http://www.n2africa.org/

Inducing the adoption of good agricultural practices by educating Tanzanian smallholder farmers – what works best and at what costs?

Verena Mitschke

MSc International Development Studies

900116 574 110

Wageningen University and Research

Development Economics Group

Marrit van den Berg

22nd of February 2017

Executive Summary

Most smallholder farmers in Tanzania depend on beans for daily subsistence. However, yields remain significantly below their potential, which is partly due to the lack of information about improved farming practices and the appropriate use of agricultural inputs. Therefore, N2Africa and its partners, notably the Centre for Agriculture and Bioscience International (CABI) and Farm Radio International (FRI) launched the Maharage Bingwa Campaign (MBC). This campaign aims to *"raise awareness of the benefits of improved common bean varieties combined with fertilizer (where appropriate) and good agricultural practices to support livelihood, food security and soil health benefits in smallholder farming families in Tanzania (especially Northern Tanzania)".* The MBC utilizes several information channels such as radio shows, while N2Africa facilitated demonstration plots.

The key questions any project is guided by are, does it generate impact and at what cost does it do so? Therefore, my MSc. thesis research with Wageningen University and Research Centre (WUR) under the N2Africa project aimed to evaluate the cost-effectiveness of the information dissemination approaches (IDAs) employed by N2Africa and its partners.

The research included the analysis of the different effects of the radio campaign and demonstration plot on the knowledge level of farmers regarding the improved cultivation of beans and their willingness to adopt the practices promoted by the IDAs. To determine their cost effectiveness, the increase in knowledge level was mirrored against the cost per farmer reached for each IDA.

The field work took place in Nov-Dec 2015, first covering interviews and meetings with N2Africa and its partners to gain a more detailed understanding of the IDAs and associated costs. Secondly, 166 farmers were interviewed in four villages in Lushoto to assess their level of knowledge with regard to the cultivation of beans. Forty of these farmers also answered a second questionnaire on the evaluation of the two IDAs (Table 1).

Table 1: OVERVIEW OF SAMPLE SOZES IN THE DIFFERENT VILLAGES.

Farmers / Village	Boheloi	Milungui	Mkunki	Mwangoi	Total
Demonstration Plot Exam	10	10	10	10	40
Demonstration Plot Exam and Evaluation	5	5	5	5	20
Radio Program Exam	11	10	10	5	36
Radio Program Exam and Evaluation	5	5	5	5	20
Control	17	10	15	8	50
Total	48	40	45	33	166

Table 2 shows the results of the cost-effectiveness analysis, showing that the average exam score of the demonstration plot group was significantly higher than the score of the radio program group and

the control group at a 5% confidence level. Therefore, the increase in knowledge level was greater for the demonstration plot group. Cost-benefit ratios for both IDAs were calculated with use of the following formula;

$$Average\ Cost - Benefit\ Ratio = \frac{Net\ Cost}{Net\ Benefit}$$

It was found that the cost-benefit ratio for the radio program was lower compared to the demonstration plot, which means that the effect of the radio program on the knowledge level of farmers was greater per USD spent.

Table 2: QUANITIFICATION OF COST-EFFECTIVENESS-ANALYSIS FOR BOTH IDAs.

	N	Mean Score	SD	Ø Knowledge Level Increase	Ø Costs per Farmer	Cost-Benefit Ratio
Control	50	0.3660	0.1645			
Demonstration Plot	60	0.5283	0.1510	16.2%	1.88USD	0.13
Radio Program	56	0.4589	0.1488	9.3%	0.36USD	0.065
Total	166	0.4560	0.1671			

Although the radio program had the potential to reach more farmers in a cost-effective way, the demonstration plot had a greater effect on the knowledge level of farmers and their intention to adopt the promoted practices.

The factor analysis on the components influencing the farmers' willingness to change their behavior revealed that the access to the demonstration plot and the credibility of the information presented during the radio show have a highly significant positive effect on the willingness of farmers to adopt the improved practices promoted by the IDAs, as shown in Table 3.

Table 3: COMPONENTS INFLUENCING FARMERS' WILLINGNESS TO CHANGE THEIR BEHAVIOR (FACTOR ANALYSIS).
The sign between parentheses shows the direction of the effect.

Willingness to Change Behavior	Demonstration Plot	Radio Program
Age of Household Head	0.010* (-)	
Household Head Finished Primary	0.064* (+)	
Information Credibility		0.002*** (+)
Presentation Quality	0.076* (+)	
Presentation Access	0.006*** (+)	

*p<0.1; **p<0.05; ***p<0.01

Based on this research, it is recommended to improve accessibility of demonstration plots and to take care that the information sources and the presenters of the radio program are trustworthy and credible. Most importantly, a mix of different IDAs is advisable, such as demonstration plots, radio

programs, comics and SMS. When doing so the following factors must be kept in mind; (a) the information of both/all IDAs need to be coherent, (b) the information needs to be presented in a way that farmers can understand (including local terms and no scientific words), and (c) the IDAs should include explanations about the target agro-ecological zone and region.

Lastly, it is crucial to conduct further research on the actual adoption of modern agricultural practices by the farmers to verify the results of this research. Also, the research could be scaled up to evaluate the cost-effectiveness of the radio program and the demonstration plot in other regions within Tanzania and the other IDAs employed by N2Afica and its partners.

Abstract

The research for this thesis was done from November until December 2015 in Lushoto, Tanzania to evaluate the cost-effectiveness of the information dissemination approaches employed by N2Africa and its partners and to analyze the factors that influence the farmers' willingness to adopt modern agricultural practices. It covered 166 interviews with farmers in order to evaluate the knowledge level of farmers with regards to the cultivation of beans, of which 40 were on the evaluation of the demonstration plot and the radio program. Furthermore, interviews were conducted with the partners of N2Africa in order to receive information on the Maharage Bingwa Campaign and the costs of the interventions. Simple Regressions and Independent Sample T-Tests were used to analyze the effect of the interventions on the knowledge of farmers regarding bean cultivation and to evaluate the cost-effectiveness of the different approaches. Furthermore, a Factor Analysis and a Simple Regression were done in order to see what factors influence the farmers' willingness to change their behavior. The results show that even though the radio program is more cost-effective, it is not necessarily the better alternative compared to demonstration plots. Especially easier accessibility and practicality are major advantages of the demonstration plot and induce behavior change. Regarding the radio program, credibility and trustworthiness play important roles for farmers to believe the information that are given during the show.

Acknowledgements

First of all, I would like to thank my supervisor Marrit van den Berg who made this research and thesis possible. Without her patience and understanding the writing of this thesis would not have been possible. Secondly, I would like to express my gratitude to Edward Baars, my supervisor at the International Institute of Tropical Agriculture for his valuable input, feedback and financial support, as well as Freddy Baijukya and the team of CABI and FRI. Next, I want to thank Dharmesh Ganatra who became a friend during the research in Tanzania and always supported me and my ideas. Furthermore, I am very thankful for the helpful and constructive advice of my study advisor Sudha Loman during the course of my study at Wageningen University. Lastly, I would like to thank my family and friends for their encouragement and patience. Special thanks go to Maximilian Barth who always believed in me and my ability to do this research and write this thesis.

List of Figures

List of Tables

List of Acronyms

ACSH	African Soil Health Consortium
CABI	Centre for Agriculture and Bioscience International
IDAs	Information Dissemination Approaches
IITA	International Institute of Tropical Agriculture
KIT	Royal Tropical Institute
MBC	Maharage Bingwa Campaign
ToC	Theory of Change
TRA	Theory of Reasoned Action

Table of Contents

1. Introduction

The Introduction includes a short section on the Background of this thesis. Next, the rationale for this thesis in form of a Problem Statement will be given, followed by the Research Questions and Hypotheses.

1.1. Background

In 2000, the international community agreed on a global agenda to eradicate poverty and hunger by 2015. While progress was made towards the Millennium Development Goals, poverty and food insecurity persist in many countries of Sub-Saharan Africa, where the agricultural sector is the largest sector of economy. Legumes like common beans play a central role in efforts to achieve food security and better people's livelihoods. They improve soil fertility, feed people and livestock, and generate income. In Tanzania in 2006, 75% of all smallholder farmers were dependent on beans for daily subsistence, which offer comparably low costs per calorie (CIAT, 2008). Yet, at 750kg/ha in 2010 (Karugia, 2013) yields remain dramatically below the potential 1500kg/ha to 3000kg/ha (Hillocks et al., 2006). Certified seeds and planting methods exist, but farmers' awareness, access to improved seeds and usage of these is small. This is because seed systems for legumes in Tanzania are weak. Seed companies are reluctant to invest in legumes due to unknown, low and fractured demand. Even though smallholders may want certified bean seeds, they are not available.

Therefore, the Centre for Agriculture and Bioscience International (CABI) with its partners launched the Maharage Bingwa Campaign (MBC) with the aim *to "raise awareness of the benefits of improved common bean varieties combined with fertilizer (where appropriate) and good agricultural practices to support livelihood, food security and soil health benefits in smallholder farming families in Tanzania (especially Northern Tanzania*)" (ASHC, 2015: 4). The MBC utilizes several information channels such as comics, demonstration plots and radio programs amongst others in order to educate the farmers about the cultivation of beans. The key questions any campaign or project is guided by are, does it generate impact and at what cost does it do so. Continuous monitoring and evaluation of the information dissemination approaches (IDAs) and their content is critical in order to provide data for improvement.

1.2. Problem Statement

There are a range of reasons contributing to the low yields by most smallholder farmers in Sub-Saharan Africa, such as bad performance of the local varieties because of their vulnerability to pests and diseases, unfavorable climatic conditions, use of traditional agricultural practices that lead to

poor crop management and low soil fertility (Hillocks et al., 2006, Bucheyeki & Mmbaga, 2013). Farmers tend to use the locally available varieties with low yield potential or recycle seeds (grains) from the last cropping cycle (Doss et al., 2003; Ouma et al., 2002), resulting in low yields per area and decreased bean production.

Similar problems prevail in the East African Community, where the agricultural sector faces major challenges despite its crucial role for poverty reduction and increased food security. Besides the low use of improved inputs such as seeds, fertilizers and modern technologies, the low yields can be explained by difficult climatic conditions, pests and diseases, inadequate access to agriculture extension services, poor infrastructure and limited access to capital. Increases in agricultural production since 1965 were mainly driven by the expansion of land under cultivation rather than efficiency gains (Karugia et al., 2013).

Tanzania, one of the main producers of dry beans worldwide (Ronner & Giller, 2013) faces low bean yields due to the reasons mentioned above. A short radio series called INUKA broadcasted all over he country revealed that the low use of good agricultural practices and modern technologies is mainly due to the lack of information about these. (ASHC, 2016). Farmers do not have sufficient access to valuable information that can help them to change their current practices (ASARECA & KIT, 2014), improve their livelihoods and close the yield gap currently prevalent in Tanzania. Therefore, the MBC was implemented to help farmers learn about new practices and use agricultural inputs appropriately. In order to ensure that farmers receive the information they need and that efforts and money are invested correctly, a quantitative and qualitative descriptive study that investigates the cost-effectiveness of the dissemination methods was necessary. With the help of this study the information and their way of distribution can be optimized for the farmers and their benefit.

1.3. Research Questions

How cost-effective are the IDAs employed by N2Africa and its partners in the MBC with regards to educating farmers about good agricultural practices and inducing behavior change?

I. What are the costs incurred by each IDA?

II. Which IDA is more effective regarding the education of farmers about good agricultural practices?

III. How many farmers are reached by each IDA?

IV. What factors influence the farmer's willingness to adopt new agricultural practices?

1.4. Hypotheses

I. Demonstration plots are more effective than radio programs in promoting knowledge and due to the power of visualization and farmers' participation.

II. Radio programs are less effective because of access obstacles for farmers and the requirement for self-initiative.

III. Radio programs are a more cost-effective IDA compared to demonstration plots due to their reach and simplicity.

IV. The farmers' willingness to change their behavior is influenced by the quality of the information and their presentation.

2. Context of the Study

This section will cover several topics that are crucial to understand the context in which this thesis is embedded. First, light will be shed on the bean yields in Tanzania, followed by a description of farmers' awareness about modern farming practices. Afterwards, the information needs of famers will be described. Next, the MBC and its partners will be presented in detail and the cellphone penetration and literacy level in Tanzania will be explained.

Yield Gap

The most important grain legume crop grown in Tanzania is Common Bean, also known under the scientific name Phaseolus vulgaris L. (Hillocks et al., 2006). Most of the bean production in Tanzania is done by smallholder farmers for home consumption (Okigbo, 1977 in Giller & Amijee, 1998; Hillocks et al., 2006, Ronner & Giller, 2013). It was estimated that 75% of all smallholder farmers in Tanzania were dependent on beans for daily subsistence in 2008. Due to their lower cost per calorie compared to maize, beans are a strategic crop to eradicate poverty and food insecurity in Tanzania (CIAT, 2008; CGIAR, n.d.). Even more importantly, beans are an affordable source of proteins in most parts of Africa (USAID, 2016) and provide about 65% of protein consumed in Tanzania and its neighboring countries (Blair, et al., 2010). Even though beans are cultivated all over the country, the main areas of production are situated in the middle and high altitudes where rainfall is more reliable and temperatures more moderate. Therefore, beans are mostly grown in the Northern region, especially around Arusha, the Southern Highlands and The Great Lakes region in the West (Hillocks et al., 2006).

Beans are not only a vital component in crop rotation due to their ability to fix atmospheric nitrogen in the soil, but they also serve as a protein-rich supplement to farmers' diets and as a cash crop

(Krouma et al., 2006). Additionally, the residues of beans provide an excellent source of feed to livestock (Shiferaw et al., 2008), which is especially important during the dry season when animal feeds are not sufficiently available.

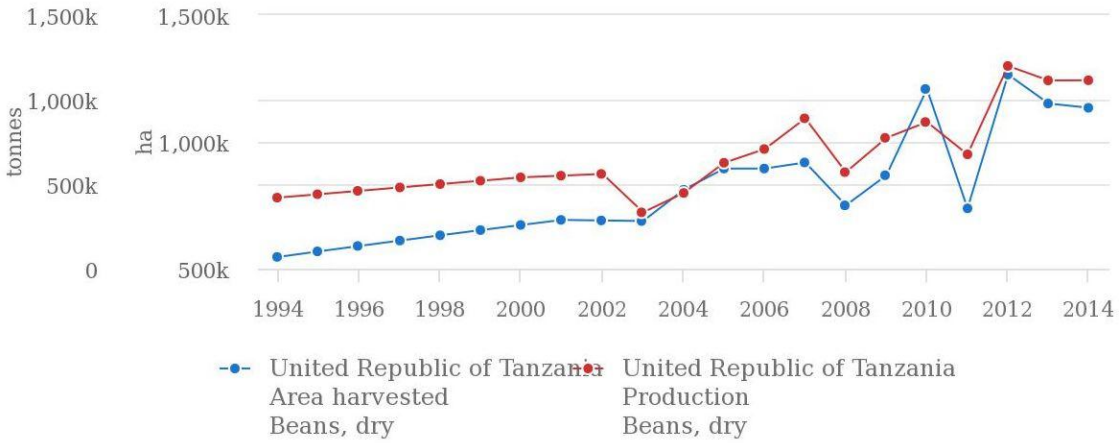
A study by Karugia et al. shows that bean yields rose marginally from 700kg/ha in 1970 to 800kg/ha in 1995 in the EAC, and dropped to 600kg/ha in 2010 (2013). When comparing the numbers of the EAC with other regions such as Egypt, Lybia and Sudan where yields of dry beans are above 2000kg/ha, it becomes obvious that a huge yield gap exists within the EAC (Karugia, 2013).

Estimates for the year 2006 show that the average bean production of Africa was 799kg/ha, while the world produced 1235kg/ha on average (FAO, 2008). Tanzania, a country ranking 7th among the major bean producers worldwide (Ronner & Giller, 2013), had an average yield of 1100kg/ha in 2013 (FAO, 2015), meaning that the country does not exploit its potential to reach bean yields ranging between 1500 and 3000kg/ha (Hillocks et al., 2006). Even though bean production in Tanzania rose from about 400kg/h in 1994 to about 1100kg/ha in 2014 as can be seen in Figure 1, this is mainly due to increased area under cultivation rather than increased productivity (Karugia, 2013; FAO, 2015).

There are several shortcomings contributing to the yield gap prevalent in Tanzania, such as unreliable irrigation, non-use of improved varieties and other inputs, inadequate crop and land management (Hillocks et al., 2006).

