; Sanginga and Bergvinson, 2015). Generally, legumes are important for human and livestock nutrition, soil fertility improvement and foreign currency earning through export. According to URT (2001) there are different initiatives which have been made in Tanzania to scale up crop productivity (legumes included) under the Agricultural Sector Development Strategy I. The initiatives include financing agriculture and promoting research activities, improving extension services provided to smallholder farmers, training for updating skills and knowledge of farmers; improving agricultural mechanization and improving agricultural information systems. Despite the efforts made to increase food productivity, the rate of legume production is low (below a ton per hectare) (Malema, 2006; URT, 2012). In addition, the cost to obtain such crops for food is high (ProFound and Mugenyi, 2012). Generally, poor productivity may be due to poor adoption of technologies or unwillingness of the farmers to pay for improved legume technologies.

In 2015/2016, Scale up Improved Legume Technologies (SILT) project through Sustainable use of Input Supply and Information Systems as supported by the International Development Research Centre (IDRC) and the Canadian International Food Security Research Fund (CIFSRF) used multi-media approaches to scale up use of improved legume technologies (MLE, 2016). The approaches included technological briefs (leaflets and brochures) and other extension approaches including demonstration plots and farmer field days. However, adoption and willingness of smallholder farmers' to pay for improved legume technologies is yet to be clearly determined or understood.

Adoption refers to a series of change that takes place within an individual with regard to the technology. These changes start from the beginning when an individual becomes aware of that technology to the final decision to use it or not (Van de Ban and Hawkins, 1996 cited in Masha, 2011). Willingness to change and aspiration to try new technologies or ideas are the main cause of innovative behaviour. Generally, the adoption process has five stages; (a) Awareness stage, whereby the farmer or potential innovator hears about the technology for the first time (b) Interest building stage in which the farmer seeks more information about the technology (c) Evaluation stage in which the farmer weighs the advantage and disadvantage of using the technology (d) Trial stage in which the farmer tests the technology on a small scale to avoid risk associated with using the technology (e) Adoption stage in which the farmer applies the technology on a large scale in preference to the old technologies (Sahin, 2006).

According to literature (Achour, 1990; Akudugu *et al.*, 2012; Mwangi and Kairuki, 2015) adoption of technologies is influenced by many factors. These include demographic (education level, gender, experience, age, religion, and marital status), institutional (extension services, input and output marketing system, credit facilities, land tenure system, information and communication infrastructure), environmental (land quality and soil type) and farmers' subjective perception of the new technology.

In measuring willingness to pay this study adopted the concept of contingent valuation, a method of estimating the value that a human being commits on accessing or achieving certain products/commodities. The method gives one room to specify/report his/her willingness to pay (WTP) to acquire/get certain goods of certain quality (Lusk, 2003). This means the technologies with high access cost are most likely to be less accepted and vice versa. In addition, the input supply policy if not in favour of subsidizing the technologies

or creating good environment for input users to allow affordability then the level of adoption and willingness to pay might be questionable.

3.3 Methodology

The study was conducted in Gairo and Mvomero districts in Morogoro Region, Tanzania between February and March 2017. The districts were purposively selected due to the fact that, multimedia approaches such as technological briefs (leaflets and brochures) and other extension approaches such as demonstration plots and farmer field days had been used in the study areas in the last cropping season 2015/2016.

3.4 Research Design

The study used a cross-sectional research design. The design allows data to be collected at a single point in time without repetition from the target population. The research design was preferred because it allows determination of relationships between variables, helps to save time and a very big sample can be used (Kothari, 2004). Two wards that received intervention on improved common bean technologies were purposively selected. The sampling unit was the household within the area with and without intervention (multi-media approach intervention). A pre-structured questionnaire was administered to 400 respondents whereby about two thirds (66.5%) were from the area of intervention, the rest were from the area with no intervention. Qualitative data were collected using focus group discussions (FGDs) and key informants interviews which were conducted at the ward level.

3.5 Sample Size

In calculating the sample size it was assumed that 50% of smallholder farmers in both control and intervention areas are willing to adopt/pay legume technology. A random

sample size calculation formula by Cochran (1977) was used to calculate a representative sample size of smallholder farmers whereby; n = Z2α/2 P (1-P)/ e2. NB: n = sample size; Z2α/2 = is the probability distribution with level of significant α = 5%; "P" = Proportion of smallholder farmers willing to adopt/pay of legume technologies; (1-P) = proportion of smallholder farmers not willing to adopt/pay for legume technologies; "e" = the level of marginal error.

Then calculation of the representative sample of the population of smallholders farmers was estimated considering the proportion of smallholder farmers in both control and intervention arms who are willing to adopt/pay for legume technologies = 50%, a 95% confidence level or ά = 0.05 and acceptable margin of error = 0.063 with a complex sample design effect = 5 and 10% non-response. Then the required sample size is 400.

n = (1.96x1.96x0.5x0.5)/0.0632 = 241.975x1.5 = 362.963/0.9 = 403.292

Table 3.1: Number of respondents selected

District	Ward	Village	Intervention	People received intervention	Sample
Mvomero	Kinda	Ndole	Farmer field days	82	47
			Farmer field days +Technological briefs	44	30
		Makate	No intervention (control village)	00	69
Gairo	Rubeho	Ikenge	Farmer field days	215	120
			Farmer field days +Technological briefs	120	68
		Rubeho	No intervention (control village)	00	66
			Total	**461**	**400**

3.6 Data Analysis

The primary data collected through the questionnaire was coded and entered into SPSS software (version 20) for cross-checking, data cleaning and analysis. Pearson Chi square statistics test was used to compare group differences for categorical variables. Crude and

adjusted odd ratios were used to ascertain strength of association between categorical variables and factors predicting adoption and willingness to pay for improved legume technologies among smallholder farmers. Tables and Figures have been used to present the results. Differences or association between variables were considered statistically significant if p-value was ≤0.05.

The statistical model and the variables that were used are presented below.

The binary logistic regression model was specified as follows:

$$Logit(Pi) = \log(Pi/1 - Pi) = b_0 + b_1x_1 + b_2x_2 + b_1x_1 + \cdots b_kx_k \ldots\ldots\ldots\ldots (1)$$

Logit (Pi) = in odds (event) that is natural log of the odds of an event (adoption or willingness to pay) occurring

Pi = Prob (event), that is the probability that the event will occur

1-Pi = Prob (no-event), that is the probability that the event will not occur

b_0 = Equation's constant

b_1-b_k = Coefficient of the independent (predator, response) variables

k = Number of independent variable

x_1 to x_k = Independent variables entered in the model

x_1 = Household size (total number of people in a household)

x_2 = Sex of the household head (Male 1, 0 female)

x_3 = Age of the household head measured in years

x_4 = Marital status of the household head (married 1, 0 otherwise)

x_5 = Education level of the household head (Primary and above 1, 0 otherwise)

x_6 = Type of intervention (With intervention 1, 0 otherwise)

x_7 = Total income from other income generating activities (IGA)

x_8 = Actual land in hectares cultivated

x_9 = Belonging to farmers association (1 Yes, 0 No)

x_{10} = Access to extension service (1 Yes, 0 No)

x_{11} = Access to credit (Ever received credit 1, 0 otherwise)

3.7 Results and Discussion

3.7.1 Socio-demographic characteristics and household's willingness to adopt/pay for improved legume technologies

The results in Table 3.2 show that, 87% of the households were headed by males. The age of the household head ranged from 18 to 79 years. In addition, the majority of household heads were in the age range of 36-60 (52%) (Middle aged household heads) and 18-35 (42.8%) (Youthful heads), which means that most of the heads were in the economically active group (URT, 2015). The fact that most heads were mature (aged) means they can influence their households' decision on adoption and willingness to pay for improved legume technologies. Also the study found that 81.5% of the household heads attained primary education this means the level of literacy in the area of study was high to the extent that, programs intended to create awareness in the area had a higher possibility using different communication channels/methods of being delivered and understood by the smallholder farmers.

Results in Table 3.2 further show that, almost all the household heads depend on agricultural production as their main occupation. According to Table 3.2 three quarters of the households in the study area had 1-6 members, the average household size was 4.75 which is equivalent to the national average household size 4.8 (URT, 2013). Household size is an important element when it comes to investment of resources as it determines the income level of the households to be invested. In addition, a household's income depends on number of working individuals. Generally, households with many individuals can be advantageous if most are in the economic active group as this mean more income.

However, many economic inactive individuals/dependants will deny household investment opportunities due to a high dependency ratio. FAO (2015) found that, smaller-sized households and a higher dependency ratio influence the use of modern inputs (improved technologies).

Table 3.2: Demographic and Socio-economic Characteristics of Surveyed Households and their Willingness to Adopt Improved Legume Technologies (n=400)

Variable	Category	Overall	Mvomero	Gairo	Adopted bean technology	Willing to pay at least one technology
Household size	1- 6	343(85.8)	125(85.6)	218(85.6)	70(73.7)	238(88.1)
	>6	57(14.2)	21(14.4)	36(85.8)	25(26.3)	32(11.9)
Sex	Male	348(87)	123(84.2)	225(88.6)	85(89.5)	238(88.1)
	Female	52(13)	23(15.8)	29(11.4)	10(10.5)	32(11.9)
Age	18-35	171(42.8)	49(33.60	122(48)	41(43.2)	110(40.7)
	36-60	209(52.2)	87(59.6)	122(48)	52(54.7)	148(54.8)
	>60	20(5)	10(6.8)	10(3.9)	2(2.1)	12(4.4)
Education level	None	68(17)	20(13.7)	48(18.9)	16(17)	40(14.8)
	Primary education	326(81.5)	120(82.2)	206(81.1)	79(83)	225(83.3)
	Above primary ed	6(1.5)	6(4.1)	0(0)	0(0)	6(1.5)
Marital status	Single	11(2.8)	6(4.1)	5(2)	0(0)	7(2.6)
	Married	334(83.5)	114(78.1)	220(86.6)	86(90.5)	229(84.8)
	Divorced	26(6.5)	13(8.9)	13(5.1)	3(3.2)	16(5.9)
	Separated	10(2.5)	6(4.1)	4(1.6)	1(1.1)	6(2.2)
	Widow/er	19(4.8)	7(4.8)	12(4.7)	5(5.2)	12(4.4)
Main occupation	Crop production	394(98.5)	143(97.9)	251(98.8)	92(96.8)	268(99.3)
	Others	6(1.5)	3(2.1)	3(1.2)	3(3.2)	2(0.7)

NB: -Number in brackets represents percentages

-Above primary includes secondary education; tertiary (certificate and diploma)

-Others refers to livestock production; salaried employment (government); casual labourer (off farm activities)

3.7.2 Determinants for adoption and willingness to pay for improved legume technologies

3.7.2.1 Distribution of smallholder farmers who adopted/cultivated improved common bean seeds

The study results (Fig. 3.1) show that about a quarter of respondents adopted at least one type of improved common bean seeds. Again, the study found that, the level of adoption differs across the treatments. The study results (Fig. 3.1) further show that the most adopted bean seeds were Lyamungo 90 (11.2%) followed by Rose-coco/Red bean (10.5%) and Uyole Njano (3%). Generally, the overall per cent of adoption was less than a quarter (23.8%) though this seems to be low, it could be seen as high based on the fact that the intervention was at its initial stage of implementation (in the first year of implementation). Therefore, it is hoped that as time passes many more farmers may adopt. The findings are supported by the study of Abebe and Bekele (2015) who argued that, rate of adoption can be understood in relation to the duration of technology intervention. Furthermore, according to the adoption theory, innovation starts to diffuse to the people from the first day of introduction but spreads wider as time passes (Rogers, 1983).

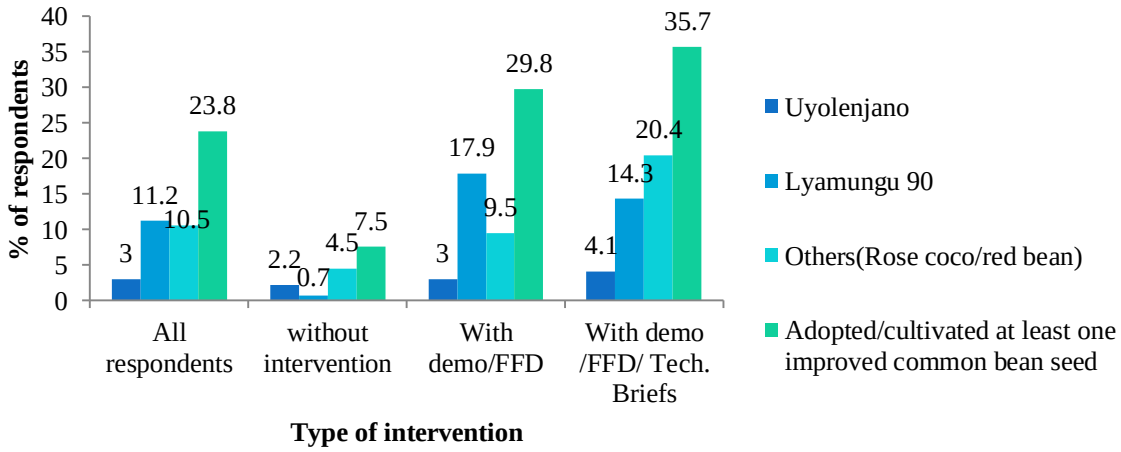

Figure 3.1: Distribution of smallholder farmers by their adoption of at least one or more improved common bean seeds in 2015/16 (n=400)

3.7.2.2 Determinants for farmers' adoption of improved common bean seeds

Study results (Table 3.3) show that, there was a significant association (P=0.000) between availability of legume technology intervention, total area cultivated, total revenue from IGA (P=0.005), household size (P=0.022), borrowing money for farming (P=0.024) and adoption of improved common bean seeds. The Logistic regression results (Table 3.3) show that availability of legume technology intervention, total area cultivated, total revenue from IGA, household size and borrowing money for farming are important factors when it comes to adoption of improved legume technologies. The results above conform to those of Nguezet *et al.* (2011) that, household size and area cultivated (farm size) influence adoption of agricultural technology. Furthermore, Abate *et al*. (2011) and FAO (2015) found that, availability of relevant technologies intervention was the foundation for smallholder farmers' adoption of improved crop technologies.

Generally, the results imply that, the mentioned determinants/factors influencing smallholder farmers' adoption in line with the intervention. Therefore, the project intervention has played a great role in changing smallholder farmers' behaviour/attitude towards adoption of improved common bean seeds because it is the first significant factor of having high values of Wald statistic, followed by total area cultivated. The observation is also supported by studies, Akudugu *et al.* (2012) and Challa and Tilahun (2014) who found that, farm size (total area cultivated) and income from other economic sources have a significant impact on the adoption of agricultural technologies. Similarly, Uaiene *et al.* (2009) reported that borrowing money from credit financial institutions is a major determinant of adoption of agricultural technologies. Based on the positive and significant association observed on availability of legume technology intervention, the study results lead to the rejection of the null hypothesis which states that "Smallholder farmers'

adoption of improved legume technologies does not differ between the area with and without intervention".