Additionally, particularly in the Northern Region soils lack nitrogen, potassium and phosphorus, which is mainly due to continuous farming and insufficient or non-existent replacement of nutrients. Also, monoculture and soil erosion play a vital role in the decline of soil fertility. The availability of improved seeds, associated technologies like fertilizer and good agricultural practices therefore have significant potential to increase bean yields (N2Africa, 2014) and improve farmers' living conditions.

Figure 1: PRODUCTION/YIELD QUANTITIES IN THE UNITED REPUBLIC OF TANZANIA, 1994-2014. *Source: FAO, 2015.*



Lack of Awareness

However, mere availability of these technologies and practices is not sufficient to overcome the low bean yields currently visible in Tanzania. As mentioned earlier, farmers lack the necessary information about good agricultural practices and the use of inputs, which keeps adoption rates low (ASHC, 2016). Therefore, the provision of relevant information and effective guidance to the farmers in combination with the supply of agricultural inputs are key to increase bean yields and improve farmers' livelihoods.

The Royal Tropical Institute (KIT) did an 'Information Needs Assessment' for Tanzania in 2015 which will be summarized below.

Sources of Information

KIT found that smallholder farmers currently mainly receive their information from their families and neighbors, extension workers, research institutes like the International Institute of Tropical Agriculture (IITA), and private extension activities that include demonstration plots and training by companies supplying agricultural inputs. Also, the 'Nane Nane Agricultural Fair', a one-week fair that takes place around the 8th of August in eight locations all over Tanzania offers farmers, researchers, agro-dealers and input companies the opportunity to show, explain and exchange new technologies.

A source of information mentioned quite frequently are product labels of agricultural inputs such as seeds and fertilizer. However, as this information is limited and often very broad it cannot be adopted by many farmers who are faced with different agro-ecological zones and climatic conditions. Furthermore, the labels merely inform the farmers about the dosage and recommended application practices. Therefore, farmers lack information on other stages in the cropping cycle such as land preparation and spacing.

Next, the private sector was mentioned as an information source, especially agro-dealers. Due to the fact that agro-dealers mainly receive their information from the product labels they can hardly assist the farmers.

Also, public extension workers are a source of information for farmers. However, Tanzanian farmers find themselves confronted with weak public extension. It is estimated that one extension worker serves 470 up to 2.300 households at the same time, implying a national average of 1 to 630. Additionally, these numbers combine livestock and crop, even though only the second category is important for ASHC campaigns. About 63% of all officers employed in the agricultural sector in 2012 were crop specialists. However, as the Tanzanian government was and is making an effort to increase the number of extension workers, the numbers increased from 10.890 to 15.800 in 2015.

Another source of information for smallholder farmers in Tanzania are the demonstration plots where new products are presented. These are often organized and financed by input suppliers to market their products and include the provision of information on improved agricultural inputs and training. The problem arising with demonstrations organized by input companies is that most of the attendees are agro-dealers and public extension workers who can bring along a few lead farmers. This means that the majority of farmers is not able to receive the information provided by input companies. Furthermore, demonstration plots organized by private extension are often limited to export commodities like tea and coffee, while extension activities by NGOs are mostly targeted at certain areas.

From time to time research institutes produce and distribute posters promoting new varieties or improved agricultural practices. Farmers can mostly find them at agro-dealer shops, district agricultural offices or local village headquarters. In general, it can be said that written materials such as flyers and leaflets were mentioned to be limited regarding their quantity.

Lastly, a few farmers considered radio and TV shows as helpful sources of information. However, due to the irregular times agricultural programs are broadcasted at and the limited applicability of the given information to different agro-ecological contexts, the use of this information is limited.

Information Needs

Besides the sources of information, KIT also investigated the information needs of smallholder farmers in Tanzania.

Besides maize, potatoes and vegetables, beans were mentioned most frequently as the crop for which more information is needed. Especially information on new seed varieties, fertilizers and

pesticides was considered to be important as new products are constantly launched on the markets. Information on seed varieties include details on proper spacing, weeding practices and additional agricultural inputs such as fertilizers and pesticides. With regards to fertilizers and pesticides it is crucial to provide farmers with clear instructions on what product should be used, the dosage for and timing of application as well as the relation to other agronomic practices.

Secondly, farmers are interested in learning more about crop diseases and pests. Information should be practical and provide details on the symptoms of the different diseases and pests, which pesticide to use when certain symptoms become visible as well as at what dosage and time they should be applied.

Lastly, post-harvest handling and market information were mentioned by farmers and should also be considered important. Due to suboptimal post-harvest practices like inappropriate storage the quality of the harvest declines, resulting in lower nutritional value and lower prices when the produce is sold on the market. Additionally, farmers often lack reliable and up-to date market information which inhibits them to sell the crop at the right market and time.

In general, it can be said that farmers need information on the whole cropping cycle in order to successfully grow beans, ranging from land preparation, planting and weeding to marketing.

Literacy and Cellphone Penetration

In 2013, 76% of the male population aged between 15 and 24 years were literate, while 73% of the female population were literate (UNICEF, 2015). According to the World Bank, literacy rates among young males and females (15 – 24 years) were 85% and 87% in 2012, respectively. However, literacy levels among female and male adults above 15 years were a little bit lower, with 74% and 84%, respectively (World Bank, 2016a). This shows that younger people are slightly more literate than older people and that male adults are better educated than female adults.

As stated in an article in *The Guardian* in 2012, most children in Tanzania do not pass literacy and numeracy tests (Tran, 2012). Even though the access to education has improved over the last years, the quality has at least stagnated if not decreased. In 2015, only 35% of the children aged between 10 and 16 years passed a basic English test, while 57% and 45% passed a basic Kiswahili and numeracy test, respectively. Large differences can be seen among the regions in Tanzania. While 80.2% of the children in Arusha region passed a test that combined all three subjects, only 66.4% of the children in Tanga did (Uwezo, 2012). Therefore, literacy was and remains a major problem in Tanzania.

Additionally, the World Bank and the United Nations International Children's Emergency Fund found that about 57 per 100 people had a mobile cellular subscription in 2012 (World Bank, 2016b; UNICEF, 2013). This number slightly increased up to about 63 per 100 people in 2014 (World Bank, 2016b), showing that that cellphone penetration in Tanzania is growing and relatively high.

Maharage Bingwa Campaign

CABI, an international non-profit organization that *"improves people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment"* (CABI, n.d.), initiated a project called Africa Soil Health Consortium (ASHC). This project, which is supported by the Bill and Melinda Gates Foundation, *"aims to improve the livelihoods of smallholder farmers through better access to practical information about integrated soil fertility management"* (CABI, 2014). Since 2011, ASHC has worked with more than twenty-one partner institutions including national agriculture research organizations, non-governmental organizations (NGOs) and donor funded initiatives in order to bridge the gap between soil scientists and people in need of information. Target countries so far were Ghana, Kenya, Uganda, Tanzania, Ethiopia, Malawi, Rwanda and Mozambique (CABI, 2014).

Until now, ASHC and its partners have generated about 100 innovative communication materials on several crops, namely maize, cowpea, soya, sorghum, millet, cassava, coffee and banana. The materials do not only cover print, but also audio-visual and radio formats and are available in multiple languages to fit the needs of the target region (CABI, 2014).

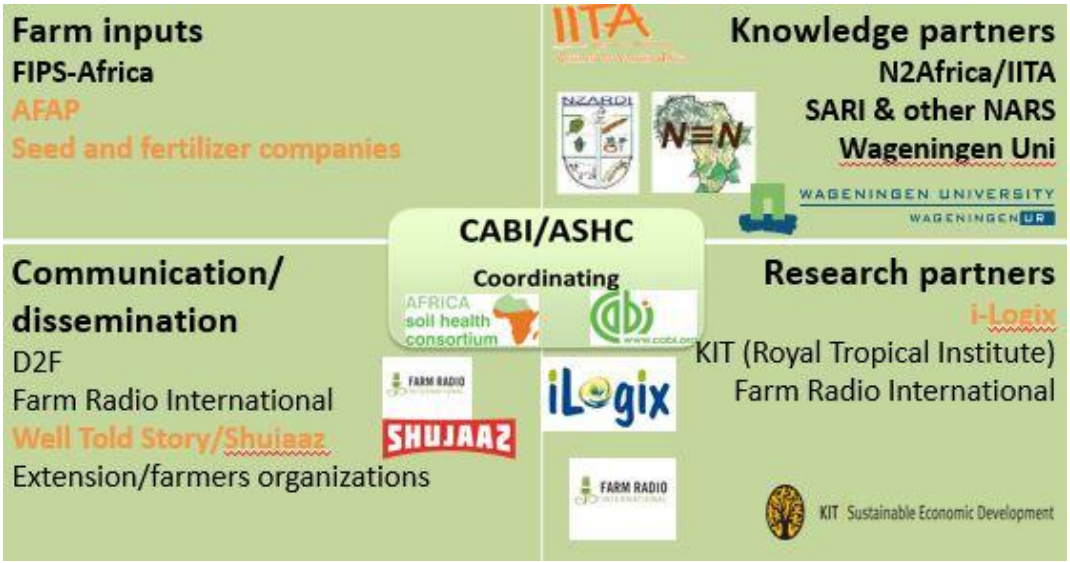
While the first phase of ASHC ended in November 2014, Phase II has started and continues to support the development of communication and extension materials and the integration of information from the various partners. However, the focus now is on creating clusters of partners that are willing and able to collaborate in scale-up campaigns that address specific topics and intermediaries (ASHC, 2015).

The first cluster of partners under Phase II of ASHC is the Legume Alliance, which has initiated a campaign on common bean in Tanzania, the Maharage Bingwa Campaign. It is a so called 'alliance of the willing' with the objective to *"raise awareness of the benefits of improved common bean varieties combined with fertilizer (where appropriate) and good agricultural practices to support livelihood, food security and soil health benefits in smallholder farming families in Tanzania (especially Northern Tanzania)"* (ASHC, 2015: 4).

This is done by seeking a combination of media and approaches that can support changes in attitude and behavior, and input supply chains. At the moment, the partners that bring together their unique expertise in the campaign are clustered into four categories: (i) Farm inputs; (ii) Communication and dissemination; (iii) Knowledge partners; and (iv) Research partners (Figure 2).

N2Africa, a project of Wageningen University, which represents one of the knowledge partners of the MBC has a vested interest in evaluation and improving the campaign activities in order to ensure success.

Figure 2: PARTNERS OF THE MBC. *Source: ASHC, n.d.*



3. Theoretical Framework

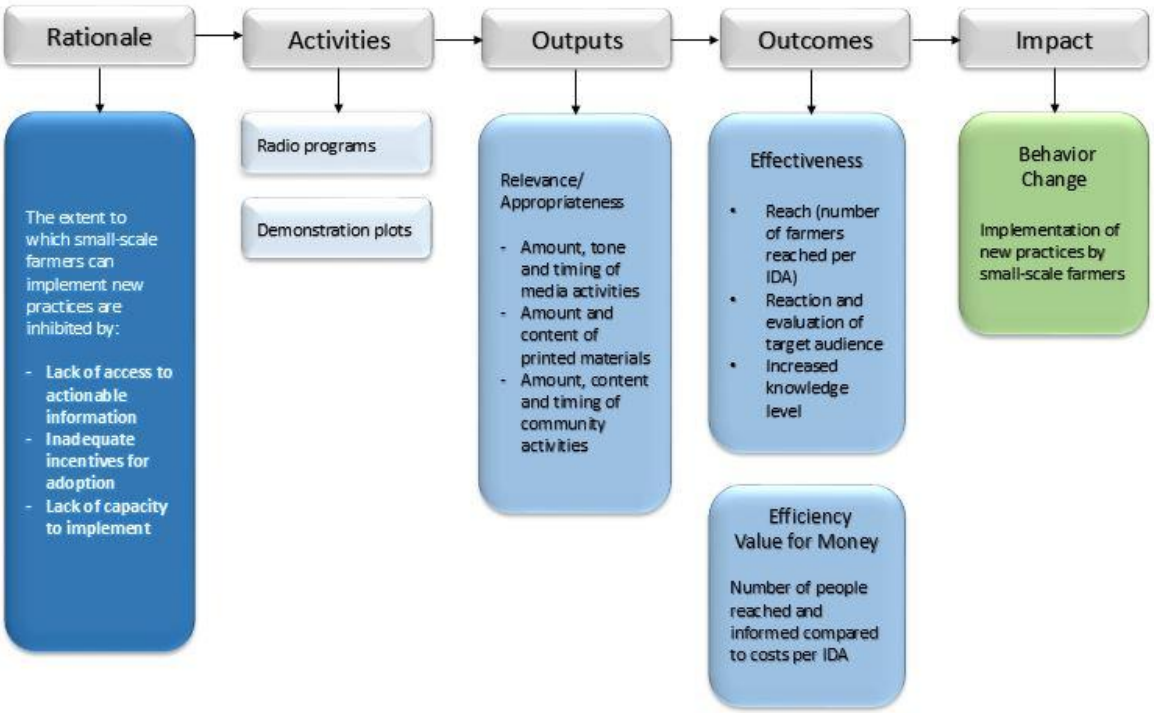
The theoretical foundation of the thesis will be provided by the theory of change, communications theory, and a theory on cost-effectiveness. The two former theories will underpin the analysis of the effectiveness of MBC, which must be the first step before any kind of cost-effectiveness analysis can be undertaken. This is because without a complete picture of the effectiveness of MBC, there would be no unit of reference against which the expense-benefit ratio (known as cost-effectiveness) could be determined, e.g. $US per farmer reached. Finally, the chapter will contain sets of indicators.

3.1. Theory of Change

The Theory of change (ToC) will serve as a larger framework (Figure 3). Its principle contribution to the analysis is the understanding of how change in development occurs. The theory lays out different stages in the process of change that will also guide the way the analysis is structured. According to ToC, change in development consists of inputs, outputs, outcomes and impact. ToC emphasizes that

especially the linkages between the different phases as well as how actors engage and shape them should be studied in order to understand the dynamics of change. However, theory of change must rely on other more specific theories for detailed analysis, here the Communications Theory by Atkin and Rice (2012).

Figure 3: THEORY OF CHANGE FOR RESEARCH PROJECT.



3.2. Communications Theory

Based on Atkin and Rice (2009) and Roger and Storey (1987), MBC can be defined as a pubic communication and information campaign representing attempts to inform and/or influence behavior towards desirable behavior in large target audiences. They do so within a specific time period and employ an organized and structured bundle of communication and information activities and feature a set of mediated messages via several different communication channels. This way they intend to produce noncommercial (and commercial) benefits to a society or individuals (Atkin & Rice, 2009; Roger & Storey, 1987). Through the coordination of media efforts in combination with a mix of other interpersonal and community-based communication channels, campaigns are able to maximize their chance of success. In order to achieve certain objectives, a mix of techniques and strategies is involved.

3.2.1. Types of Communication Campaigns

This section provides an overview on the different types of communication campaigns and a variety of theories as well as a framework for their evaluation.

In general, there are two types of communication campaigns, namely Individual Behavior Change Campaigns and Public Will Campaigns (Table 1). Individual Behavior Change Campaigns try to change an individuals' behavior that leads to social problems or promotes behavior that improves individual and social well-being (Coffman, 2002). On the other hand, Public Will Campaigns attempt to mobilize public action for policy change by legitimizing or raising the importance of a specific social problem to the public (Coffman, 2002; Henry and Rivera, 1998 in Salmon et al., 2003). The MBC can be categorized as an Individual Behavior Change Campaign, as it attempts to educate farmers about modern agricultural practices and consequently change their behavior, which will be beneficial for the farmers' well-being.

Table 4: TYPES OF COMMUNICATION CAMPAIGNS. *Source: Coffman, 2002.*

Campaign Type/ Goal	Individual Behavior Change	Public Will
Objectives	- Influence beliefs and knowledge about a behavior and its consequences - Affect attitudes in support of behavior and persuade - Affect perceived social norms about the acceptability of a behavior among one's peers - Affect intentions to perform the behavior - Produce behavior change (if accompanied by supportive program components)	- Increase visibility of an issue and its importance - Affect perceptions of social issues and who is seen as responsible - Increase knowledge about solutions based on who is seen as responsible - Affect criteria used to judge policies and policymakers - Help determine what is possible for service introduction and public funding - Engage and mobilize constituencies to action
Target audience	Segments of the population whose behavior needs to change	Segments of the general public to be mobilized and policymakers
Strategies	Social marketing	Media advocacy, Community organizing and mobilization
Media Vehicles	Public service/affairs programming; Print, television, radio, electronic advertising	News media; Print, television, radio, electronic advertising
Examples	Anti-smoking, condom usage, drunk driving, seat belt usage, parenting	Support for quality child care, afterschool programming, health care policy

3.2.2. Evaluation of Communication Campaigns

The usual outcomes of Individual Behavior Change Campaigns are *"awareness, saliency, attitudes, social norms or context, and finally behavior change or action"* (Coffman, 2002: 10). To evaluate these campaigns, four basic types of evaluation can be distinguished. While the first type – formative evaluation – represents front-end evaluation, the other three types – process, outcome, and impact evaluation – represent back-end evaluation (National Cancer Institute, 1992 in Coffman, 2002).