Table 3.3: Determinants for adopting improved common bean seeds by surveyed households

Factor/determinants	B	Std. Err.	Wald	Df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	0.186	0.081	5.247	1	0.022**	1.205	1.027	1.413
Sex	-0.547	0.784	0.488	1	0.485	0.578	0.124	2.689
Age	-0.002	0.012	0.021	1	0.884	0.998	0.974	1.023
Marital status	0.822	0.729	1.270	1	0.260	2.274	0.545	9.489
Education	0.172	0.358	0.231	1	0.631	1.188	0.589	2.393
Availability of technology intervention (Yes)	1.667	0.375	19.792	1	0.000***	5.297	2.541	11.042
Total income from IGA	0.000	0.000	7.945	1	0.005***	1.000	1.000	1.000
Total area cultivated	0.527	0.139	14.402	1	0.000***	1.693	1.290	2.223
Being member farmers association (Yes)	0.122	0.474	0.066	1	0.797	1.129	0.446	2.861
Ever visited by extension worker during the last cropping season(Yes)	0.099	0.498	0.040	1	0.842	1.104	0.416	2.929
Ever borrowed money for farming (Yes)	-0.857	0.379	5.123	1	0.024**	0.424	0.202	0.891
Constant	-3.482	0.819	18.095	1	0.000***	0.031		

MODEL SUMMARY: Cox& Snell R^2= 0.171, Nagelkerke R^2= 0.257, Hosmer and Lemeshow Test, Chi-square 8.474 (Sig. 0.389), -2Log likelihood = 363.581

3.7.3 Challenges facing surveyed households in accessing improved common bean seeds

The study results (Table 3.4) show that more than three quarters of the respondents failed to access improved common bean seeds because of the absence of seed dealers in their area. The Table also shows that less than three quarters of respondents failed to access

improved common bean seeds because of lack of market information in relation to improved common bean seeds. The study results further show that more than half of respondents were unable to use improved common bean seeds because of their high prices (Table 3.4). Generally, the challenges associated with accessing improved common bean seeds can be the limiting factor for farmers not to use improved bean varieties. According to Abate and Orr (2012), lack of access to improved legume technologies as well as the high cost associated on accessing such inputs (technologies) leads to poor adoption of legume technologies by smallholder farmers. Further to the above, during the FGDs participants pointed out that they face the challenge of technologies being expensive so denying many the possibility of using them or even making others to be unwilling to adopt them. In addition, they argued that the knowledge they have on improved legume technologies is not sufficient. In addition, they pointed out that there was lack of availability of permanent and trusted seed dealers from whom they could access technologies easily. In addition, Ngwira *et al.* (2012) argued that, sufficient supply of high quality legume seed and its associated accessing costs play great roles in adoption of the technology.

Table 3.4: Problems in acquiring improved common bean seeds (n=400)

Problem	All respondents	Without intervention	With Demo/FFD	With Demo/FFD/Tech. Briefs
High price	235(58.8)	65(48.5)	121(72)	49(58.8)
Low quality of seeds	92(23)	25(18.7)	44(26.2)	23(23.5)
Lack of market information	281(70.2)	96(71.6)	122(72.6)	63(64.3)
No seed dealers in the vicinity	312(78)	104(77.6)	138(82.1)	70(71.4)
Long distance to the seed dealers	152(38)	43(32.1)	75(44.6)	34(34.7)
Lack of knowledge/ lack of land	3(0.8)	2(1.5)	1(0.6)	0(0)

NB: Number in brackets is percentages

3.7.4 Determinants for willingness to pay for improved legume technologies

3.7.4.1 Distribution of smallholder farmers who were willing to pay for the improved legume technologies

Table 3.5 presents the distribution of smallholder farmers who were willing to pay for improved legume technologies. Generally, the results show that more than half of the farmers were willing to pay for at least one improved legume technology. The results further show that, technologies which had a higher acceptance were boosting fertilizers (UREA) (42.5%), followed by herbicides (38.5%) and improved common bean seeds (33%).

Table 3.5: Distribution of smallholder farmers who were willing to pay for improved legume technologies (n=400)

Improved common bean seeds	Overall willingness	Without intervention	With demo/FFD	With demo/FFD/Tech. Briefs	Chi-squire	P-value
Improved Common bean seeds at Tzs ≥4000	132(33)	59(44)	42(25)	31(31.6)	12.319	0.002
Basal fertilizers (NPK; DAP) Tzs ≥2000	108(27)	36(26.9)	40(23.8)	32(32.7)	2.458	0.293
Boosting fertilizers (UREA) Tzs ≥1500	170(42.5)	52(38.8)	70(41.7)	48(49)	2.480	0.289
Pesticides Tzs ≥20000	52(13)	23(17.2)	10(6)	19(36.5)	12.968	0.002
Herbicides Tzs ≥10000	154(38.50)	49(36.6)	61(36.3)	44(44.9)	2.246	0.325
Anti-fungal Tzs≥12000	44(11)	18(13.4)	9(5.4)	17(17.3)	10.307	0.006
At least one technology	270(67.5)	93(69.4)	108(64.3)	69(70.4)	1.390	0.499

NB: Numbers in bracket indicate percentage

3.7.4.2 Determinants of smallholder farmers' willingness to pay for improved legume technologies

The study results (Table 3.6 and Appendices 3.1-3.7) show that, there was a significant association between visit by extension officer (P=0.017), marital status of household head (P=0.030) and smallholder farmers' willingness to pay for herbicides. The study results further show that there was a significant association between availability of legume technology intervention (P=0.002), being a member of a farmers' association (P=0.004) and smallholder farmers' willingness to pay for the improved common bean seeds. In addition, the study shows that there was a significant association (P=0.026) between total area cultivated and smallholder farmers' willingness to pay for pesticides. Asante *et al.* (2013) revealed that, farm size (total area cultivated) influences smallholder farmers' preference/willingness to pay for agricultural technologies. Lastly, the study results (Table 3.6) show that there was a significant association between total area cultivated (P=0.007), visit by extension officer (P=0.025) and smallholder farmers' willingness to pay for anti-fungal.

Generally, the study findings are supported by Ainembabazi *et al.* (2017) who found that, smallholder farmers' memberships to associations, technologies disseminated and extension services provided have a significant role in the determination of smallholder farmers' willingness to adopt improved legume technologies. In addition, Uaiene *et al.* (2009) and Abate *et al.* (2014) have reported that farmers' membership to agricultural cooperatives/association has a positive impact on accessing inputs and market information in general. Based on the study results of improved common bean seeds which shown significant association with smallholder farmers willingness to pay for improved legume technologies, the null hypothesis which states that "smallholder farmers' willingness to pay for improved legume technologies does not differ between the area with and without intervention" is rejected.

Table 3.6: Determinants for willingness to pay for the improved common bean seeds (n=400)

Factor/ determinants	Improved Common bean seeds	Basal fertilizers (NPK; DAP)	Boosting fertilizers (UREA)	Pesticides	Herbicides	Anti-fungal	At least one or more technology
Household size	-0.046 (0.446)	-0.079 (1.244)	-0.032 (0.243)	0.185* (3.250)	0.089 (1.691)	0.104 (0.916)	-0.077 (1.244)
Sex	-0.482 (0.73)	0.435 (0.57)	0.078 (0.024)	-0.596 (0.456)	0.755 (1.638)	0.105 (0.014)	0.114 (0.046)
Age	0.013 (1.603)	0.008 (0.599)	0.001 (0.013)	-0.004 (0.089)	0.007 (0.561)	0.005 (0.115)	0.000 (0.000)
Marital status	-0.158 (0.107)	-0.285 (0.296)	-0.179 (0.157)	-0.612 (0.721)	-1.18** (4.689)	-0.679 (0.705)	0.259 (0.300)
Education	-0.004 (0.000)	0.063 (0.039)	0.09 (0.101)	0.733* (3.437)	-0.058 (0.038)	0.535 (1.541)	0.344 (1.386)
Availability of technology intervention (Yes)	0.734*** (9.826)	0.007 (0.001)	-0.169 (0.572)	0.608* (3.554)	-0.09 (0.154)	0.482 (1.926)	-0.091 (0.145)
Total income from IGA	0.000* (2.75)	0.000 (0.019)	0.000 (1.297)	0.000 (0.012)	0.000 (0.024)	0.000 (0.038)	0.000 (1.340)
Total area cultivated	-0.076 (0.563)	-0.191* (3.591)	-0.05 (0.267)	-0.255** (4.971)	0.007 (0.004)	-0.313*** (7.380)	0.003 (0.001)
Being member farmers association (Yes)	-1.083*** (8.505)	-0.319 (0.713)	-0.697* (3.714)	-0.527 (1.259)	-0.631* (2.997)	-0.572 (1.335)	1.156** (5.203)
Visit by extension officer (Yes)	-0.303 (0.492)	-0.634 (2.327)	-0.500 (1.545)	-0.95* (3.659)	-0.984** (5.659)	-1.125** (5.006)	0.761 (2.157)
Borrowing money for farming (Yes)	0.182 (0.435)	-0.321 (1.376)	0.043 (0.028)	-0.423 (1.415)	-0.316 (1.482)	-0.192 (0.243)	0.086 (0.094)
Constant	0.967 (2.334)	1.224* (3.664)	0.507 (0.777)	1.942** (4.394)	0.426 (0.5070	1.768* (3.648)	0.206 (0.118)
-2 Log likelihood	476.466	454.809	536.464	286.531	511.632	259.719	486.709
Cox& Snell R2	0.074	0.029	0.022	0.055	0.052	0.043	400
Nagelkerke R2	0.103	0.042	0.03	0.102	0.071	0.086	0.043
Chi-square	8.93	3.418	13.793	9.561	10.989	10.972	0.061
P-value	0.348	0.905	0.087	0.297	0.202	0.203	1.393

NB: Number outside the bracket refers to B values while number in bracket indicate Wald statistics

***, **, * are significance levels at 1%, 5%, and 10%, respectively. For the details of the six Logistic models run see Appendices 3.1-3.7

3.8 Conclusions and Recommendations

This manuscript has assessed the determinants of smallholder farmers' adoption and willingness to pay for improved legume technologies in Tanzania. Based on the study's findings it can generally be concluded that the surveyed farmers had a low uptake for improved common bean varieties. Although the adoption seems to be low in figure, it could be seen as high based on the fact that the intervention was at its initial stage of implementation (in the year of implementation). In addition, poor adoption is due to high prices associated on acquiring improved bean seeds, lack of seed dealers in the rural production areas and lack of enough knowledge. Despite the above it can also be concluded that farmers were willing to pay for improved legume technologies with caution to price fluctuation of some technologies and provision of extra knowledge demand on the input output relationships.

Based on the study's findings and conclusions it is hereby recommended that:

i. In order to increase smallholder farmers' adoption and willingness to pay for improved legume technologies the government needs to provide a conducive environment for reduced technology prices or provide subsidies for smallholder farmers. Doing the above will allow affordability of the technologies by farmers.
ii. The Government and non-governmental organisations should invest more on awareness creation approaches in order to enable those smallholder farmers lagging behind in adoption of improved legume technologies to do so.
iii. Smallholder farmers should form farmer groups/associations as these may enable them to easily access market information and inputs more easily. In addition, through the groups/association they could save and borrow money for investment on improved legume technologies.

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3.10 Appendices

Appendix 3.1: Factors associated with willingness to pay for improved common bean seeds

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-.046	.069	.446	1	.504	.955	.834	1.094
Sex	-.482	.564	.730	1	.393	.617	.204	1.866
Age	.013	.010	1.603	1	.205	1.013	.993	1.034
Marital status	-.158	.482	.107	1	.743	.854	.332	2.196
Education	-.004	.315	.000	1	.991	.996	.537	1.849
Availability of technology intervention (Yes)	.734	.234	9.826	1	.002	2.083	1.316	3.296
Total income from IGA	.000	.000	2.750	1	.097	1.000	1.000	1.000
Total area cultivated	-.076	.102	.563	1	.453	.926	.759	1.131
Being member of farmers association (Yes)	-1.083	.371	8.505	1	.004	.339	.163	.701
Visit by extension officer (Yes)	-.303	.432	.492	1	.483	.739	.317	1.722
Borrowing money for farming (Yes)	.182	.276	.435	1	.510	1.200	.698	2.062
Constant	.967	.633	2.334	1	.127	2.631		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 3.2: Factors associated with willingness to pay for basal fertilizers

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-.079	.071	1.244	1	.265	.924	.803	1.062
Sex	.435	.577	.570	1	.450	1.546	.499	4.787
Age	.008	.011	.599	1	.439	1.008	.987	1.030
Marital status	-.285	.525	.296	1	.587	.752	.269	2.103
Education	.063	.317	.039	1	.843	1.065	.572	1.982
Availability of technology intervention (Yes)	.007	.249	.001	1	.978	1.007	.619	1.639
Total income from IGA	.000	.000	.019	1	.892	1.000	1.000	1.000
Total area cultivated	-.191	.101	3.591	1	.058	.826	.678	1.007
Being member of farmers association (Yes)	-.319	.377	.713	1	.398	.727	.347	1.524
Visit by extension officer (Yes)	-.634	.416	2.327	1	.127	.531	.235	1.198
Borrowing money for farming (Yes)	-.321	.274	1.376	1	.241	.725	.424	1.241
Constant	1.224	.640	3.664	1	.056	3.402		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 3.3: Factors associated with willingness to pay for boosting fertilizers (UREA)

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-.032	.065	.243	1	.622	.969	.853	1.099
Sex	.078	.508	.024	1	.878	1.081	.399	2.927
Age	.001	.009	.013	1	.911	1.001	.983	1.020
Marital status	-.179	.452	.157	1	.691	.836	.345	2.027
Education	.090	.283	.101	1	.751	1.094	.628	1.904
Availability of technology intervention (Yes)	-.169	.224	.572	1	.450	.844	.544	1.309
Total income from IGA	.000	.000	1.297	1	.255	1.000	1.000	1.000
Total area cultivated	-.050	.097	.267	1	.605	.951	.787	1.150
Being member of farmers association (Yes)	-.697	.362	3.714	1	.054	.498	.245	1.012
Visit by extension officer (Yes)	-.500	.402	1.545	1	.214	.607	.276	1.334
Borrowing money for farming (Yes)	.043	.256	.028	1	.867	1.044	.632	1.722
Constant	.507	.576	.777	1	.378	1.661		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 3.4: Factors associated with willingness to pay for pesticides