Table 5: EVALUATION TYPES FOR COMMUNICATION CAMPAIGNS. *Source: Coffman, 2002.*

Evaluation Type	Definition/Purpose	Example Questions
1) Formative	Assesses the strengths and weaknesses of campaign materials and strategies before or during the campaign's implementation.	- How does the campaign's target audience think about the issue? - What messages work with what audiences? - Who are the best messengers?
2) Process	Measures effort and the direct outputs of campaigns – what and how much was accomplished. Examines the campaign's implementation and how the activities involved are working.	- How many materials have been put out? - What has been the campaign's reach? - How many people have been reached?
3) Outcome	Measures effect and changes that result from the campaign. Assesses outcomes in the target populations or communities that come about as a result of grantee strategies and activities. Also measures policy changes.	- Has there been any affective change (beliefs, attitudes, social norms)? - Has there been any behavior change? - Have any policies changed?
4) Impact	Measures community-level change or longer-term results that are achieved as a result of the campaign's aggregate effects on individuals' behavior and the behavior's sustainability. Attempts to determine whether the campaign caused the effects.	- Has the behavior resulted in its intended outcomes (e.g. lower cancer rates, less violence in schools) - Has there been any systems-level change?

This thesis seeks to do a Process Evaluation and partly an Outcome Evaluation (Table 2).

A Process Evaluation is the first type of back-end evaluation and is seeking to assess how well the campaign was delivered. It answers questions on how many materials have been distributed and how much media time broadcasted. Also, it estimates of how many people were reached by the campaign or the campaign's exposure, which is more difficult to capture. A process evaluation does however not assess the effects of the campaign and is therefore not meaningful from a causal point of view (Coffman, 2002).

Next, an Outcome Evaluation measures the outcomes in the target population. This is usually done before and after the campaign is implemented, but can also be done during the campaign. It is supposed to assess to what degree the campaign affected the target population in terms of several indicators, such as attitude, behavior or policy change (Coffman, 2002).

Even though behavior change will not be assessed within the framework of this thesis in detail, theories dealing with behavior change will be used as this represents the final goal of the MBC. However, in order to reach this goal, farmers have to be given appropriate information on the basis of which they are able to change their current practices. Therefore, the first step is to evaluate whether the information provided to the farmers actually change their level of knowledge about certain topics, modify their attitude towards and increase the likelihood to adopt new technologies.

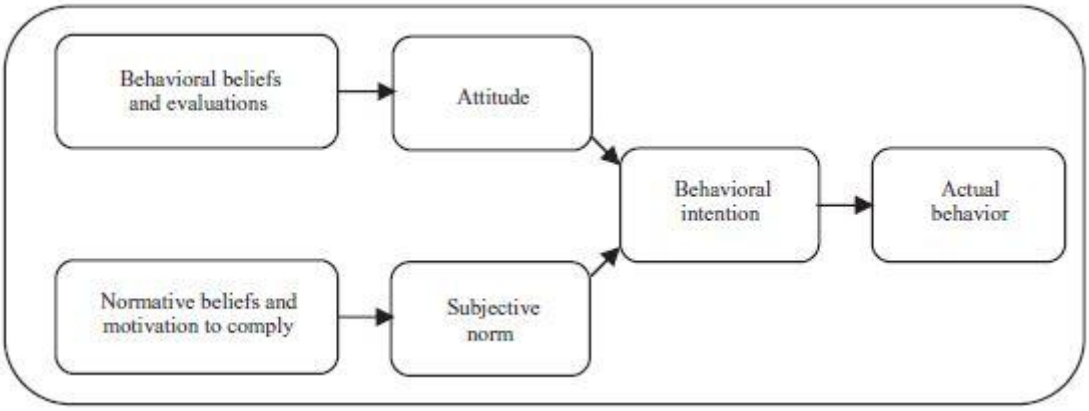
3.2.2.1. Theories for the Evaluation of Communication Campaigns

As a basis for a campaign's implementation and evaluation, it needs to be provided with a theoretical base (Fishbein et al. 1997 and Valente, 2001 in Coffman, 2002). This is because in order to change behavior, there is a need to understand why people behave the way they do (Fishbein et al, 2001 in Coffman, 2002) and what influences their decision-making. Andreasen pointed out that *"what is missing from most of the process models is any kind of underlying theoretical framework. The models tell managers what to do and in what sequence. But, they do not tie these steps to any particular framework that makes clear how what they do is supposed to work to impact crucial social behaviors. This is a role, however, that can be played by … social science theories … It is important to have some framework. Frameworks provide a basis for both research and strategy"* (1997: 8, 10).

A review by Coffman (2002) uncovered theories that can be used for a campaign evaluation. These are derived from the fields of public health, social psychology, communications, and clinical disciplines that deal with behavior change and the variables affecting it. In the following two theories will be explained in detail as they serve the purpose of this thesis best.

First, the Theory of Reasoned Action (TRA) (Figure 4) assumes that individuals are rational and will first consider the implications and consequences of their behavior before deciding whether to perform it (Ajzen & Fishbein, 1975 in Yousafzai et al., 2010). It is a well-established social psychological model suggesting that the performance of a certain behavior is mainly determined by the individual's intention to behave this way. These intentions are influenced by two major factors: (a) an individual's attitude towards, and (b) an individual's subjective norms about the behavior, also referred to as social pressure. In turn, an individual's attitudes and norms are influenced by behavioral norms and normative beliefs (Ajzen & Fishbein, 1980 in Coffman, 2002). The TRA is known and presented as a meaningful, intuitive and insightful tool to explain behavior (Bagozzi, 1982 in Yousafzai et al., 2010).

Figure 4: THEORY OF REASONED ACTION. *Source: Ajzen & Fishbein, 1980 in Coffman, 2002.*



Second, the Stages of Change Model views behavior change as a sequence of events or actions (Prochaska et al., 1992 in Coffman, 2002). The five stages included in the model are

(a) Precontemplation, in which people are not aware of the problem and do not intend to change their behavior,
(b) Contemplation, the step in which people are aware of a problem and thinking about changing their behavior,
(c) Preparation, the stage in which people intend to perform the behavior and attempt to adopt it,
(d) Action, when people actually change and modify their behavior due to several reasons, and
(e) Maintenance, the stage in which people work not to relapse and consolidate the benefits of their behavior change (Prochaska et al., 1992 in Coffman, 2002; Prochaska et al., 2013).

3.2.2.2. Framework for the Evaluation of Communication Campaigns

The following paragraph will deal with the Framework for Effective Campaigns by Weiss and Tschirhart (1994), which, even though not a model or theory as above, can be used as a framework for evaluating public communication campaigns. In the context of this thesis, it will serve as a guide for an outcome evaluation and the questionnaires. Even though each campaign is different, they all include some general components and characteristics.

Capture the Attention of the Right Audience. It is crucial for a campaign to consider its target audience(s) from the beginning of the development and design of the campaign. An understanding of the audience helps to tailor the communication and information campaigns to *the "views, needs and opinions"* of the audience (Weiss & Tschirhart, 1994 in Bloomfield et al., 2015: 5). Furthermore, the

audience is crucial for determining the types of IDAs used (Weiss & Tschirhart, 1994 in Bloomfield et al., 2015).

Deliver an Understandable and Credible Message. *A*s soon as the target audience is defined, the campaign needs to make sure the messages are well developed to reach their audience. Usually campaigns are most effective in reaching their goals when messages are creative, interesting and catchy (Weiss & Tschirhart, 1994 in Bloomfield et al., 2015; Weiss & Tschirhart, 1994 in Coffman, 2002). The following six general principles should be taken into account when developing and analyzing the messages that are being distributed to the audience: (1) simplicity; (2) unexpectedness;(3) concreteness; (4) credibility; (5) emotions; and (6) stories (Heath & Heath, 2007 in Bloomfield et al., 2015).

Deliver a Message that Influences the Beliefs or Understanding of the Audience. It is crucial to provide information that directly address the needs and problem of the audience and trigger norms. They should be well targeted in order to have the ability to change underlying value and preferences (Weiss & Tschirhart, 1994 in Coffman, 2002; Weiss & Tschirhart, 1994 in Bloomfield et al., 2015).

Create social contexts that lead toward desired outcomes. In order to be able to change behavior it is important to understand and evaluate the external influences and factors that determine the behavior of interest (Weiss & Tschirhart, 1994 in Coffman, 2002; Weiss & Tschirhart, 1994 in Bloomfield et al., 2015).

3.2.2.3. Quantitative and Qualitative Aspects of Communication Campaigns

Additionally, Atkin and Rice (2012) argue that qualitatively, campaigns can range in type from informational and simple to instructional/persuasive and complex, and define the following five elements as essential to the dissemination of information: (1)

conveyed through the trustworthiness of the source; (2) interesting and engaging style of presentation of message; (3) relevance for person; (4) comprehensibility; and (5) motivational content and incentives. Quantitatively, the success of a communications campaign depends on the overall volume of messages, repetition and frequency, prominence of placement, timing of dissemination and duration of campaign. For example, repetition can facilitate understanding and promote recognition, but too much repetition can lead to fatigue and ignorance. Also appropriate timing is important as information might only be relevant under certain circumstances and during a particular time of the year. Furthermore, campaigns should be maintained over longer periods of time in order to accommodate newcomers, backsliders, vacillators and latecomers alike. Concerning

actors, Atkin and Rice also address the role of so-called interpersonal influencers, subset actors within a group who through facilitation, enforcement and serving as a role model can maximize and expedite changes in knowledge, attitude and behavior (2012). Last but not least, Atkin and Rice (2012) put forward the notion that information dissemination can occur in various directions and on various levels including monologue, feedback, responsive dialogue and mutual discourse.

3.3. Cost-Effectiveness Analysis

A ratio between inputs and outputs is usually referred to as efficiency. The more efficient a system is, the more output it obtains for a given set of inputs or achieves similar levels of output with fewer inputs, other things equal. When education is under consideration, the term output usually refers to the development of the participants that can be attributed to a specific intervention. Participant development does not only include literacy and numerical skills, but also other skills and attitudes. The net improvement in skills due to education is often called 'value added'. Even though educational efficiency and educational effectiveness are frequently confused, it is clear that what is most effective is not necessarily most efficient (Lockheed & Hanushek, 1988). Generally, the term effectiveness deals with the question whether sufficient output was produced by a certain intervention, whereas the term efficiency refers to a ratio between inputs and outputs. However, according to Lockheed and Hanushek (1988) the following categorization of efficiency and effectiveness is useful. First, the nature of the inputs determines if an intervention is effective or efficient. This means, if non-monetary inputs are used for an intervention the term effectiveness should be used, while the term efficiency should be applied for interventions with non-monetary inputs. Furthermore, the output of an intervention informs the evaluator about whether efficiency and effectiveness are internal or external. Similar to the explanation above, non-monetary outputs imply internality, whereas monetary outputs imply externality. For example, the educational effect of an intervention is internal when it can directly be linked to the intervention, whereas the possible effect on income (measured in monetary terms) is external. However, this categorization is nit rigid and different cases can be observed in reality (Lockheed & Hanushek, 1988).

As the inputs to the IDAs of the MBC are measured in monetary terms and the output in non-monetary terms, the category of interest for this thesis is internal efficiency, which is typically used for cost-effectiveness analyses. This term refers to a ratio of learning or knowledge development to the costs of the educational intervention, or more general to a ratio of non-monetary output to the unit costs. A cost-effectiveness analysis seeks to answer the question how resources should be best allocated in order to achieve the highest possible output. There is a simple conceptual rule employed

by economists to determine how funds should be spent vis-à-vis several alternatives. Given a set of different interventions and a certain amount of money, decision-makers should always choose the project that provides the highest output (Lockheed & Hanushek, 1988).

In the 1950s, the United States Department of Defense developed the cost-effectiveness analysis as a *"device for adjudicating among the demands of the various branches of the armed services for increasingly costly weapons systems with different levels of performance and overlapping missions"* (Hitch & McKean 1960 in Levin, 1995: 381). Even though the cost-effectiveness analysis has not become a tool to consider the appropriate allocation of educational resources worldwide, it was widely used in the United States as such in the early 1990s (Levin, 1995).

In order to assess the cost-effectiveness of the two IDAs employed by the MBC, it is important to define and distinguish the term cost-effectiveness from cost-benefit and cost-utility (Levin, 1983). All of the terms above describe an approach to compare the costs and the outcomes of alternative programs. However, a cost-benefit analysis assesses the outcomes in terms of their monetary value, whereas a cost-utility analysis evaluates the outcomes in terms of their subjective value to the decision-maker (Lewin 1983). Importantly, even though a cost-effectiveness analysis also identifies and places monetary values on the costs of an intervention, its unit of effectiveness is simply a measure of any quantifiable outcome (Cellini & Kee, 2010). Therefore, all three analyses have the same methodology regarding the cost measurement but use different approaches with regards to their measurement of the outcome.

As most educational programs are meant to improve achievement or any other educational outcome that cannot be easily converted into monetary terms, the comparison of alternatives is automatically limited to programs with similar goals (Levin, 1995; Levin, 1988). A cost-effectiveness analysis can help to answer the question which alternative can achieve the program objective at the lowest cost.

The basic technique of cost-effectiveness analyses is to derive results for educational effectiveness of each alternative by using evaluation studies (Rossi & Freeman, 1985 in Levin, 1988) and to combine these with the costs per alternative. The costs incurred by each alternative can be calculated with the help of the ingredients approach, which was developed to equip evaluators with a systematic approach for estimating the costs of a project (Levin, 1975; Levin 1983).

3.3.1. Measuring Cost-Effectiveness

Before being able to do a cost-effectiveness analysis, four questions need to be answered: 1) What is the decision problem; 2) How can effectiveness be measured; 3) Which alternatives have to be considered; 4) What are the effects of the alternatives? As soon as the problem is well understood it is necessary to think about how the effectiveness of a solution can be assessed, which asks for clear measures. Having established the problem and the criteria for assessing the effectiveness of possible solutions, alternative interventions can be formulated and their effectiveness estimated (Levin, 1988).

As mentioned by Lockheed and Hanushek, an appropriate standardized achievement test is a valuable tool in order to evaluate participant learning and performance (1988). Standardized means that the tests are *"constructed, administered, scored, reported and interpreted in a consistent fashion to provide for the measurement of individual differences in as unambiguous way as possible"* (Lockheed & Hanushek, 1988: 26).

3.3.2. Cost Estimation

The ingredients method is based on a straightforward approach to estimate the costs incurred by a social intervention. The basic stages of the Ingredients Approach will shortly be outlined below.

In general, the costs of an intervention are defined as the value of the resources that are used for it, also referred to as 'ingredients of the intervention'. The Ingredients Approach distinguished three phases: 1) identification of ingredients; 2) determination of the costs of the ingredients and the overall costs of the intervention; 3) an analysis of the costs (Levin, 1988).

Firstly, the ingredients necessary for the intervention have to be identified. This includes personnel, facilities, equipment as well as other resources. It is crucial that all resources are included and described in detail in order to be able to express them in monetary terms (Levin, 1988).

Secondly, the costs have to be determined, meaning that once the ingredients have been ascertained, their costs have to be estimated. The underlying assumption here is that all ingredients have a cost, whether they are actually paid for or donated (Levin, 1988). Even though the estimation of the costs seems to be straightforward, it can be very difficult as costs have to be directly linked to the inputs (Lockheed & Hanushek, 1988).