Factor/determinants	B	Std. Err.	Wald	Df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.185	.102	3.250	1	.071	1.203	.984	1.470
Sex	-.596	.883	.456	1	.500	.551	.098	3.111
Age	-.004	.013	.089	1	.765	.996	.971	1.022
Marital status	-.612	.721	.721	1	.396	.542	.132	2.226
Education	.733	.395	3.437	1	.064	2.081	.959	4.517
Availability of technology intervention (Yes)	.608	.323	3.554	1	.059	1.837	.976	3.457
Total income from IGA	.000	.000	.012	1	.911	1.000	1.000	1.000
Total area cultivated	-.255	.114	4.971	1	.026	.775	.619	.970
Being member of farmers association (Yes)	-.527	.470	1.259	1	.262	.590	.235	1.482
Visit by extension officer (Yes)	-.950	.496	3.659	1	.056	.387	.146	1.024
Borrowing money for farming (Yes)	-.423	.355	1.415	1	.234	.655	.326	1.315
Constant	1.942	.926	4.394	1	.036	6.969		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 3.5: Factors associated with willingness to pay for herbicides

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.089	.068	1.691	1	.193	1.093	.956	1.250
Sex	.755	.590	1.638	1	.201	2.129	.669	6.769
Age	.007	.010	.561	1	.454	1.007	.988	1.027
Marital status	-1.180	.545	4.689	1	.030	.307	.106	.894
Education	-.058	.297	.038	1	.845	.944	.527	1.690
Availability of technology intervention (Yes)	-.090	.230	.154	1	.694	.914	.582	1.433
Total income from IGA	.000	.000	.024	1	.876	1.000	1.000	1.000
Total area cultivated	.007	.100	.004	1	.947	1.007	.828	1.224
Being member of farmers association (Yes)	-.631	.365	2.997	1	.083	.532	.260	1.087
Visit by extension officer (Yes)	-.984	.414	5.659	1	.017	.374	.166	.841
Borrowing money for farming (Yes)	-.316	.259	1.482	1	.223	.729	.439	1.212
Constant	.426	.599	.507	1	.477	1.531		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 3.6: Factors associated with willingness to pay for anti-fungal

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	.104	.109	.916	1	.338	1.110	.896	1.374
Sex	.105	.890	.014	1	.906	1.111	.194	6.361
Age	.005	.015	.115	1	.734	1.005	.976	1.035
Marital status	-.679	.809	.705	1	.401	.507	.104	2.475
Education	.535	.431	1.541	1	.214	1.707	.734	3.970
Availability of technology intervention (Yes)	.482	.347	1.926	1	.165	1.619	.820	3.199
Total income from IGA	.000	.000	.038	1	.845	1.000	1.000	1.000
Total area cultivated	-.313	.115	7.380	1	.007	.731	.583	.916
Being member of farmers association (Yes)	-.572	.495	1.335	1	.248	.565	.214	1.489
Visit by extension officer (Yes)	-1.125	.503	5.006	1	.025	.325	.121	.870
Borrowing money for farming (Yes)	-.192	.390	.243	1	.622	.825	.384	1.773
Constant	1.768	.926	3.648	1	.056	5.860		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

Appendix 3.7: Factors associated with willingness to pay for at least one or more improved legume technology

Factor/determinants	B	Std. Err.	Wald	df	Sig.	Exp(B)	95% CI	
							Lower	Upper
Household size	-.077	.069	1.244	1	.265	.926	.810	1.060
Sex	.114	.531	.046	1	.831	1.120	.395	3.175
Age	.000	.010	.000	1	.997	1.000	.981	1.020
Marital status	.259	.473	.300	1	.584	1.296	.513	3.276
Education	.344	.292	1.386	1	.239	1.411	.795	2.502
Availability of technology intervention (Yes)	-.091	.239	.145	1	.703	.913	.572	1.458
Total income from IGA	.000	.000	1.340	1	.247	1.000	1.000	1.000
Total area cultivated	.003	.105	.001	1	.978	1.003	.817	1.231
Being member of farmers association (Yes)	1.156	.507	5.203	1	.023	3.176	1.177	8.572
Visit by extension officer (Yes)	.761	.518	2.157	1	.142	2.141	.775	5.916
Borrowing money for farming (Yes)	.086	.279	.094	1	.759	1.090	.630	1.884
Constant	.206	.601	.118	1	.732	1.229		

a. Variable(s) entered on step 1: V1_QNB1, V2_QNB2IBb, V3_QNB2IC, V4_QNB2IEb, V5_QNB2IFb, V6_Intervtn_status, V7_TOTALINCOME, V8_TOTAREACULT, V9_FAMERASSOC, V10_EXTOFVISIT, V11_L01.

CHAPTER FOUR

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Summary of Major Findings

Below is a summary of the study's major findings in a chorological order as per presented manuscripts.

4.1.1 Effectiveness of communication channels on knowledge of smallholder farmers' adoption of improved common bean technologies

Objective one aimed at assessing the level of awareness of smallholder farmers on improved legume technologies. Objective two involved assessment of the determinants of smallholder farmers' awareness on improved legume technologies. In addition to the above, objective three aimed at determining the effectiveness of various awareness creation approaches on smallholder farmers understanding of improved legume technologies. Generally, the study results show that smallholder farmers were aware of all the technologies assessed; i.e. improved common bean varieties; new planting methods (time and spacing); type, rate and time of use fertilizers; weeding method (when and times); harvesting method (stage and when to harvest); type, rate, time and safe use of chemicals; and post-harvest and storage management. However, the level of awareness differed across the treatments with awareness higher in the area of intervention and low in the none intervention area. The results also show that, the technology with the highest awareness was improved common bean seeds (78%) while that with the lowest level of awareness was post-harvest and storage management (54%). The results further show that, factors that were positively and significantly associated with level of awareness of smallholder farmers on improved legume technologies were availability of legume technology intervention ($P<0.01$) across all the technologies assessed. In addition, the

other factors significantly associated with level of awareness was total revenue from income generating activities ($P<0.05$) and harvesting method (stage of harvesting and time) and post-harvest and storage management. Further to the above, the study results show a significant association between visit by extension officer ($P<0.05$) and type, rate and time of use fertilizers. Based on the results the null hypothesis which states that "smallholder farmers' knowledge on improved legume technologies do not differ based on awareness creation approaches used" is rejected.

The study results further show that, out of the seven improved legume technologies assessed, the technologies mostly used by the surveyed smallholder farmers were weeding method (when to weed and number of times to weed) (7.5%) and new planting methods (timely planting and proper spacing) (6.3%). The study results also show that, factors significantly associated with smallholder farmers' use of improved legume technologies were visits by extension officer ($P<0.05$) and improved common bean varieties; visits by extension officer ($P<0.01$), age of household head ($P<0.05$) and new planting methods (timely planting and proper spacing); visit by extension officer ($P<0.05$) and use of proper rate, time and type of fertilizers; being a member to a farmers' associations ($P<0.05$), revenue from IGA ($P<0.05$) and harvesting methods (stage of maturity and time to harvest); age of household head ($P<0.01$), household size ($P<0.05$) and post-harvest and storage management. Based on the results, the alternative hypothesis which states that "smallholder farmers' knowledge on improved legume technologies does not differ significantly between the area with and without intervention" is rejected.

4.1.2 Determinants of smallholder farmers' adoption and willingness to pay for improved legume technologies

Objective four of the study aimed at assessing the determinants for smallholder farmers' adoption of improved legume technologies. Objective five involved assessment of the determinants of the smallholder farmers' willingness to pay for improved legume technologies. The results of the study show that less than a quarter (23.8%) of the respondents adopted improved common bean seeds. Results from the binary logistic regression analysis show that factors significantly associated with adoption of improved common bean seeds were availability of legume technology intervention (P=0.000), total area cultivated (P=0.000), total revenue from other income IGA (P=0.005), household size (P=0.022), borrowing money for farming (P=0.024). Based on the results the null hypothesis which states that "smallholder farmers' adoption of improved legume technologies does not differ based on awareness creation approaches used" is rejected. In addition, the null hypothesis which states that "smallholder farmers' adoption of improved legume technologies does not differ between the area with and without intervention" is also rejected.

The results further show that more than two thirds (67.5%) of the surveyed farmers were willing to pay for at least one improved legume technology. In addition, the study found that there were significant relationships between availability of legume technology intervention (P<0.01), being a member to a farmers' association (P<0.01) and smallholder farmers' willingness to pay for the improved common bean seeds; total area cultivated (P<0.05) and smallholder farmers' willingness to pay for pesticides; visits by extension officer (P<0.05), marital status of household head (P<0.05) and smallholder farmers' willingness to pay for herbicides; total area cultivated (P<0.01), visits by extension officer (P<0.05) and smallholder farmers willingness to pay for anti-fungal. Based on the study

results of improved common bean seeds which showed significant association with smallholder farmers willingness to pay for improved legume technologies, the null hypothesis stating that "smallholder farmers' willingness to pay for improved legume technologies does not differ between the area with and without intervention" is rejected.

4.2 Conclusions

Generally, based on the study's findings it can be concluded that the level of awareness of smallholder farmers of improved legume technologies is high and this differs across the treatments (very high in the area of intervention and low in the none intervention area). It is also concluded that, the level of smallholder farmers' knowledge in terms of using improved legume technologies is low for all treatments whereby farmers pinned this to lack of enough knowledge on how to properly use improved legume technologies and the high costs associated with access to improved common bean seeds, fertilizers and chemicals. In general, awareness creation approaches were observed to be effective as ranked in order of importance or usefulness starting with farmer field days, demonstration plots, village council extension officer, technological briefs and neighbours and relatives.

It is further concluded that, smallholder farmers' adoption of improved common bean seeds is generally low across all the treatments. Although the adoption seems to be low based on the fact that the intervention was at its initial stage of implementation (in the year of implementation) one may expect it to rise as time passes as highlighted in the adoption theory by Rogers. Also, poor adoption is due to the fact that, smallholder farmers were facing a number of challenges which include high prices of the improved bean seeds, lack of seed dealers in the rural areas and lack of enough knowledge on improved legume technologies. Lastly, it can be concluded that, on overall, smallholder farmers were willing to pay for improved legume technologies.

4.3 Recommendations

Therefore, based on the study findings and conclusions it is recommended that;

i. The government and non-governmental organisations should invest more on awareness creation approaches in order to make sure that all smallholder farmers are sensitised to adopt improved legume technologies to raise productivity and their general well-being.

ii. In order to increase smallholder farmers' adoption and willingness to pay for improved legume technologies the government must create a conducive environment that will allow smallholder farmers to access cheap quality improved common bean seeds, fertilizers and chemicals or provision of subsidies. Doing the above could enhance farmers' adoption of improved legume technologies.

iii. Smallholder farmers should form farmer groups/association as these may enable them to get easy access to market information and inputs. In addition, through groups/association they could save and borrow money for investment into improved legume technologies.

4.4 Area for Further Study

Generally, the study has observed that smallholder farmers' adoption of improved common legume technologies is low. Therefore, there is a need to conduct a similar research to see if there will be more progress (impact assessment). The current study only captured the basic information of the previous cropping season. Moreover, the intervention had also been done in the same cropping season (2015/2016). Therefore, farmers may not have had enough time to process and adopt or drop the intervention. This is supported by adoption theory which says that innovation diffuses from the first introduction and spreads wider in a few years (Rogers, 1983).

4.5 Appendices

Appendix 4.1: Respondents Questionnaire

TITLE: Effectiveness of Communication Channels and Smallholder Famers Adoption of Improved Legume Technologies: A Case of Morogoro Region, Tanzania.

A Master Student research questionnaire for:

LUGAMARA, C.B. SUA, MOROGORO.

Specific objectives

i. To assess smallholder farmers level of awareness on improved legume technologies.
ii. To assess determinants of smallholder farmers awareness on improved legume technologies.
iii. To determine the effectiveness of various awareness creation approaches on smallholder farmers understanding of improved legume technologies.
iv. To assess the determinants of smallholder farmers' adoption of improved legume technologies.
v. To assess the determinants of smallholder farmers' willingness to pay for improved legume technologies.

General Instructions to Enumerators

Make brief introduction to each respondent before starting any question. 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 record your own words/feelings). Please ask each question clearly and patiently until the respondent understands clearly. Please do not

try to use technical terms while discussing with the respondents (use simple local language for better communication). Also, explain to the respondent that information collected shall be private, confidential and only used for the purpose and benefit of the study

Section A. General Information

A01. Questionnaire No……..…..

A02. Name of enumerator…….

A03. Date of interview……

A04. Respondent's name…… ……....

A07. Respondent's mobile phone number……....…

A5. District…….

A6. Ward……

A7. Village…….

A8. Household GPS coordinates: A8.1 Altitude_____

A8.2. Latitude_____

A8.3. Longitude_____

A9. Type of respondent:

1. Without intervention
2. With intervention (demonstration plot + farmer field days) ( )
3. With intervention (demonstration plot + farmer field days + technological briefs)

Section B. Household's Information

B01: Total number of people in the household ……..

B02: Record information of each household member in the Table below:

Person ID	a)Name	b)Sex 0=M, 1=F	c)Age (in complete years)	d)Relationship with the Household head 1=Head, 2=Spouse, 3=Son/Daughter, 4=Grandchild, 5=Servant, 6=Others-specify	e)Marital status 1. Single 2. Married 3. Divorced 4.Separated 5.Cohabiting 6. Widow/er 7.Others (specify)	f)Highest level of education 0=None, 1=Primaryed, 2=Secondaryed, 3=Tertiary (Certificate/Diploma) 4= University 5= Others (specify	g)Main occupation of the Household member 1=Crop production 2=Livestock production 3=Salaried employment-government 4=Salaried employment-private sector 5=Self-employed off-farm 6=Casual labourer on-farm 7=Casual labourer off-farm 8=Herding 9=Fishing 10=Household chores 11=Other (specify)
01*							
02**							
03							
04							
05							
06							
07							

should be the respondent/person interviewed

****should be the household head (if respondent interviewed not the HH)***

Section C. Household Income

C01. How much income did your household earn in the past one year preceding the survey (2015/2016)? Fill in the table below:

S/N	Income generating activities	Average amount earned in 2015/16(Tzs)
C01	Petty-trade businesses	
C02	Motorcycle transportation (bodaboda)	
C03	Carpentry	
C04	Fishing	
C05	Mining	
C06	Hunting	
C07	Rented/land rent	
C08	Rented out oxen for ploughing	
C09	Salaried employment	
C10	Farm wages	
C11	Non-farm wage labour	
C12	Non-farm agribusiness income (e.g. grain milling/trading)	
C13	Other business NET income (shops, trade, tailor, sales of beverages etc.)	
C14	Pension income	
C15	Drought/flood relief	
C16	Safety net or food for work	
C17	Remittances (cash transfer from relatives, son/daughter)	
C18	Marriage gifts	
C19	Sales of firewood/charcoal	
C20	Brick making	
C21	Poles from own and communal forests	
C22	Sale of crop produce/residues	
C23	Quarrying stones	
C24	Rental property (other than land and oxen)	
C25	Interest from deposits	
C26	Social cash transfer	
C27	Sale of livestock, livestock products and by-products	
C28	Others (specify).....	