Lastly, the costs have to be analyzed, which means that once the costs for the ingredients have been determined, they can be added in order to obtain the total costs for the intervention. At this stage the unit for expressing the costs and the question who pays the costs have to be considered. It is

obvious that the unit in which costs are expressed depends on the measurement unit of effectiveness. In most cases, educational effectiveness is measured in terms of achievement gains per participant. Therefore, it becomes necessary to calculate the costs per participant to compare alternative intervention, resulting in a cost-effectiveness ratio which is based on average effects and costs per participant. The average cost effectiveness of an intervention can therefore be described with the following equation:

$$\textit{Average Cost-Effectiveness} = \textit{Net Cost}/\textit{ Net Benefit} \qquad (1)$$

However, if this approach is not feasible it is possible to analyze the total costs of the intervention. Additionally, it is crucial to differentiate between the several actors who bear the costs of the program as the total costs may be entirely irrelevant for the decision-maker (Levin, 1988). The attribution of the costs to the different stakeholders would be beyond the scope of this thesis. Therefore, only the total costs of the interventions will be taken into account.

3.3.3. Interpretation of Results

When information on the costs and the effectiveness on each of the alternatives is gathered, a decision based on these cost-effectiveness ratios can be made within the context of limited resources. Usually, the alternative with the lowest costs relative to the effects is considered the best alternative and should be prioritized by the decision-maker. Even though cost-effectiveness ratios can inform the decision-maker, they should never be mechanically translated into decisions. The following four issues have to be considered and discussed before a final decision can be made (Levin, 1988).

Firstly, the question whether *"the results are representative for the level of scale of the intervention that is appropriate"* has to be raised (Levin, 1988: 56). It has to be taken into account that the costs per participant in an intervention can differ significantly when used for 30 or for 1.000 participants. Therefore, it is necessary to ensure that *"the scale of use on which the cost-effectiveness ratio is based is pertinent to the decision-making context"* (Levin, 1988: 56).

Next, one has to ask whether an increase in costs also raises the effect by the same factor. This means, if for example $18 per participant generate one additional unit of effectiveness, would $180 generate 10 additional units? We cannot know the answer to this question without further analysis of effectiveness under different scenarios of resource use, but generally the results are considered to only hold for small changes in resource intensity (Levin, 1988).

Thirdly, in case the magnitude of differences between the alternative interventions are small, say 10% to 20%, it is advisable to use other criteria in the decision-making process. This is due to the fact that the precision of the estimates highly depends on the quality of the data as well as on the evaluation methodology and implementation (Levin, 1988).

Finally, the question on whether the evaluation of effectiveness is appropriate has to be raised as the cost-effectiveness ratio can only be as good as the underlying evaluation of the costs and the effectiveness. Even though the costs can mostly be estimated quite accurately, the estimates of effectiveness are often confounded. For example, if differences in the population are not properly controlled for, the results of the intervention can be biased. Therefore, it is necessary to ensure that the estimated difference can truly be attributed to the intervention. Also, several outcome indicators for effectiveness can lead to a better estimate of effectiveness rather than a single outcome (Levin, 1988).

3.4. Indicators

Indicators serve as important benchmarks against which empirical observations can be classified and interpreted in order to answer the question of cost-effectiveness. Not all indicators are always directly relevant to answer the question but will eventually merge and provide a comprehensive analysis. Also, the indicators are of both, quantitative and qualitative nature. Due to the limitations of experiments to fully reflect reality, particular indicators and questions are rendered inapplicable.

In this chapter a set of evaluation indicators is created that is supposed to measure to what extent the activities have been cost-effective in reaching their objectives.

Cost-Effectiveness mainly covers four issues that can be formulated as the following indicators:

- **Coverage** - number of people reached.
- **Increased Level of Knowledge** – exam score of participants.
- **Costs per Unit of Output -** costs of dissemination method compared to number of people reached.
- **Costs per Unit of Outcome** - costs of dissemination method compared to knowledge level.

Additionally, the following three indicators will be added to the above list as they are deemed to be important for assessing the factors that influence the farmers' willingness to change their behavior and what source of information they would prefer in order to advice project leaders about how to improve the layout and the content of the IDAs.

- **Appropriateness of Information** - average score for overall rating of information.
- **Appropriateness of Presentation** - average score for overall rating of presentation and preferred source of information.
- **Behavior Change -** degree to which information and presentation motivate farmers to change their behavior.

4. Methodology

In this section the data collection methods and variable descriptions will be given. First, the intervention will be explained, then information on the sample of villages and farmers will be presented. Afterwards, an overview of the different variables and their way of measurement will be given. Lastly, the complete estimated model will be explained and the descriptive statistics displayed.

4.1. Data and Variables

4.1.1. The Intervention

The table below shows the structure of the experiment, which was conducted during the research from November until December 2015 (Table 3). In total, 166 farmers out of four villages in Lushoto District, Tanga Region (Figure 5) were assigned to either of the treatment groups or the control group. The required sample size for a rural population of about 219.000 (City Population, 2012) older than 15 years, a confidence level of 95% and a confidence interval of 8 would have been 150.

The intervention for the radio program group was that the farmers had to listen to a short session about how to plant beans that was originally aired by the radio station Sauti Njili. It is important to note that the experiment tried to mimic reality as far as possible.

Table 6: EXPERIMENTAL DESIGN.

		Time 1		**Time 2**	
		Assignment	Pretest	Intervention	Posttest
Group	Radio program	R		X	O_1
	Demonstration			X	O_2
	Control	R			O_3

Therefore, the farmers in the radio program group were not forced to listen to the program but were allowed to leave the room whenever they wanted. In detail, they were told that a short session on how to plant beans will be played to them in order to make use of the time until they were interviewed.

Next, the farmers in the demonstration plot group had seen the demonstration plot on how to plant beans prior to the experiment, which means that the intervention for this group took place before the actual research. This was mainly due to time and money constraints. The researcher was not able to set up a demonstration plot and invite farmers during the research. The farmers in the control group had neither seen the demonstration plot nor listened to the radio program

Please note that both the radio program and the demonstration plot covered the topic *planting beans* only as to make results comparable. After the intervention, farmers were asked multiple exam-like questions on the content of the radio program (Appendix I) and the demonstration plot (Appendix II) in order to evaluate whether their level of knowledge on planting has risen. These questions were specific to the content of the radio program and the demonstration plot. The same questions were given to the control group.

Figure 5: LUSHOTO DISTRICT, TANGA REGION, TANZANIA. *Source: Google Maps.*

The questionnaire was divided into 12 parts (Appendix III). Afterwards, five farmers of each treatment group and in each village were randomly chosen to answer a second questionnaire in order to identify the strengths and weaknesses of each IDA, and to analyze which attributes of the information and their presentation influence their willingness to adopt modern agricultural practices. This evaluation questionnaire was divided into five parts (Appendix IV).

4.1.2. Village Coverage and Sample of Farmers

As mentioned above, the farmers in the demonstration plot group had seen the plot before the actual research. This is why the villages where the experiments were conducted were chosen by a

village extension officer, as he had the necessary knowledge about the region and the demonstration plots that had only been set up in several places. The villages chosen were Boheloi, Milungui, Mkunki and Mwangoi, all situated in Lushoto District.

The above implies that the farmers in the demonstration plot group were not randomly assigned to this group. In order to ensure that they had seen the demonstration plot they were chosen by the village extension officer. He also collected the farmers for the radio program and the control group and made sure that none of the farmers in these groups had seen the demonstration plot or listened to the radio program before, as this would have biased the results. Once the farmers for the radio program and control group were chosen, they were randomly selected to either of the groups by assigning every second farmer to the control group.

Table 4 presents the number of farmers in each treatment and control group and in each village in detail. It shows that 166 farmers were interviewed in total. Furthermore, 50 farmers were part of the control group, while 60 and 56 farmers were in the demonstration and radio program group, respectively. The reason for the different numbers of farmers that participated in the research in each village was that farmers had lost their trust in scientific studies and development projects because researchers and development workers did not appear for meetings and interview sessions. Many farmers did not want to take part in another research and did not show up.

Table 7: SAMPLE OF VILLAGES AND FARMERS IN LUSHOT DISTRICT.

# Farmers / Village	Boheloi	Milungui	Mkunki	Mwangoi	Total
Demonstration Plot	15	15	15	15	60
Radio Program	16	15	15	10	56
Control	17	10	15	8	50
Total	48	40	45	33	166

4.1.3. Variables

The following section is divided into two parts: 1) explaining average exam score, and 2) explaining farmers' willingness to change their behavior.

Measurement of the Average Exam Score

In this thesis, the effect of the two IDAs demonstration plot and radio program on the **level of knowledge on planting beans** is measured in terms of an **exam score**. As mentioned earlier, farmers were asked multiple exam-like questions about the content of the radio program and the demonstration plot. The exam-like quantitative questionnaire included different questions that were

weighted according to their importance and lead to a final score. Farmers were able to obtain a maximum score of 100%. The different weights given to the questions that are based on pre-existing knowledge of the farmers and importance of the question can be seen in Table 5 and will be explained briefly.

Time for planting beans. As most farmers are aware of the time at which they should start to plant their beans, this question was only given a weight of 5%. Farmers were asked at what time of the year they should start to plant the beans. This is an important factor that has to be taken into account as the climate varies during the year and beans cannot be planted in the cold season, as their germination would be inhibited when a certain temperature is not reached. Additionally, beans have to be planted in the rainy season. The correct answer to this question is March up to April.

Reason for planting beans at mentioned time. This question was given a weight of 2,5% due to the fact that most farmers already know when to plant their beans. As explained above, certain conditions have to be fulfilled in order to grow beans successfully and harvest a decent amount. Farmers that mentioned climate, rainy season and temperature answered this question correctly.

Time for preparation of the field. This question was also given a weight of 5% as it is considered as important as the time for planting and because most farmers have pre-existing knowledge. Besides the question at what time farmers should start to plant, they were also asked to indicate when they should start to prepare their field. Preparation of the field should start in February to March, depending on the climatic conditions.

Fertilizer. Farmers needed to answer the question which fertilizers they should apply on their field in order to increase the yield. Possible answers were booster, DAP, NPK, Urea and organic manure. The different fertilizers were given different weights according to their importance for the cultivation of beans. Organic manure and Urea received a weight of 5%, as most farmers are already aware of organic manure and Urea as agricultural inputs. Furthermore, even though beans benefit from the application of organic manure and Urea, there are more vital inputs to increase yields. Two of the more important industrial fertilizers are Booster and DAP, which are therefore weighted with 7,5%. The most beneficial industrial fertilizer for the cultivation of beans is NPK, as it contains nitrogen and phosphorus. Even though beans already fix nitrogen in the soil, NPK substantially increases bean yields and is given a weight of 10%.

Combination of fertilizers. As this is considered to be crucial for the cultivation of beans, it is given a weight of 12,5%. Farmers were asked to indicate which of the fertilizers mentioned above should

best be combined. The correct answer in this case was organic manure and NPK, as organic manure improves soil fertility in general and NPK provides additional nitrogen and phosphorus to the beans.

Benefit of improved seeds. As most farmers are not aware of the benefits of improved seeds and use grains instead as well as the relevance of the question, it was given a weight of 10%. Possible correct answers were drought resistance or disease resistance. Farmers that mentioned one of the two answered this question correctly.

Seeds per hole. Because most farmers still use grains instead of seeds, this is an important question with a weight of 10%, as farmers need to know how many seeds they should put into one hole when using them. When asking the farmers about their planting method, a question about the number of seeds that should ideally be put into one hole was included. This question clearly referred to the number of seeds and not grains.

Planting method. As Lushoto region is hilly and ploughs hardly available, this question was only given a weight of 2,5% as farmers mostly mentioned hands due to the absence and inappropriateness of any other tool. This question referred to the mode of planting, meaning whether farmers should use their hands to grow beans or any other tools such as a plough. As it is most beneficial to grow beans by hands, this was the correct answer to this question. Any other tool inhibits the ability to grow beans in lines with a fixed distance (asked for in the next question).

Spacing. Because both the radio program and the demonstration plot put a lot of emphasize on this topic, it was considered most important and therefore received a weight of 15%. Farmers had to indicate at what distance bean lines and plants should be planted. It is advised to grow bean lines with a distance of 50cm and bean plants in one line with a distance of 25cm. If farmers mentioned these distances, the question was seen as answered correctly.

If farmers answered a question correctly they obtained ‘1’, if a wrong answer was given they scored a ‘0’. These numbers were then weighted according to the table above and a final score per famer and an average score among the farmers were calculated.

Table 8: OVERVIEW OF WEIGHTS FOR DIFFERENT TOPICS.

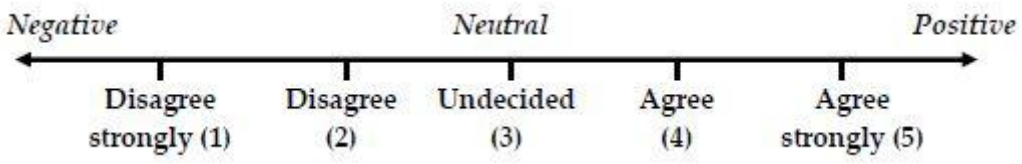
Question	Weight
Time for planting beans	5%
Reason for planting at mentioned time	2,5%
Time for preparation of the field	5%

Booster	7,5%
DAP	7,5%
NPK	10%
Urea	5%
Organic manure	5%
Combination of fertilizers	12,5%
Benefit of improved seeds	10%
Seeds per hole	10%
Planting method	2,5%
Reason for using mentioned planting method	2,5%
Monocropping	15%

Effect of the Quality of the Information and Their Presentation on the Farmers' Willingness to Change Their Behavior

As mentioned earlier, ten farmers in each village that had seen the demonstration plot or that had listened to the radio were given a questionnaire to answer multiple questions on the attributes of these. This means that five farmers per village of each treatment group answered a second questionnaire, summing up to 40 interviews on the evaluation of the information and the layout of the IDAs. This was done with the help of a 5-point Likert scale (Figure 6) ranging from strongly disagree (1) to strongly agree (5).

Figure 6: LIKERT SCALE. *Source: Johns, 2010.*



Farmers were then able to explain their rating in their own words. In total, the questionnaire consisted of five parts (Appendix IV). The attributes that were meant to describe the appropriateness and quality of the information and that had to be rated by the farmers are listed below:

Appropriateness of the Information

- trustworthiness of the source
- credibility of the information
- usefulness of the information
- relevance of the information
- comprehensibility of the information
- understandability of the information

Next, regarding the quality and appropriateness of the presentation of the information, farmers were asked to indicate their evaluation of the following attributes:

Appropriateness of the Presentation

- appropriateness of the presentation
- accessibility of the presentation
- presentation holds listener's interest
- presentation is understandable
- farmers can ask questions during presentation
- presenter emphasizes important issues

Farmers were also asked to state to what degree the information and their way of presentation influence their willingness to adopt modern agricultural practices, against which the attributes mentioned above will be estimated.

4.2. Model Description

Cost-Effectiveness Analysis

For the cost-effectiveness analysis, the equation mentioned in chapter five will be employed:

$$Average\ Cost - Effectiveness = \frac{Net\ Cost}{Net\ Benefit}$$

The net benefit in this equation is equal to the knowledge gain of the farmers. In the end, the IDA with the lower cost-effectiveness ratio should be preferred, as the smaller value implies that spending the money on this IDA is the most efficient way to spend the money.

Simple Linear Regression

However, in order to estimate what influences the farmers' behavior the following models will be used. The relationship between the different variables is modelled in a linear model for the farmers'

willingness to adopt new agricultural practices. The equation below shows the model for the influence of the different attributes of the information and their presentation on the farmers' motivation including some control variables:

$$Motivation = f(Q, X)$$

where Q is a set of variables reflecting the quality of the information and its presentation, namely trustworthiness of the source, credibility of the source, relevance of the information, usefulness of the information, understandability of the information, comprehensibility of the information, appropriateness of the presentation, accessibility of the presentation, understandability of the language, ability to ask questions during the session, emphasis on important topics by the presenter and interest kept throughout the presentation; and X are the control variables age of the household head, gender of the household head, education level of the household head and household size.

Factor Analysis

Next, a factor analysis will be done in order to "summarize data so that relationships and patterns can be easily understood" (Yong & Pearce, 2013: 79). A factor analysis reduces several variables (or factors) that share a common variance and are not observable into descriptive categories. This is also known as dimension reduction (Bartholomew et al., 2011), which helps to focus on the underlying concept and makes an interpretation easier (Rummel, 1970 in Yong & Pearce, 2013).

In detail, a factor analysis assumes that each observable variable is a linear function of underlying factors together with a residual variance. The model below intends to reproduce maximum correlations

$$X_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jm}F_m + e_j$$

where $j = 1,2, \dots, p$. P represents the number of variables ranging from X_1 to X_m, while m denotes the number of underlying factors $(F_1, F_2, \dots, F_m)$ and X_j denotes the variables represented in latent factors. The factor loadings $a_{j1}, a_{j2}, \dots, a_{jm}$ represent the factor loading of the variables on the factors. Factor loadings are similar to the weights in multiple regression and tell us how much a certain variable has contributed to the factor, or how strong the correlation between the factor and the variable is (Yong & Pearce, 2013).