Section D: Common bean production

D01. Are common beans your main cash crop? 1. YES ( ) 2. NO ( )

Section E: Common Bean Plots Cultivated during the Last Cropping Season, 2015/2016

E01: How much land does your household have?..... acres

E02: How much land is allocated for common bean production? Fill in the Table below:

Plot No	**i. Plot size (acres)**	**ii. Type of common bean variety planted**	**iii. Who manages the plot?**	**iv. Plot tenure**	**v. Distance from home to the plot in kilometers**	**vi. Is the plot inter-cropped?**	**vii. Type of intercropping**
a							
b							
c							
d							

Code for ii: Type of common bean variety planted: 1= Improved common bean; 0=Local common bean

Code for iii: Who manages the plot? 1=family members; 0=others

Code for iv: Plot tenure? 1= Owned; 2= Rented in; 3= Share-cropped

Code for vi: Is the plot inter-cropped? 1=Yes; 0=No

Code for vii: 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)

Section F. Awareness, willingness to pay for Common Bean technologies

F01. Have you ever heard about improved common bean technologies? 1. YES 2. NO

F02. If yes, fill in the table below:

No.	**Common bean technologies**	**i. Are you aware of? 1= Yes. 0=No**	**ii. If yes, where did you get the information?**	**iii. If you are aware, are you currently using them?)**	**iv: If you are not currently using them, will you be willing to use them in the future?**
a	Improved common bean varieties				
b	New planting methods – (timely planting and proper spacing)				
c	Type, rate and time of application of chemical fertilizers				
d	Weeding method (when to weed and how many times to weed)				
e	Harvesting method (at what stage and when to harvest, moisture in the seeds)				
f	Type, rate and time and safe use of chemicals – herbicides, pesticides				
g	Post-harvest and storage management – to prevent production loss due to storage pests				

Code for ii: for source of information: 1. District council extension staff; 2. Farmer Field Days; 3. Input suppliers; 4. Radio; 5. Demonstration plot; 6. Neighbours and relatives; 7. Reading technological briefs (Brochures, leaflets); 8. others (specify)

Code for iii: Are you currently using them? 1= Yes; 0=No

Code for iv: Will you be willing to use them? 1= Yes; 0=No

F03. Useful of the sources of information: Fill in the Table below

SN	Sources of information	Usefulness (Code A)
	District council extension staff	
	Farmer Field Days	
	Input suppliers	
	Radio	
	Demonstration plot	
	Neighbours and relatives	
	Reading technological briefs (Brochures, leaflets)	

KEY: Code A: 1. Useful; 2. Indifferent; 3. Useless

SESTION G: ADOPTION OF COMMON BEAN VARIETIES IN THE PAST TWO PRODUCTION SEASONS IN 2015/2016

G01. List of common bean varieties you are aware of: fill in the table below

No.	Common bean varieties	i. Have you ever planted it? 1= Yes. 0=No	ii. If yes, which year did plant it for the first time?	iii. Did you cultivate this variety in the last production season of 2015/16?	iv. If yes, how many acres of land?	v. How many kilograms of output did you harvest from the planted plot?	vi. Are you planning to plant the same in the next production season? 1= Yes. 0=No
A	Uyole njano						
B	Lyamungu 90						
C	Others (specify)						

Key

The local name for the improved common bean varieties

1. Uyole njano= Njano; 2. Lyamungu 90= Rose coco, Farm, Nyayo

Section H: Farm labour and size

H01. What is the total household size and how may this contribute to your farm's labour force? Fill in the table below:

s/n	i. Name of family member	ii. Age (years)	iii. Sex 0=male; 1=Female	iv. Approximate number of hours working on the farm per day
a				
b				
c				
d				
e				

H02. Apart from family labour, do you use hired labour or none family members to work on the farm? 0=Yes; 1=No

H03. If yes, how do you hire them? 1.Each year ( ) 2. Occasionally ( )

H04. How does this help solve your labour shortage? (a). Able to cultivate more land; (b). Able to have more farm enterprises; (c). Others (specify) ……

H05. How much money did you spend in 2015/16 for paying hired labour? …….. Tzs

Section I: Respondents membership to farmer's organizations

I01. Do you belong to any farmers' association? 1. YES ( ) 2. NO ( )

I02. If yes how many members are in the association? .....

I03. When was the group formed? .....

I04. What are the benefits accrued from the group?

(a) Agronomic practices/knowledge sharing; (b) Input-output market; (c) Credit and saving

(d) Safety net (risk sharing); (e) Others (specify)

Section J: Respondents' access to extension services

J01. Did an extension worker visit your legume farm during the last cropping season 2015/2016? 1= Yes ( ) 2= No ( )

J02. If yes, how many times did the extension worker visit to provide advice about farming? …….. Number of visits in 2015/2016

J03. What topics were discussed during the visit?

(a).Seeds; (b) Fertilizers; (c) Pests and diseases; (d) Pesticide uses; (e) Cropping practices; (f) Soil types; (g) Other (specify) …….

J04. Did any extension worker from an NGO visit your legume farm during the last cropping season 2015/2016? 1= Yes ( ) 2= No ( )

J05. If yes, how many times did the extension worker from the NGO visit to provide advice about farming? …….. Number of visits in 2015/2016

J06. What topics were discussed during the visit?

(a).Seeds; (b) Fertilizers; (c) Pests and diseases; (d) Pesticide uses; (e) Cropping practices; (f) Soil types; (g) Other (specify) ……

MODULE K. Access to Inputs in the Past Two Production Seasons (Year 2015/16)

K01. Access t input: fill in the table below:

Type of Inputs	i. Did you get access to? 1=yes 0=no	ii. Where did you get it from? (source)	iii. How many kilograms did you get?	iv. How much did it cost per unit (Tsh)	v. Distance from house to the source (km)	vi. Time taken to get to the source (min)	vii. Main constraints in using the input
a)Basal fertilizer							

(DAP)							
b) Top dress Fertilizer (UREA)							
c) Certified Seeds							
d)Herbicides							
e)Fungicides							
f)Pesticides							
g)Animal Manure							

Code for source of inputs: a=purchased from market; b=purchased from stockists;c=purchased from other farmers; d=received from government; e=received from NGOs;f=others (specify) ……

Main access constraints: a=Too far from household, b=Unsuitable packaging (large)c=No knowledge of how to use d=No transport, e= others (specify)

Section L: Access to Credit

L01. Did you borrow money from any source last cropping season 2015/16? Yes/No

L02. If yes in question L01 fill in the blanks?