With the help of this statistical we want to see whether the different attributes of the information and their presentation can be reduced to a few underlying concepts. These concepts will then be

regressed on the farmers' motivation to change their behavior in order to evaluate whether one or more of the concepts significantly influence the farmers' behavior.

4.3. Descriptive Statistics

4.3.1. Demographics

In general, 61% of the respondents were male, while 39% were female. Most respondents had primary education (93%) and were aged between 46 and 55 years (30%), while only 5% had secondary education and 1% had post-secondary education or went to University. Male respondents were slightly better educated than female respondents, as 9% of the male respondents had secondary or University education, whereas only 5% of the female respondents had more than primary education.

Table 9: GENDER OF RESPONDENT AND HOUSEHOLD HEAD.

		Gender of respondent		**Gender of HH head**	
		Male	Female	Male	Female
Group	Control	50%	50%	86%	14%
	Demonstration	55%	45%	82%	18%
	Radio program	77%	23%	91%	9%
Total		61%	39%	86%	14%

As can be seen in Table 6, half of the farmers in the control group were male, while the other half was female. In the demonstration plot group 55% and 45% of the farmers were male and female, respectively. However, 77% of the farmers in the radio program group were male, whereas only 23% of the farmers in this treatment group were female. This means that the demonstration plot and the control group are quite similar, but the radio program group is significantly different with regards to the gender distribution. When calculating the numbers for both treatment groups together it becomes obvious that 65% of the farmers in these groups were male, compared to 50% in the control group. The remaining 35% of the respondents in the treatment groups were female, given 50% of female farmers in the control group. The difference between the groups is statistically significant at the 1% level. Additionally, 86% of the households had a male household head, while 14% of the households had a female household head. The difference between the groups with regards to the gender distribution of the household head is not statistically significant.

Table 10: EDUCATION LEVEL OF RESPONDENT.

	Education level of respondent				
	Primary	Secondary	Post-secondary	University	**Total**

Group	Control	92%	4%	2%	2%	50
	Demonstration	88%	10%	0%	2%	59
	Radio program	98%	2%	0%	0%	55
Total		93%	5%	0.5%	1.5%	166

Table 7 presents the education level of the respondents in the treatment and control groups that are not significantly different. It can be seen, that almost all respondents only had primary education, namely 93%. In more detail, 92% of the respondents in the control group had only primary education, while 88% and 98% of the respondents in the demonstration plot and the radio program group only went to primary school, respectively. In total, 93% of the respondents in the treatment group only had primary education. Regarding secondary education, the distribution is fairly similar with 4% of the respondents in the control group having secondary education, and 6% in the treatment group. Post-secondary school and University were hardly visited by any of the respondents.

Table 11: EDUCATION LEVEL OF HOUSEHOLD HEAD.

		Education level of HH head			
		Primary	Secondary	University	**Total**
Group	Control	94%	2%	4%	47
	Demonstration	88%	11%	1%	56
	Radio program	96%	4%	0%	53
Total		92%	6%	2%	156

The education level of the household head is presented in Table 8. In total, 92% of the household heads had primary education, while only 6% and 2% had secondary or University education, respectively. The difference between the groups is not statistically significant, which means that the groups are relatively similar.

Table 12: NUMBER OF HOUSEHOLD MEMBERS.

		Number of household members			**Total**
		1-4	5-7	>8	
Group	Control	20%	52%	28%	50
	Demonstration	20%	56%	24%	59
	Radio program	18%	54%	28%	56
Total		19%	54%	27%	165

The above table shows that the number of household members was quite evenly distributed among the three groups, which is supported by a statistical test telling us that the difference between the groups is not significant. While 20% of the households in the control group had one to four members,

19% of the households in the treatment group had the same number of members. A similar picture holds true for households with five to seven members, with 52% for the control group and 55% for the treatment group. Lastly, 28% of the households in the control group had more than eight members, whereas 26% of the households in the treatment group consisted of more than eight members (Table 9).

		Age category of respondent					Total
		[<20]	[20;35]	[36;45]	[46;55]	[>55]	
Group	Control	4%	22%	32%	26%	16%	50
	Demonstration	3%	25%	22%	35%	15%	60
	Radio program	0%	34%	21%	27%	18%	56
Total		2%	27%	25%	30%	16%	166

Table 13: AGE CATEGORY OF RESPONDENT.

Table 10 indicates that most of the respondents were aged between 20 and 55 years, namely 81%. It can be seen that the age distribution is quite even among the different respondent groups. The number of farmers aged above 55 years is 16%, 15% and 18% for the control, demonstration plot and radio program group, respectively. This means that the control and the treatment groups were both comprised of 16% of farmers older than 55. When looking at the respondents aged between 20 and 35 years the table shows that 22% of the farmers in the control group were that age, whereas 29% in the treatment groups were between 20 and 35 years old. For the farmers aged between 36 and 45 years, the opposite becomes obvious. Here, more farmers in the control group were between 36 and 45 years old, namely 32%, while only 22% of the farmers in the treatment groups were at that age. In general, it can be said that the groups were fairly similar with no big differences between the various age categories and respondent groups.

		Age category of HH head				
		[20;35]	[36;45]	[46;55]	[>55]	**Total**
Group	Control	20%	26%	30%	24%	50
	Demonstration	22%	16%	42%	20%	60
	Radio program	29%	25%	23%	23%	56
Total		24%	22%	32%	22%	166

Table 14: AGE CATEGORY OF HOUSEHOLD HEAD.

As can be seen in Table 11, most of the household heads were aged between 46 and 55 years. All remaining household heads are evenly distributed among the other three age categories, while none

of the household heads was younger than 20 years. The difference between the treatment and control groups is not statistically significant, which means that they are relatively similar.

Table 15: CELLPHONE PENETRATION.

	Group		
	Control	Demonstration	Radio program
Respondent has mobile-phone number	80%	95%	84%

Lastly, the cellphone penetration for the respondent groups is presented. With 87% of the respondents having a cellphone, cellphone penetration is high. 80% of the farmers in the control group possess a cell-phone, while 20% do not have a cellphone. These numbers are slightly different compared to the treatment groups. While 95% and 84% do have a cellphone in the demonstration plot and the radio program group, respectively, 5% and 16% do not. In total, 90% of the respondents in the treatment groups possess a cellphone, whereas 10% do not have a cellphone (Table 12). The difference between the groups is statistically significant at the 10% level.

For details on the significance tests please consult Appendix V.

4.3.2. Sources and Preferred Sources of Information

Next, we will have a look at the sources of information and the preferred sources of information of farmers in Lushoto. Farmers were asked to indicate their first and if applicable second source of information on agricultrual topics. Due to the small sample size no statistical tests will be used in this section. As can be seen in the table below, ten out of 37 farmers mentioned that demonstration plot and extension officer are their first source of information, while two farmers named the extension officer as their second source of information. However, the sample included the farmers that voluntarily went to the demonstration plot before the survey, which may have affected the results. On the contrary, the radio was not mentioned as a first source of information as often, with six farmers or 16% of the farmers stating that they receive information on agricultrual topics via a radio program. However, it still is the second-most used source of information. Other sources of information were agro-dealer, farmer group, flyer, own experience and Vicoba Group. In total, it seems as if the most important sources of information for farmers are demonstration plots and extension officers. However, the radio as an information source should also no be ignored, as it was mentioned as a source of information by eight farmers. When looking at the groups seperately, it can be seen that seven and three out of 17 farmers in the demonstration plot group receive their information from demonstration plots and the extension officer. Surprisingly, three farmers in the

radio program group inform themselves about agricultural topics by visiting demomstration plots. There may be two possible explanations for this results. First, even though the farmers are not officially part of the group of farmers that visit the demonstration plot regularly, they can go there and learn from what they see. Secondly, as was mentioned by some respondents, farmers created their own groups to distribute their knowledge among their neighbours and friends. Furthermore, only two farmers in the demonstration plot group and four in the radio program group mentioned the radio program as a first source of information. Importantly, SMS and comics were not said to be a source of information by any respondent.

Table 16: CURRENT SOURCES OF INFORMATION BY TREATMENT GROUP.

	Group		
Information source 1	Demonstration plot	Radio program	**Total**
Agro-dealer	1	0	1
Demonstration plot	7	3	10
Extension officer	3	7	10
Farmer group	1	1	2
Own experience	3	1	4
Radio program	2	4	6
Vicoba Group	0	4	4
Total	17	20	37
Information source 2			
Agro-dealer	0	1	1
Extension officer	2	0	2
Farmer group	1	1	2
Flyer	1	0	1
Own experience	1	0	1
Radio program	1	1	2
Total	6	3	9

Mirroring this with the preferred sources of information draws the following picture. Twenty out of 40 farmers ranked the demonstration plot as one of the most preferred first sources of information, while ten farmers would like to receive information via SMS. Only four and three out of 40 farmers would like their first source of information to be a comic, a flyer or a radio program and no farmers mentioned an agro-dealer as a preferred source of information. Due to the fact that the farmers who voluntarily went to the demonstration plot may bias the results, we will also have a look at the numbers for the two groups seperately. It can be seen that ten farmers in both groups, the

demonstration plot and the radio program group, indicated that their first preferred source of information is the demonstration plot. Only one farmer in the radio program group and two farmers in the demonstration plot group would like to receive their information via a radio program as a first source. Interestingly, five farmers in each group mentioned that SMS would be a valuable alternative as a first source of information on agricultural topics.

When looking at the second preferred source of information, again eight farmers mentioned the demonstration plot, namely six farmers in the demonstration plot group and two in the radio program group. However, it is visible that SMS, comic and radio would also be welcome as a second source of information.

The third source of information that were mentioned most often were the radio program and the comic, with 13 and ten farmers, respectively. The farmers in the radio program group especially value the demonstration plot, the comic, the SMS and the radio program as a third source of information, whereas the demonstration plot group would like to receive additional information via a radio program.

In total, the demonstration plot was mentioned by 36 out of 40, meaning 90% of the farmers as the first, second or third source of information. A reason for this result might be that demonstration plots are practical, that farmers can see the benefit and that they can 'learn by doing'. Even though the radio program was also said to be a good source of information by 57.5% of the farmers, one can see that the number of farmers stating that the radio program is preferred as the first source is very low and increases only because the relevance declines towards the third source. The greatest concern for famers with regards to the radio program that was mentioned by many farmers during the suvey is the credibility and understandability of the information. Farmers mentioned that the information provided by fellow farmers during the program were most trustworthy and understandable. In general, the above table shows that the demonstration plot is most preferred as a first source of information by both groups. However, espeially the comic, the SMS and the radio program seem to be useful additions to the demonstration plot and could serve as valuable second or third source of information. Agro-dealers and flyers are least prioritized by the farmers (Table 14).

These results are coherent with the information on the combination of different sources, as most farmers mentioned that the demonstration plot should go hand in hand with any written material, either a comic, a flyer or an SMS. Furthermore, it can be seen that most farmers do no receive the necessary information via the preferred channel. Even though the extension officer was not part of the question what source farmers would prefer, it becomes clear that farmers would like to learn

more with the help of demonstration plots and any written material, such as a comic or an SMS. With regards to the comic, farmers were of the opinion that pictures can be more helpful than text as illiteracy remains to be a problem. Lastly, the radio program can also be considered a supportive additional source of information. However, money constraints might inhibit farmers to buy a radio or the needed battery, as was mentioned by some farmers.

Table 17: PREFERRED SOURCES OF INFORMATION BY TREATMENT GROUP.

	Group		
Information source 1	Demonstration plot	Radio program	**Total**
Comic	3	1	4
Demonstration plot	7	10	20
Flyer	0	3	3
Radio program	2	1	3
SMS	5	5	10
Total	20	20	40
Information source 2			
Agro-dealer	0	1	1
Comic	5	5	10
Demonstration plot	6	2	8
Flyer	1	2	3
Radio program	2	5	7
SMS	6	5	11
Total	20	20	40
Information source 3			
Comic	5	5	10
Demonstration plot	2	6	8
Flyer	2	0	2
Radio program	8	5	13
SMS	3	4	7
Total	20	20	40

4.3.3. Overall Rating of Information and Their Presentation

As can be seen in Table 15, only one farmer stated that the information is poor, while all other farmers said that the information is good or very good. On average, the information was rated with a

3.4 out of 4, meaning that farmers were generally satisfied with the information that was provided by the IDAs.

Table 18: OVERALL RATING OF INFORMATION AND PRESENTATION FOR BOTH IDAs.

		Overall rating of information		Overall rating of presentation	
		Frequency	Percent	Frequency	Percent
Rating	Poor	1	3		
	Fair			2	6
	Good	17	48,5	19	52
	Very good	17	48,5	15	42
Average score		**3,4**		**3,3**	

The overall evaluation of the presentation of the information draws a slightly different picture. No single farmer gave the label poor to the presentation, but two farmers said that the presentation was fair. However, most farmers, namely 34, stated that the presentation of the information were good or very good. Again, the average score of the overall evaluation of the presentation is 3.3, indicating that most farmers liked the way the information were presented (Table 15).

Table 19: OVERALL RATING OF INFORMATION AND PRESENTAITON FOR IDAs SEPERATELY.

		Overall rating of information		Overall rating of presentation	
		Frequency	Percent	Frequency	Percent
Demonstration	Poor	1	6		
	Fair			1	6
	Good	7	39	5	27
	Very good	10	55	12	67
Average score		**3,4**		**3,6**	
Radio program	Poor				
	Fair			1	6
	Good	10	55	14	78
	Very good	8	45	3	16
Average score		**3,4**		**3,1**	

When looking at the overall rating for the information and their presentation for the radio program and the demonstration plot group separately, it shows that the information was given the same average score of 3.4 for both IDAs. This might be due to the fact that similar information was given

via both channels. However, the average score of the presentation was higher for the demonstration plot with a value of 3.6 compared to 3.1 for the radio program (Table 16). This indicates that farmers generally prefer to receive information via a demonstration plot, which is mainly because farmers can participate and 'learn by doing'.

4.3.4. Adoption of Modern Agricultural Practices

When looking at Table 17 it becomes obvious that only ten farmers of the radio program group answered the question on whether or not they are using any of the mentioned modern farming practices. This might be because most of the farmers in the radio program group do not use one or more of the practices demonstrated on the plot, because they do not have any information about these. To the contrary, 18 out of 20 farmers of the demonstration plot group answered this question. Even though these numbers make a fair comparison difficult we can see that farmers in the demonstration plot group generally had a higher adoption rate than farmers in the radio program group. This was expected since the farmers in the demonstration plot group had seen the demonstration plot a while ago, which gave them the opportunity to adopt one or more of the demonstrated practices. However, even though an effect for the radio program was not possible at the time the interviews were conducted, this is an important indication as it allows a better comparison of the two IDAs later on.

First, 39% of the farmers in the demonstration plot apply fertilizer on their fields, while only 30% of the radio program do. The same is true for organic fertilizer, even though the difference between the groups is extremely small. Next, 17% of the farmers in the demonstration plot do proper spacing when planting beans and only 10% on the radio program group do. Lastly, while only 30% of the farmers in the radio program group use improved seeds, 33% in the demonstration plot group do.

Table 20: ADOPTION OF NEW AGRICULTURAL PRACTICES BY RESPONDENT GROUP.

		Respondent group		**Total**
		Demonstration plot	Radio program	
Industrial fertilizer	No	61%	70%	64%
	Yes	39%	30%	36%
Total		18	10	28
Organic manure	No	56%	60%	57%
	Yes	44%	40%	43%
Total		18	10	28
Proper spacing	No	83%	90%	86%
	Yes	17%	10%	14%

Total		18	10	28
Improved seeds	No	67%	70%	68%
	Yes	33%	30%	32%
Total		18	10	28

However, please note that the above figures highly underestimate reality. When talking to the farmers it became clear that most farmers in the demonstration plot group actually apply the practices they had seen on the plots, especially proper spacing and organic manure. Furthermore, farmers who had seen the demonstration plot started to educate farmers in neighboring villages who do not have access to the plots as was mentioned by some farmers during the survey. It is unlikely that farmers who did not adopt the new practices successfully would educate other farmers.

In conclusion it can be said that the adoption of modern agricultural practices is higher amongst farmers in the demonstration plot group than actually shown in the above table.

5. Results

5.1. Average Costs of the Radio Program

Unfortunately, an estimate of the costs and the number of listeners of the program on Radio Njili is not available. Therefore, a proxy for this variable will be used which was calculated with the help of several other radio stations and programs on similar topics by Farm Radio International (FRI). The procedure of calculating these is shortly explained below.

The coverage of the radio station was based on the mapping of the stations by FRI overlaid with populations from census data (only including working age people). Through the outcome evaluation method of FRI a representative sample of the people living in communities covered by the stations was identified. Here, a two-stage cluster-sampling method was used by FRI. The primary sampling unit was the community and the secondary sampling unit was the household. In the second stage a systematic random sampling procedure was used. The household survey then included some questions around listenership to the radio station and the specific program that was produced in partnership with FRI. This percentage enabled FRI to estimate the number of listeners or the reach of the program. Furthermore, the survey yielded information on the percentage of the surveyed audience that applied at least one of the practices promoted in the radio program in this survey. However, this is just an estimation, which heavily relies on ensuring a truly random sample from the radio coverage area.

Afterwards, the total costs of the project are looked at and divided by the number of farmers reached. The total costs included the following categories:

- Salaries
- Project set up costs
- Training of broadcasters
- Direct costs around equipment
- Payment for radio airtime

There are no official documents that can be shared externally on these data. However, given the available data, the costs were about 0.23 to 0.46 USD per listener (that listened to at least one episode of the program). Furthermore, the average costs per farmer that applied at least one of the promoted practices were 1 to 1.5USD. For easier comparison, an average cost per listener of **0.36USD** and **1.25USD** will be used for further analysis, which will serve as a proxy for the costs per participant of the radio program (Appendix VI).

5.2. Average Costs of the Demonstration Plot

In order to estimate the costs of the demonstration plots per participant in Lushoto, the following data was needed: the costs for the demonstration plots and the number of farmers reached.

Table 18 shows the estimated costs per demonstration that also include staff costs plot for bush beans. These number also include staff costs. The average costs per single demonstration plot in Lushoto were about **24USD**.

Table 21: COST ESTIMATE PER SINGLE DEMONSTRATION PLOT ON BUSH BEANS (USD). *Source: Appendix VII.*

Activity	Cost Estimate*
Land preparation	11
Seed input	10
Fertilizer input	3
Total	24

*Exchange rate during establishment of demonstration plots: 1USD=1820Tshs

Next, 31 demonstration plots were established in Lushoto in 2015 and reached 400 farmers (Appendix VIII), meaning that 13 farmers were targeted with each demonstration plot on average. Unfortunately, there are no information on the number of farmers reached by demonstration plots on bush beans only available.

$$\frac{400}{31} = 13.$$

20 demonstration plots in Lushoto were on bush beans (Appendix VII), which are under consideration for this thesis. This means that about 258 farmers were reached by the demonstration plots on bush beans in Lushoto in 2015.

$$13\ x\ 20 = 258$$

Given the data above, the average costs per participant can be calculated. First of all, the average costs per demonstration plot have to be multiplied with the number of demonstration plots established in 2015

$$24.2USD\ x\ 20 = 484USD.$$

Then, the total costs can be divided by the number of farmers that were reached by the demonstration plots in Lushoto

$$\frac{484USD}{258} = 1.88USD.$$

Therefore, the average costs per participant for the demonstration plot were about **1.88USD**.

5.3. Cost-Effectiveness Analysis

First, the average test score of the control group and the treatment group as a whole will be looked at. As can be seen in the table below, the control group comprised 50 farmers, while the treatment group was made up of 116 farmers, of which 60 were in the demonstration plot group and 56 in the radio group. It can be seen that the average score on the exam questions of the control group was 36.6% with a standard deviation of 16.5%, while the treatment group scored 49.5% on average with a standard deviation of 15.3%, meaning that the treatment groups scored better on average compared to the control group. The difference between these groups is significant at the 5% level (Table 19).

Table 22: AVERAGE TEST SCORES CONTROL VS. TREATMENT GROUP.

	Descriptives				**Anova**				
	N	Mean	SD		Sum of Squares	Df	Mean	F	Sig.
Control	50	.3660	.1645	**Between**	.580	1	.580	23.596	.000
Treatment	116	.4948	.1533	**Within**	4.030	164	.025		
Total	156	.4560	.1671	**Total**	4.610	165			

However, in order to be able to evaluate the cost-effectiveness of the different IDAs, the mean score of the demonstration plot group and the radio program group has to be computed, which will be presented in the following. When looking at the table below it becomes obvious that the average

score of the demonstration plot group was 52.8% with a standard deviation of 15.1%, while the radio program group scored 45.1% on average with a standard deviation of 14.9%. The differences in exam scores for the control and the two treatment groups are significant at the 5% confidence level (Table 20).

Table 23: AVERAGE TEST SCORES CONTROL VS. DEMONSTRATION PLOT VS. RADIO GROUP.

	Descriptives				Anova				
	N	Mean	SD		Sum of	Df	Mean	F	Sig.
Control	50	.3660	.1645	**Between**	.719	2	.360	15.069	.000
Demonstration	60	.5283	.1510	**Within**	3.891	163	.024		
Radio program	56	.4589	.1488						
Total	156	.4560	.1671	**Total**	4.610	165			

Next, a t-test with independent samples between the demonstration plot group and the radio program group was computed. This was done in order to see whether the difference in exam scores between the two groups is statistically significant. The test verifies that the difference in test scores between the demonstration pot and the radio program group is statistically significant at the 5% level (Appendix IX).

In summary, the treatment group scored significantly better than the control group, with average scores of 49.4% and 36.6%, respectively, which can be attributed to the intervention. This means that the demonstration plot and the radio program actually do have an effect on the farmers' level of knowledge on planting. Additionally, the demonstration plot group scored 52.8% on average, which is significantly better than the radio group that obtained an average score of 45.9%. However, please note that selection bias might have changed the results for the demonstration plot and the radio program group. The net effect of the radio program can be calculated as the difference between the score of the control group and the radio program group

$$Average\ Score\ (RP) = 45.9\% - 36.6\% = 9.3\%$$

whereas the net effect of the demonstration plot is the difference between the score of control group and the demonstration plot group

$$Average\ Score\ (DP) = 52.8\% - 36.6\% = 16.2\%.$$

In order to know which of the IDAs is more cost-effective, the costs for each of them and the number of farmers reached needs to be included in the analysis, which will be done in the following.

As mentioned earlier, the average costs per participant for the radio program and the demonstration plot in Lushoto were **0.36USD** and **1.88USD**, respectively. Therefore, simply looking at the costs per IDA indicates that the radio program is more cost-efficient than the demonstration plot.

In order to evaluate the cost-effectiveness of the two IDAs, the following equation will be utilized

$$Average\ Cost - Effectiveness = \frac{Net\ Cost}{Net\ Benefit}$$

First, the average cost-effectiveness of the radio program will be calculated, which will be called ACE(RP). Putting in the numbers calculated earlier yields the following results:

$$ACE\ (RP) = \frac{0.36USD}{9.3\%} = 0.04$$

Next, the average cost-effectiveness for the demonstration plot, called ACE (DP) will be calculated:

$$ACE\ (DP) = \frac{1.88USD}{16.2\%} = 0.11$$

Since the average cost-effectiveness of the radio program is lower, it can be said that it is more cost-effective than the demonstration. Even though the net effect of the radio program is lower than the effect for the demonstration plot, this is more than compensated by the substantially lower costs of the radio program. Even assuming that the cost per participant for the radio program were at their highest of 0.6USD, the average cost-effectiveness of the radio program would still be lower than the average cost-effectiveness of the demonstration plot with a value of 0.065.

$$ACE(RP) = \frac{0.6USD}{9.3\%} = 0.065$$

However, when taking into account the actual effect on behavior the results are significantly different. As said earlier, the average costs per listener that applied at least one of the practices mentioned in the radio program varies between 1USD and 1.5USD. When calculating the average cost-effectiveness of the radio with average costs of 1.25USD the following number is obtained

$$ACE\left(RP^{Adoption}\right) = \frac{1.25USD}{9.3\%} = 0.13.$$

As described in chapter four it can be assumed that most farmers in the demonstration plot group actually apply the practices that were shown on the plot, which was not only mentioned by the farmers themselves but also by the extension officers. When interviewing the farmers, it became obvious that they had a deep understanding of the modern practices shown on the plot. If it is true that the farmers in the demonstration plot group apply the practices presented on the demonstration plots, the above number can be compared with the average cost-effectiveness of the demonstration plot.

$$ACE\left(DP^{Adoption}\right) = ACE(DP) = 0.11.$$

This means that, in the case of actual behavior change, the average cost-effectiveness of the demonstration plot is lower than the average cost-effectiveness of the radio program, implying that the demonstration plot should be prioritized in this scenario. Even using average costs of 1USD for the radio program results in an average cost-effectiveness of 0.11 for the radio program, meaning that both IDAs would be as good.

To sum it up, when simply looking at the education effect of the demonstration plot and the radio program, the average cost-effectiveness of the radio program is substantially lower. In case the costs for the radio program are higher than 1USD per participant both IDAs show the same cost-effectiveness. However, when taking into account the adoption rate of modern agricultural practices, the average cost-effectiveness of the demonstration plot is lower. This holds true even if the average costs for the radio program per participant would be at their lowest of 1USD.

The results presented above are as expected. The effect of the demonstration plot is greater compared to the radio program, especially for small groups of people. However, in order to reach a broad audience, the radio program is the better IDA, even though its effect on the knowledge of farmers is slightly lower. Also, it was expected that the demonstration plot is significantly more expensive than the radio program due to set-up costs and the payment of the extension officers. With regards to the literature it can be said that both the radio program and the demonstration plot help the farmers to become aware of the problems they are faced with. This phase is called *contemplation* and describes the step when people are aware of a problem. However, in order to motivate farmer to actually change their behavior (a*ction*) the demonstration plot is more successful.

Also, both IDAs are able to change the attitudes of the farmers about modern agricultural practices, even though the demonstration plot might well be the more effective IDA due to visibility of success.

5.4. Regression on Farmers' Motivation to Change their Behavior

Due to the fact that the two treatment groups only comprised 20 respondents each, a simple linear regression of all the attributes of the information and their presentation on the motivation of farmer might be incorrect, as too many variables are included in the regression given too few observations. Therefore, a factor analysis was done in order to reduce the twelve attributes to three to four components. The motivation of farmers can then be regressed on the resulting components, which can give better insights into the farmers' behavior.

Table 24: FACTOR ANALYSIS RESULTS.

Respondent group	Component	Attribute
All	Information quality	- Trustworthiness of source - Credible information - Comprehensibility of information - Understandability of information
	Information relevance	- Relevance of information - Usefulness of information
	Presentation quality	- Understandability of language - Farmers' ability to ask questions - Presenter emphasizes important topics
	Presentation access	- Presentation of information is appropriate - Presentation is accessible - Presenter holds farmers' interest
Demonstration	Information quality	- Trustworthiness of source - Credible information - Comprehensibility of information - Understandability of information
	Information relevance	- Relevance of information - Usefulness of information
	Presentation quality	- Understandability of language - Farmers' ability to ask questions - Presenter emphasizes important topics
	Presentation access	- Presentation of information is appropriate - Presentation is accessible - Presenter holds farmers' interest
Radio program	Information relevance	- Relevance of information - Usefulness of information - Comprehensibility of information

	Information credibility	- Trustworthiness of source - Credible information - Understandability of information
	Presentation quality	- Presentation is accessible - Farmers' ability to ask questions - Presenter emphasizes important topics - Presenter holds farmers' interest
	Presentation understandability	- Presentation of information is appropriate - Understandability of language

Table 21 presents which of the attributes load on which component that were renamed after the factor analysis was done. It can be seen that the components of all respondents and the demonstration plot group are the same, namely information quality and relevance, as well as presentation quality and access. For the radio program, however, the components are slightly different and made up distinct attributes. Even though the relevance of the information is one component, the other is not information quality as for the demonstration plot group, but credibility of the information. This is logical since farmers need to trust the radio station, the program and the presenter as they are unable to see the actual benefit of the new practices. Furthermore, even though the first component of the presentation of the information is also called information quality, it is partly made up if different attributes compared to the demonstration plot group with even stronger emphasis on the actual quality. Next, the second component of the presentation is called understandability, as the farmers ability to understand the language is the more important attribute for this component.

In the following, the results for a regression of the farmers' motivation on the above components will be presented (Table 22).

Table 25: REGRESSION ANALYSIS - COMPONENTS ON THE MOTIVATION OF FARMERS TO CHANGE BEHAVIOR.

Motivation	**All**	**Demonstration**	**Radio program**
Age of household head	0.490 (-0.100)	0.010* (-0.544)	0.291 (0.206)
Household head is female	0.316 (0.146)	0.694 (0.088)	0.601 (-0.095)
Household head finished primary	0.225 (0.178)	0.064* (0.354)	a)
Number of household members	0.986 (-0.003)	0.357 (-0.158)	0.595 (0.112)
Information			
Quality	0.004***	0.271	

	(0.534)	(-0.298)	
Relevance	0.291	0.981	0.933
	(0.190)	(0.008)	(0.014)
Credibility			0.002***
			(0.930)
Presentation			
Quality	0.782	0.076*	0.445
	(0.047)	(0.535)	(0.114)
Access	0.267	0.006***	
	(0.196)	(1.013)	
Understandability			0.305
			(-0.306)
Constant	0.000***	0.000***	0.002***
Observations	40	20	20
R^2	0.436	0,761	0.682
Model Significance	0.013**	0.013**	0.023**

* p<0.1; ** p<0.05; *** p<0.01 a) Variable excluded, is a constant

Again, we will first have a look at the results for all respondents. It can be seen that the quality of the information is positively correlated to the willingness of farmers to change their behavior at the 1% confidence level. In detail, when the information quality increases by 1, the motivation of farmers to adopt modern agricultural practices increases by 0.534, *ceteris paribus*. This is logical and in compliance with the results of the regression including all attributes, since information comprehensibility is part of the information quality in the second regression. However, none of the demographics and the components of the presentation are significantly correlated to the farmers' motivation.

When looking at the regression results for the demonstration plot group we can see that age of the household head is negatively correlated to the farmers' motivation to adopt new practices at the 10% level. This means that households with younger household heads are more likely to adopt compared to households with older household heads. In detail, if the age of the household head increases by 1, the motivation of farmers to change their behavior decreases by 0.544, *ceteris paribus*. This result might be explained by the fact that younger farmers are more open to innovations and not as risk averse as older farmers. Next, the primary education of the household head is positively correlated to the motivation of farmers at the 10% level, meaning that households whose household head finished primary school are more likely to adopt modern practices. This

seems logical, as farmers with a higher education levels are better able to understand the modern ways of farming and apply what they learned on the plot, including the measurement of distances and reading the leaflets handed out during the session. Also, the quality of the information is positively correlated to the motivation of farmers at the 10% level. Same holds true for the access to the information, which is positively correlated to the farmers' motivation at the 1% level. This means that especially the access to the information is crucial when intending to change the farmers' behavior and make them adopt modern practices. The result is logical, since farmers without access to the information are unable to change their behavior. In detail, improving the access to the information by 1, the farmers' willingness to adopt increases by 1.013, *ceteris paribus*.

The regression results imply that younger and better educated farmers tend to be more willing to adopt modern practices and abolish traditional ways of farming. This might imply that human capital is an important measurement for the motivation and ability to change the farmers' behavior. Additionally, the access to the demonstration plots is a crucial factor when doing an information campaign. As was mentioned by many farmers during the field work, access to the demonstration plots could be improved and sessions with an extension officer held more often. This would increase the farmers' ability to learn about new practices and enable them to ask questions, which was said to be limited to certain days. The results, however, confirm what was mentioned in the literature presented in chapter three. As can be seen in Table 21, the trustworthiness of the source as well as the credibility, the comprehensibility and the understandability of the information were reduced to the component information quality. All of these attributes are said to be crucial for public information campaigns. However, it cannot be explained why the relevance of the information does not seem to be correlated to the motivation of farmers to change their behavior even though it was mentioned as one of the important factors in the literature.

Lastly, we will have a look at the regression results for the radio program group. It is interesting to see that only one of the components is significantly correlated to the motivation of farmers, while the other three and the demographics are not. This is in sharp contrast to the regression results that included all different attributes. However, it is intuitive that the credibility of the source is positively correlated to the motivation of farmers at the 1% level as explained earlier. Without trusting the source of the information and the information itself farmers will be less likely to adopt new practices as they are not able to see the benefit of these. The result is coherent with the result of the first regression, when trustworthiness of the source was positively correlated to the motivation of farmers at the 10% level, just that the correlation is even stronger when regressing on the components only.