Source of borrowed Money	i) Borrowed? 1=Yes 0=No	ii) Amount Borrowed (TZS)	iii) For how many months did you borrow the indicated amount of money?	iv) How much interest did you pay for the indicated period?	v) Amount paid back within the promised period	vi)Purpose of borrowing
a)Relative(s)						
b)Friend(s)						
c)Government						

e)NGO/Church						
f) Informal savings and credit group						
g)Bank or microfinance institution						
h) Others (specify						

Codes for purpose and use of money: a=food purchase; b=non-food household necessities (Soap, Paraffin); c= Scholastic materials e.g. school fees, uniform, books; d=; Buying agricultural inputse=others (specify)…

Section M: Output from common bean

M01. How many bags of improved common bean seeds did you harvest in the 2015/16 cropping season? …….. (50kg/bag)

M02. How many bags of local common bean seeds did you harvest in the 2015/16 cropping season? …….. (50kg/bag)

M03. At what price did you selling the beans? Fill in the table below:

	i. January-March 2016 (Tzs/kg)	ii. October-December 2016 (Tzs/kg)	iii. Average price (Tzs/kg)
a)Improved common beans			
b)Local common beans			

Section N: Market access and availability of common bean seeds

N03. Do you have any problem in acquiring improved common bean seeds? 1=Yes; 0=No

N03. If yes, fill in the table below:

No.	Factors	Whether the factor in column 1 is the problem associated inacquiring improved common bean seed. 1=Yes; 0=No
A	High price	
B	Low quality of seeds	
C	Lack of market information	
D	No seed dealers in the vicinity	
E	Long distance to the seed dealers	
F	Other (specify)	

Section O. Assessment of the willingness to pay for improved common bean technologies

Scenario of Improved Common Bean Technologies

It is obvious, common beans are an important cash and food crop for most farmers in Tanzania. As a way of promoting the crop, the Government and other stakeholders come up with quite number of improved legume technologies. Farmers have different sources of accessing improved legume technologies. If all farmers could access the technologies offered by Government and other stakeholders, given that money is not a problem, the researcher wants to assess the value farmers attach to their preferred improved legume technologies.

NB: It should be noted that, the information to be collected here is for research purposes, meaning we are not going to sell anything or you are not going to pay anything

O01. Will you be willing to pay for improved common bean technologies indicated in the Table below?

Improved legume technologies and its market price (Tzs per kg or litre)	**i)Ability to pay for market price 0=yes 1=no**	**ii)If yes in column 2, are you still willing to pay (Code A)**	**iii)If no in column 2, could you be willing to pay (code B)**	**iv) How much are you willing to pay for your preferred technology?**	**v)Why are you willing to pay such money (Code C)**	**vi)If not willing to pay any amount, please state the reason (Code D)**
Common bean seeds =4000						
Basal fertilizers (NPK; DAP) =2000						
Boosting fertilizers (UREA) =1500						
Pesticides =20,000						
Herbicides=10,000						
Anti-fungal =12,000						

Key:

Code A: 1. +25%; 2. +50%; 3. +75%; 4. +100%

Code B: 1. -25%; 2. -50%; 3. -75%; 4. -100%

Code C: 1. the technology's worth is more than that amount; 2. because you can afford it; 3. you want to access good service/variety; 4. others (specify)

Code D: 1. the technology is not worth any amount of money; 2. you just don't want to spend money on the improved varieties; 3. you can still access technology from friends; 4. others (specify)

Section P: Attitudinal questions

P01. Effectiveness of communication channels and smallholder famers' adoption of improved legume technologies (*tick one of the alternatives given*). Rate the extent to which you agree or disagree with each of the following statement:

S/N	Attitudinal Statements	Extent of Agreement				
		1	2	3	4	5
A	Farmers grow improved legume seeds because seeds are readily available					
B	Farmers have knowledge on how to grow improved legume seeds					
C	Farmers grow improved legume seeds because they are not expensive					
D	Yields obtained from improved legume seeds are higher than from local legume seeds					
E	The taste of improved seeds is preferred by most of the people					
F	Improved seeds are not easily attacked by pests and disease					
G	Post-harvest handling of improved seeds is not difficult					
	Total					

Key: 1. strongly disagree 2. Disagree 3. Undecided 4. Agree 5. Strongly agree

THANK YOU FOR YOUR COOPERATION

Appendix 4.2: Questionnaire for SILT implementers (AFAP, CABI & FRI)

Title: Effectiveness of Communication Channels and Smallholder Famers Adoption of Improved Legume Technologies: A Case of Morogoro Region, Tanzania.

Specific objectives

i. To explore smallholder farmers awareness on improved legume technologies
ii. To determine the effectiveness of various awareness creation approaches on smallholder farmers understanding of improved legume technologies
iii. To assess the determinants of the smallholder farmers' willingness to adopt improved legume technologies

Introduction

The following questions aim at collecting information about costs used by SILT implementers (AFAP, CABI & FRI) in implementing extension methods when providing common bean information to smallholder farmers. Such information may be useful in strengthening the agricultural extension services in Morogoro Region and elsewhere. There is no right or wrong answer. Please write or tick where appropriate.

MODULE A: Background Information

SILT implementer: …… (1=AFAP, 2=CABI, 3=FRI)

MODULE B: Extension Method

B1. Which extension methods are you mostly using in disseminating improved common bean technologies to small scale farmers and what are the reasons for using those methods and how many farmers do you reach in ONE YEAR by the extension method you are using? Can you also estimate the cost needed to reach the estimated number of farmers? (**Fill in table below)**

No.	**Methods**	**B1. Do you use the listed extension methods? (1=Yes; 0=No)**	**B2. Reason(s) for using the selected method? (code is provided below the Table)**	**B3. Total number of farmers reached in one year with the method you selected)**	**B4. An estimate of the cost incurred to reach the estimated number of farmers with each selected method (in TZS)**
1	Field day				
2	Demonstration plots				
3	Farm field school				
4	Radio				
5	Technological briefs (Leaflets/brochures)				
6	Phone call				
7	Training and visiting				
8	Farmers exchange visits				
9	Others (specify)				

Code for question B2:

a) Less expensive

b) Take less time to prepare

c) Take less time to deliver information

d) Lessons are easily understood

e) Farmers centred

f) Many people are taught at time

g) Others (specify) …….

B. Rank of Cost Effectiveness of Extension Services

B1. Please rank the following extension methods in order of their cost effectiveness (defined in terms of reaching many farmers and delivering extension services with lower cost) on common bean technologies?

Methods	**D1. Rank of cost effectiveness (1 being the most effective and 8 being the least effective)**
Field days	
Demonstration plots	
Farm field schools	
Radio	
Leaflets/brochures	
Phone calls	
Training and visiting	
Farmers exchange visits	

THANK YOU FOR YOUR COOPERATION

Appendix 4.3: Key Informant Interview guide (checklist)

1. What kind of communication channels are normally used to create awareness on improved legume technologies in your area?
2. What types of improved legume technologies are usually disseminated in this area?
3. What communication channels are more useful in awareness creation in relation to adopting improved legume technologies?
4. What type of improved legume technologies are real practised/adopted in this area?
5. How much (in Tsh) are farmers willing to pay for the preferred legume technologies?
6. Do you have any opinion on the communication channels used to create awareness on improved legume technologies in your area?

THANK YOU FOR YOUR COOPERATION

Appendix 4.4: Focus group discussion guide

1. What kind of communication channels are normally used to create awareness on improved legume technologies in your area?
2. What types of improved legume technologies are usually disseminated in this area?
3. What communication channels do you find more useful in awareness creation in relation to adopting improved legume technologies?
4. What type of improved legume technologies are actually practised or have been adopted in this area?
5. What type of improved legume technologies are you willing to adopt in the future?
6. How much (in Tsh) are you willing to pay for the preferred legume technologies?
7. Do you have any opinion on the communication channels used to create awareness on improved legume technologies in your area?

THANK YOU FOR YOUR COOPERATION