During the field work farmers said that especially information provided by other farmers in the radio program are credible because they talk about their actual experience with the new practices. This improves the credibility and the trustworthiness of the information given during the session. The result is coherent with the requirements for public information campaigns to be successful, as one of the demands mentioned is to deliver a credible message, which is often conveyed by the trustworthiness of the source. This is especially important for IDAs where farmers cannot directly participate and see the benefits resulting from the adoption of modern agricultural practices.

6. Discussion

6.1. Discussion on Limitations

Before discussing the results of the cost-effectiveness analysis, the question whether the results can be translated into decisions will be assessed. Firstly, since the sample size is relatively small, it might be that the results of the cost-effectiveness analysis do not hold true for greater samples. However, the results can be generalized for Lushoto because the required sample size for Lushoto with a confidence level of 95% and a confidence interval of 8 would have been 150 farmers. This number was excelled by 16 farmers with an actual sample size of 166 farmers.

Next, does an increase in costs also raise the effect by the same factor? Generally, this question can only be answered with the help of further analysis. Normally the results can only be considered to hold for small changes in resource intensity. However, the purpose of this thesis was not to assess the effect of increasing the costs of the IDAs on the knowledge level and the willingness to change the behavior of the farmers, but to compare the IDAs.

Thirdly, since the magnitude of the differences between the alternative IDAs is greater than 20% and statistically significant as mentioned in chapter five, the cost-effectiveness analysis can be used to inform the decision maker.

Lastly, the evaluation of the effectiveness has to be appropriate as the cost-effectiveness ratio is only as good as the underlying evaluation of the costs and the effectiveness. The information on the costs of and the number of farmers reached by each IDA were made available to us by N2Africa and its partners. As it was not possible for the researcher to verify them we have to trust our partners that the information is correct. Furthermore, the sampling method was supposed to be totally random, but unfortunately randomization cannot be fully guaranteed. The researcher had to rely on an extension officer working for N2Africa who selected the farmers that were to be interviewed. The researcher could not be present at the time of the selection of the farmers, which means that the

random sampling of the respondents cannot be verified. Furthermore, the farmers in the demonstration plot group were not randomly chosen as they had visited the demonstration plot prior to the survey. The above might have introduced selection bias, since the farmers in the demonstration plot group could have been different compared to the farmers in the radio program and the control group. In detail, the famers in the demonstration plot group could have been more interested in learning about and adopting modern agricultural practices before the survey, which would then lead to a better exam result for the demonstration plot group. Additionally, the gender distribution is significantly different among the treatment groups and the control group. While the demonstration plot group and the control group were fairly similar, the radio program group is statistically significant different to these groups. Almost 80% of the respondents in the radio program group were male, whereas in the demonstration plot and the control group about half of the respondents were male. Next, the answers in the questionnaire with which the effect of the IDAs was measured and the different IDAs evaluated, will be susceptible to the standard questionnaire issues. Therefore, the effect of the intervention and the results of the evaluation of the different IDAs might be biased. Several effectiveness indicators and the randomization of all treatment groups would make the analysis more trustworthy.

Another constraint that has to be kept in mind when reading this thesis is that the actual effect of the demonstration plot on behavior change was not directly evaluated during the study. The researcher did not visit the farmers in order to verify if farmers really apply the modern practices shown on the plots. This means that the cost-effectiveness ratios of adoption for the demonstration plot can only serve as a proxy. Also, the information on the costs of the radio program were not calculated by the researcher and do not only refer to the program evaluated during this research. Here, a proxy was used in order to be able to get the average cost-effectiveness of the radio program that was calculated with the help of other similar programs in Tanzania. This also means that the cost-effectiveness of adoption for the radio program is not more than a proxy and cannot be verified.

6.2. Discussion on Findings

In chapter five the average cost-effectiveness of the radio program (0.04) and the demonstration plot (0.11) was calculated. The net costs and the net benefit of the radio program were significantly lower for the radio program compared to the demonstration plot, which led to the result that the average cost-effectiveness of the radio program was lower. This means that the radio program should be preferred as a way to disseminate information to the farmers when simply looking at this ratio and in

case the amount of money that can be spend on the intervention is fixed, because the effectiveness of the radio program is higher per USD that is spent.

When taking into account the actual adoption rate of modern agricultural practices by farmers, the demonstration plot is more cost-effective than the radio program as its power to incentivize farmers to change their behavior is stronger. This holds true even if the costs of the radio program are at its lowest. The cost-effectiveness ratio for adoption of the radio program was 0.13, while the cost-effectiveness ratio of adoption for the demonstration plot was 0.11. The lower cost-effectiveness ratio of the demonstration plot implies that the effect of the demonstration plot is greater per USD that is spent. Therefore, the demonstration plot should be used in order to disseminate information to the farmers when actually intending behavior change as demonstrated by the cost-effectiveness ratios calculated in chapter five. This might be due to the fact that the demonstration plot enables the farmers to see the success of the modern practices and 'learn by doing'. The practicality of the demonstration plot is one of the most important advantage of this IDA and should not be underestimated. However, a major disadvantage of the demonstration plot is the limited reach of it, as it can only be set up in villages with a good network and extension officers. With regards to that, the radio program might be more suitable for the scattered and not densely populated area in Lushoto. A problem that projects might run into is the scarcity of radios and batteries, as many farmers do not have the financial means to purchase either. Also, farmers prefer the demonstration as a mean to learn about agricultural topics, followed by SMS, comic and radio program. This is also shown by the fact that the rating of the demonstration plot was better compared to the radio program.

Until now farmers mainly receive their information from demonstration plots and extension officers, while other channels of information are widely unavailable. Even though some farmers also mentioned the radio program as a current source of information, this number is very low and most programs are not trusted by the farmers. This means that there still is a huge potential of demonstration plot that is not exploited yet, even though they are already used by several projects and organizations. This might also be because the organizational effort to prepare and set up demonstration plots is relatively high compared to other IDAs. However, another advantage of demonstration plots is that they can be targeted to certain areas and climatic conditions, which is more difficult with other IDAs such as radio programs and comics.

A possible solution could be to combine two or three of the IDAs in an effective way. For example, organizations could set up demonstration plots and hand out a comic during the session. Another

option would be the combination of demonstration plots, comics and a radio program. Furthermore, SMS can be included in the project as the cellphone penetration within Lushoto is relatively high. An obstacle for SMS might be the low literacy rate among farmers, which is why comics are preferred by many farmers as they can visualize the modern practices and are therefore better understandable.

Lastly, we will have a look at the effect of the different components of the information and their presentation on the farmers' willingness to change their behavior. As explained in chapter five, certain components of the IDAs would lead to an increased motivation of farmers to adopt modern agricultural practices. In case of the demonstration plot, the components *Information Quality* and *Presentation Accessibility* do have a significant effect on the motivation of farmers to use new agricultural practices. Furthermore, younger and better educated farmers tend to be more willing to adopt new agricultural practices shown on the demonstration plots.

In case of the radio program the *Information Credibility* is crucial. Farmers need to be able to trust the source of the information and the information itself that is presented in the radio program in order to have an incentive to change their behavior.

7. Conclusion

Having done the research and analyzed the results the following conclusions can be drawn.

First of all, as the cost-effectiveness ratio for the radio program is lower compared to the demonstration plot, N2Africa should increase the number of radio shows and therefore reach more farmers in order to educate them about modern agricultural practices as the effect per USD spent is higher for the radio program. However, the demonstration plot is more effective when it comes to promoting behavior change and the most preferred source of information by farmers. A great advantage of demonstration plots is that they can be targeted to existing conditions all over Tanzania. 'Learning by doing' and 'seeing is believing' are the keywords for demonstration plots and make the difference when comparing them with other IDAs as was mentioned by many farmers during the survey. In order to make demonstration plots even more effective in terms of educating farmers and promoting behavior change, they should be set up in more, also distant places, in order to improve accessibility, which was one the factors that influence the farmers' willingness to change their behavior. Also, accessibility could further be improved by more and/or longer sessions, meaning that multiple sessions should be done per month or the time of one session increased so that farmers are better able to ask questions.

However, this is not to say that radio programs do not have an effect and are not welcomed by farmers at all. They also have the potential to educate farmers, even though this effect is substantially lower than for demonstration plots. A possible solution that should be considered by N2Africa and its partners is the combination of radio programs and demonstration plots. But in order for this combination to be successful care has to be taken that the radio station is well trusted by the farmers and that the information is credible, which was mentioned as the most important factor influencing the farmers' willingness to change their behavior with regards to radio programs. Further conclusions that can be drawn from talking to the farmers are that (a) the information of both IDAs are coherent, otherwise farmers will be confused, leading to a loss of confidence and credibility, (b) the information in the program are presented in a way that farmers can understand, meaning that known measures and no scientific words should be used, and (c) the program includes explanations about the agro-ecological zone and region the information fit into.

When considering other IDAs as well, it is advisable to incorporate comics into the project that are either handed out during the sessions at the demonstration plots or distributed elsewhere. As literacy rates in Tanzania are still relatively low, comics that feature pictures are more helpful than flyers and should definitely be preferred as was shown in chapter four. However, as the cellphone penetration in Lushoto and Tanzania is relatively high, SMS can be an easy and cheap way to add to the knowledge gained on the demonstration plots, but should not be treated as a substitute. They can be especially helpful for literate and younger farmers that want to gain a deeper understanding about agricultural practices and want to ask questions, but cannot serve as the main source of information.

In the future, further research should be done on the actual adoption of modern agricultural practices by farmers in order to verify the results above. This will help N2Africa and its partners to better target their activities and will enable them to improve their IDAs in terms of content and layout. Furthermore, the research done within the framework of this thesis should be scaled up to evaluate the cost-effectiveness of the demonstration plot and the radio program in other regions of Tanzania, as they differ regarding their economic and climatic conditions. Lastly, research on the other IDAs employed by N2Africa and its partners should be conducted, which can guide future projects and activities with regards to the most cost-effective IDAs that should be used in order to educate farmers and induce behavior change.

Appendices

Appendix I

KILIMO NI UTAFITI - Radio Program

00:15 *Presenter:* Dear listeners, welcome to *Kilimo ni utafiti* radio program, broadcasted to you by Radio Sauti Ya Injili Moshi. In this program we will talk about bean production and you will get a chance to learn and participate by asking questions and getting answers from extension officers live on the radio. Today we are going to talk about how to correctly plant beans. We will be with bean farmers from Karangai from Meru District Arusha and also you will also hear Digna Massawe, our extension officer from Meru district Arusha. This program is brought to you by Radio Sauti ya Injili and Farm Radio International. My name is Helen Madijongo.

01:05 *Presenter:* Dear listeners, you can participate in the program by beeping the following number: 0687140142 or 0687140143. There are farmers who are successful in growing beans, let us listen to them.

01:29 *Farmer:* My name is Shabani Kimaro, I have been growing beans since 1982. I grow beans with organic manure which I collect with my tractor and transport to my farm. I never used industrial fertilizers on my farm before, I only apply organic fertilizer. I apply organic manure once in two years and grow beans for two years before applying another round of organic fertilizers. As soon as I notice my beans are attacked by pests I spray my farm with *dudu hole* pesticide which is the only one I use. I believe that any farmer can get good bean harvest if he or she takes good care of the beans on the farm. It is possible to harvest six to eight bags on one acre and sell one bag for 210.000Tsh.

03:31 *Presenter:* That was farmer Kimaro from Kware village explaining to us how he is growing beans. Today's question is: How do you grow beans? Let's hear voices of farmers who participated in paza sauti by beeping number: 0687140142 or 0687140143 explaining how they grow their beans.

03:59 *Farmers (call in):*

- How can we be trained how to grow beans in a modern way that simplifies the work and gives higher yields in the future? The local/traditional methods that we use to grow beans do not give good harvest.
- Experts should teach us good beans farming practices so that we can get good harvest.
- I think the easiest way of growing beans is cultivating the land with a tractor and use hand hoe and rope to plant.
- I advise other farmers to plant beans in rows.
- I thank Kilimo ni utafiti program for giving us alternative ways of growing beans

05:19 *Presenter:* Those were farmers answering our question; how do you grow beans? *Through Paza Sauti* by beeping the numbers; 0687140142 or 0687140143. Now let's listen to a farmers' discussion from Karangai village Meru District as interviewed by Samwel Shao.

05: 48 *Samwel Shao:* Sauti Ya Injili listeners, I am here at Karangai village, ward of Kikwe Meru district. Today I have met with bean farmers and we are going to hear how these farmers grow beans.

06:04 *Farmers:*

- My name is Neema Anfrey, I live in Karangai village, I grow my beans in April after preparing my land.
- My name is Anna Richard from Karangai village, I prepare the farm and leave it for several months before planting. I plant my beans in April using maksai, I leave space between one whole and another.

- My name is Kahaya. First I prepare my farm in March and in April soon after the first rain I plant my beans. I separate my land into two plots, I grow beans in one plot and maize in another plot. I grow beans using Maksai.
- My name is Elizabeth Kahaya, I have divided my farm into three plots. On one plot I grow beans using a hand hoe, on the second plot I grow beans using Maksai and on the third plot I grow maize.

07: 47 *Samwel Shao:* After hearing how farmers grow beans, let's now learn something about the use of fertilizers. This is our question: What type of fertilizers do you use and how do you apply it on your farm?

08:00 *Farmes:*

- I use organic manure, I put fertilizer while I am cultivating the land. Afterwards I leave the land for a while before planting. Honestly, I only use industrial fertilizers for growing maize, but not for beans. I usually put lots of organic manure covering most the land and then later I cultivate the land using maksai so that when I come to plant beans the soil is fertile enough.
- Farmer: Mostly we use organic manure. We take lots of it to the farm before starting to cultivate the land. This is done so the soil is mixed well with the manure and then we plant the beans.
- Farmer: I also use organic manure and make sure I put organic manure covering the land before cultivating it. I like using organic manure, it is good for beans and also easy to get.

09:09 *Samwel Shao*: Our next question is: Is it bad to apply organic manure after planting the beans?

09:15 *Farmer:* It is not good to apply organic manure after planting, we usually apply it when we prepare the land and then plant beans afterwards.

09:30 *Samwel Shao*: Why do many farmers not like to use industrial fertilizers?

09:35 *Farmer:* We do not apply industrial fertilizers on beans because then will not get good harvest and it is expensive.

09:40 *Samwel Shao:* What is a good time to start plant beans?

09:42 *Farmers:* It is best to start planting beans at the end of March and beginning of April.

09:32 *Samwel Shao:* Moring or evening, what is a good time to grow beans?

09:35 *Farmer:* Morning is a good time to grow beans.

09:50 *Samwel Shao*: Why do you grow beans at this time of the year?

09:52 *Farmer:* We usually wait for the first rain in March or April before planting beans.

10:09 *Samwel Shao*: What would go wrong if you planted the beans during evening and not morning?

10:11 *Farmer:* There is nothing wrong with planting beans in the evening. You can either plant in the evening or in the morning.

10:19 *Samwel Shao:* What is good time to grow beans?

10:22 *Farmer:* A good time to grow beans is in the morning.

10:25 *Samwel Shao:* If you had to advice other farmers about intercropping and conventional farming, what would you say?

10:30 *Farmers:*

- When intercropping you should plant four rows of beans before planting one row of maize and in conventional farming you do not leave any rows, but plant beans in every row.
- In convectional farming you need to plant beans on every row and when intercropping you need to plant four rows of beans before planting one row of maize to give room for the beans to grow.
- Intercropping is good since the maize stores moisture, whereas moisture gets lost easier with conventional farming.
- You plant one row of maize after four rows of beans to give the beans enough space and light.
- Intercropping is good because the maize helps to retain moisture for the beans compared to conventional farming where you grow only beans.

11:40 *Samwel Shao:* How much space do you leave between one plant and another in convectional farming?

11:50 *Farmer:* We leave one feet between one plant and another plant, we were taught to do this to give beans enough space to grow.

12:10 *Jingo Playing:* Dear Kilimo ni utafiti listeners, please participate in paza sauti by beeping number 0687140142.

Then carefully follow the instructions after beeping to answer the question. This week's question is: Which of the following methods do you use to grow beans? Press 1 for planting in rows, press 2 for planting using animals, press 3 for broadcasting, and press 4 for mchaka mchaka (planting bean seed by walking fast between the rows in the farm).

13:16 *Presenter:* After having listened to the farmers discussion about planting beans, let us now listen to this experienced farmer who wants to share with us how he is planting beans.

13:20 *Farmer:* My name is Ndekesia Elias from Karangai village, I am an experienced bean farmer. I usually start to cultivate my land before the first rains in March. After it rained I start to plant the beans in April with very carefully selected seeds. I grow my beans using cows (maksai). Also, I separate my land into two plots. On one plot I only grow beans, whereas on the other plot I intercrop maize and beans. I plant the beans around the 23rd to 25th of March after the first rain.

14:30 *Samwel Shao:* Which fertilizer do you use and how do you apply it?

14:40 *Farmer:* I only use organic manure, because it is easy to get since I have cattle at home.

14: 50 *Samwel Shao:* How do you use fertilizer?

15:00 *Farmer:* I use organic fertilizer, before cultivating my land I cover the field with organic manure and leave it for a few days. Afterwards I cultivate the land and then plant the beans after the first rains. I use organic manure because it is cheap and reliable compared to industrial fertilizers.

15:20 Samwel Shao: Were you ever trained on how to use industrial fertilizers?

15:25 *Farmer:* Yes we have received training this year, we have a small demonstration plot that we grew beans and applied industrial fertilizers on.

15:30 *Samwel Shao:* What is a good time to plant beans?

15:40 *Farmer:* It is always good to plant beans in early March to 20th of April

16:00 *Samwel Shao*: What would happen if you grew beans during the cold season?

16:10 *Farmer:* When you grow beans during the cold season you will be forced to use a lot of pesticides. In March and April it is raining but still warm enough to plant beans.

17:00 *Samwel Shao:* What is good time to plant beans, morning, noon or evening?

17:10 *Farmer:* Usually we plant the beans in the morning and if it happens that you did not finish planting in the morning, we usually go back at the evening to finish planting. There is no problem growing beans at evening time

17:30 *Samwel Shao*: How do you plant beans in space in intercropping or conventional farming?

17:50 *Farmer:* When intercropping you plant one row of maize after three rows of beans, but this is the case when we plant with cows (maksai). When planting with hands, we usually leave 25 to 60 cm between the plants. Our training covers planting in space using hands but most of the time we plant using cows (maksai).

18: 40 *Presenter:* That was Ndekesia from Karangai village explaining us how she grows beans. Now it is time to listen to our expert Digna Masawe from Arusha Region Meru District talking about planting beans in modern ways.

19:02 *Expert:* Today we are going to talk about how to plant beans. First, we will talk about planting beans in space and we will look at how to intercrop beans and maize in one plot of land.

Intercropping is a farming practice in which maize and beans are planted on one plot of land. When intercropping maize is planted in distance of 90cm between one row of maize and another row and 30cm between one maize plant and another. Beans are then planted between two rows of maize. Beans should be planted when the land is wet and one week after the maize has been planted. Do not wait too long to plant the beans after having planted the maize, because when the maize grows too high it will block the sunlight from the beans, which means that the beans will fail to grow. Also, beans should be planted in rows. Do not simply broadcast the seeds (as maize is planted in rows so should the beans be), leave at least 20cm between one plant and another and do not put more than two bean seeds in one whole. Lastly, beans should be planted between two rows of maize in zig zag fashion, meaning between 30cm between one maize plant and another plant beans in between meaning plant beans at every 15cm. Usually when intercropping farmers do not get lots of harvest, but it is good food crop. Farmers like intercropping because they know they are going to harvest two crops at once.

Regarding modern ways of planting beans, there are two ways: one option is to plant beans in rows and the other option is to plant beans on terraces. When planting beans in rows, there should be 40 cm between one row and another and 20cm between one plant and another plant. The holes in a row should be in zig zag fashion to avoid plant roots to intercept in the soil. Farmers can get eight to ten bags of beans in one acre.

When planting on terraces, the terraces should be 20 above the ground and 30cm wide, there should be two rows of beans on one terrace and farmers should put one or two beans seed into one hole. With this method a farmer can get 12 to 15 bags in one acre, beans do not need too much water - 650 to 600mm of water/rain

23:26 *Samwel Shao:* What is the important of planting in zig zag fashion?

23:40 *Expert*: Planting in zig zag fashion will still be in a straight line but they will appear in zig zag between one plant from one line and another line this will give more room for plant roots and avoid two plants to compete for resources. It is also advised to use NPK fertilizer even though beans fix atmospheric nitrogen in the soil. Since this is not enough you need to apply fertilizers as well to get a good harvest. On one acre a farmer can get eight to twelve bags of beans.

26:21 *Presenter:* That was our expert Digna Masawe from Arusha Region Meru District. Before ending this program I would like to welcome again Digna Masawe to answer your questions

26:50 *Farmer:* Which is a suitable method for growing beans, using animals like cows or planting by hand?

27:10 *Expert*: Planting using hand is good because you are able to plant in rows and we have seen that planting in space in rows results in higher harvest. I think it is not possible to plant in rows if you use an animal like a cow to plant your beans.

28:00 *Farmer:* Which pesticide should I use if my beans are covered with white insects?

28:10 *Expert:* DASBAND pesticide.

28:30 *Farmer:* Are there any special bean seeds?

29:00 *Expert:* There are good quality seeds from ASA and SELIAN. It is advised to buy seeds from known distributers and get new seeds every season when growing beans.

31:02 *Presenter:* Thank you very much Digna Masawe. We will end the program for today now, remember next week we will talk about weeding. Dear listeners, continue to register yourself to paza sauti by beeping number 0687140142 or 0687140143 if you have questions or want to share your opinion. You can write to us via Radio Sauti ya Injili 777 Moshi or contact your extension officer.This program was brought to you by radio Sauti Ya Injili and Farm Radio International.

Appendix II

Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa (N2Africa)

General protocol for demonstrations on best bush bean varieties (Lyamungo 90 and Uyole njano,) and their better agronomic management in Northern Tanzania, for the 2015 long rain growing season

1. Introduction

Demonstration plots aim to demonstrate a basket of best options at the level of farmer groups/ associations. These demos are to be co-implemented and managed by associations and other N2Africa partners. A single demonstration plot should be implemented for each farmer group, aiming for a total of approximately 10-20 trials per district. Demonstration plots will serve as the basis for large-scale distribution of technology packages in the so-called **adaptation/ baby** demo plots.

2. Objectives

To demonstrate the performance of different varieties of bush beans with and without inputs.

To demonstrate the effect of different types of inputs (manure, NPK, and their combination) on bushy bean grain yield

To evaluate the preference of the different varieties and inputs with farmers

3. Site selection

The demonstration sites should be chosen in a strategic location, which is visible and accessible for as many people as possible (e.g. a prominent roadside location, next to a school, etc. But not too close to dusty areas).

The trial should be laid out on an N-deficient site that is homogenous, does not have a very steep slope and no indicators for soil degradation (e.g. lots of gravel in the topsoil). Also avoid areas in inland valleys with potential for water-logging.

The area needed per demonstration site is approximately 484m^2 (22 * 22 m).

4. Treatments and rationale

In Lushoto and Moshi we will demonstrate the use of improved bush bean varieties and the best fertilizers (NPK, PK+ farm yard manure-FYM) to increase bean productivity. This follows farmer request and interest during field visits and field days organised by N2Africa during 2014 short rains season. During these field days farmers requested to test new improved bush bean varieties and best fertilizer combination to achieve optimum yields. Varieties of choice were Lyamungo 90 and Uyole

njano. These will be tested against the prominent farmer variety to be identified later. The fertilizer factor will be control, NPK and FYM+PK. The two treatments (NPK and FYM+PK) were the one observed to perform better than the other demonstrated treatments in the 2014 short rain season.

Table 1. Treatment structure of the demonstration plots

Treatment number	Variety	NPK	PK+FYM
1	Lyamungo 90	-	-
2	Lyamungo 90	+	-
3	Lyamungo 90	-	+
4	Uyole njano	-	-
5	Uyole njano	+	-
6	Uyole njano	-	+
7	Local variety	-	-
8	Local variety	+	-
9	Local variety	-	+

5. Design of demonstration

- Demonstrations will be installed as one experiment.

- Plot size: 6 m long and 6 m wide = 36m^2 per plot (Figure 1).

- Spacing beans: 50 cm between rows by 20 cm within row. Plant two seeds per hole at planting. Each plot should accommodate 12 lines (Figure 2).

-

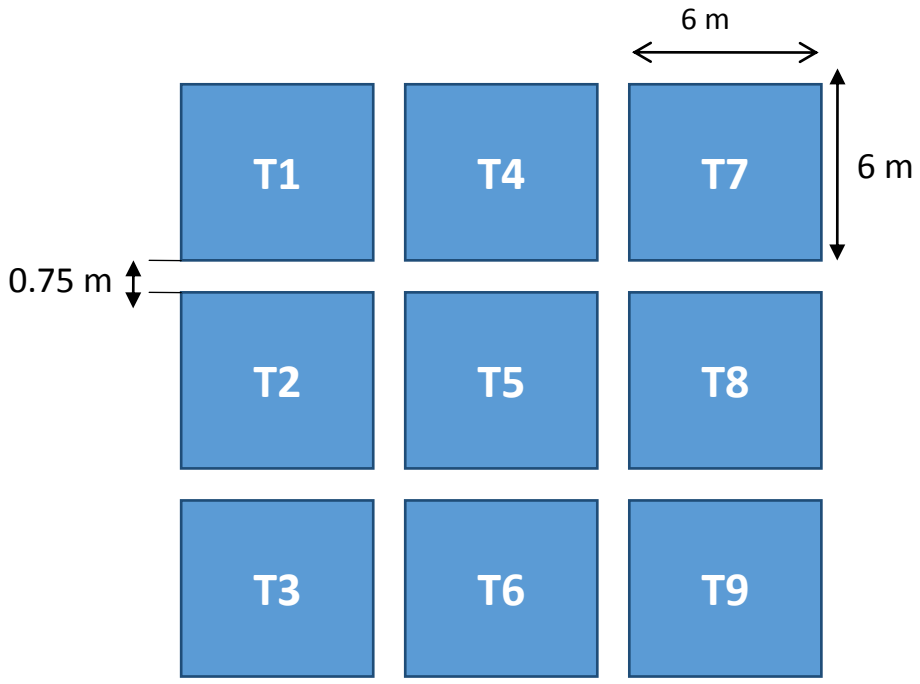


Figure 1: Sketch of the bush bean variety and input management demonstrations

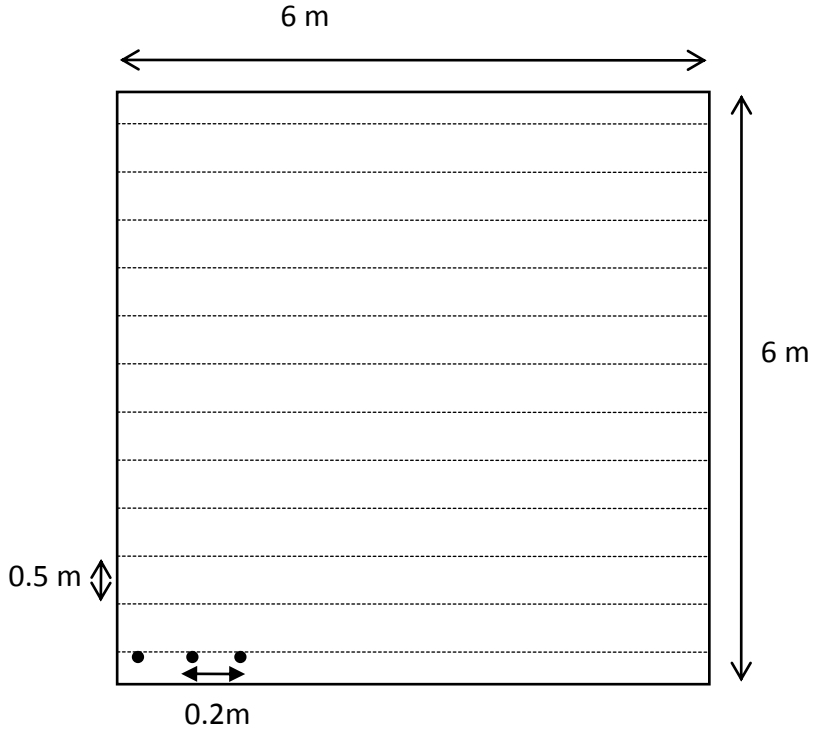


Figure 2: Sketch of row and plant spacing per plot

Laying-out of plots and planting will be done by researchers in collaboration with field extension workers and the farmers

- Lay out and mark the plots in the field.

- Clearly **label** each plot (with large, easy to read signs) with the plot number and treatment applied. This way both farmers and N2Africa staff can easily identify which treatment was applied to which plot.

- If possible, lay out the adjacent plots in a **square or rectangular layout** as much as possible. By doing so, there is less possibility of heterogeneity in the field affecting the performance of the different plots.

- Number the plots **consecutively** from 1 to the number of treatments

The demonstration plot size in this season will be 6mx6m. All plots should have the same number of rows (12). The path between plots will be 0.75m; a space of 0.25m (half row spacing) will be left before and after first and last row respectively.

6. Application of inputs

- Fertilizer rates: NPK (10:18:24) will be applied using a rate of 824.8 g/ plot (at an equivalent P application rate of 20 kg/ha). Cattle manure will be applied at a moderate rate of 4 t/ha.

- Fertilizer application: NPK will be banded, 10 cm away from the planting line, in a 2-cm deep trench and covered after application. Cattle manure will be broadcasted followed by shallow tillage before planting.

- Weeding: weed the demonstration according to recommended practice.

- Retain some seed to fill gaps as necessary.

Inputs needed per 36 m^2 plot

Type of input	Amount needed per 36 m^2plot
Seed	0.45 kg
NPK	0.825 kg
Manure	14.2 kg

7. Management

Crop management, such as fertilizer application and weeding should be defined and supervised by researchers, in collaboration with extension workers from respective villages although actual implementation may be done by farmers.

8. Measurement

8.1 During the season

All observations, measurements and farmer information will be collected in special field books, which will be provided together with specific instructions for their use (field book protocol). These field books will be the most important source of data for yield gap analysis and should be filled with the greatest care. The following observations need to be recorded throughout the season:

Planting dates

Percent emergence (for each treatment)

Fertilizer application dates

Weeding dates (1st/2nd/3d)

Rainfall (protocol), at least one rain gauge per site for daily rainfall measurement.

Occurrence of pests/disease (for each treatment, protocol)

Occurrence of severe drought flooding or other catastrophic events

Harvest dates

8.2. Measurements at harvest

Harvesting should preferably be done by the N2Africa staff, in collaboration with respective extension workers and farmers. It is very important to **ask farmers not to harvest** anything during the season. All legumes will be shelled on site at harvest, with the exception of groundnut. Store (shelled) grain, husks and stover in separate yield bags that are labelled with the corresponding plot numbers and treatments. Fresh weight of grain, husks and stover will measured with a precision of two decimals with a digital hanging scale (provided).

9. Organization of field days

At least two field days need to be organized around each demonstration trial. The first should take place before planting and serves to communicate the different technology options to farmers and offer them the possibility of participation in the adaptation/ baby demos. The second should be around harvest time to allow farmers to compare and discuss the relative performance of the different treatments. Demonstration plots should be freely accessible to farmers, and a contact person should be assigned to answer questions by farmers during the season

10. Evaluation of technology

At the end of the season and **evaluation** of the performance of the demonstrated technologies should take place at the level of farmer groups, as interactive feedback through workshops etc., and implementing farmers, by having them reply to the evaluation questions in the field book.

Appendix III

Exam on Content

Name of the interviewer: _____

Date of interview: _____/_____/2015

Country: _____ Region: _____

District: _____ Ward: _____

Village: _____

Information received via: _____

Introduction

Introduce yourself and the Maharage Bingwa Campaign. Explain the purpose of the survey and assure the interviewee of the confidentiality. Please check if the farmer has any questions at this time.

Part A: General Information

A.1. Name of the farmer: _____

A.2. Sex of the farmer: Male ___ /Female ___

A.3. Age: _____ years

A.4. Phone number of farmer or contact person: _____

A.5. Is farmer head of the household: Yes ___ / No ___

A.6. If no, head of household is Male ___ / Female ___; Age _____ years

A.7. Member of the household: Total number of people in the household: _____

Age	# females	# males
0 – 16 years		
17 – 35 years		
35-60 years		
Over 60 years		

A.8. Education level of interviewee: _____ years

A.9. Education level of person with the highest education in household and the education level of the household head (years)?

Schooling level	Within household	Household head
1. Primary		
2. Secondary		
3. Post-secondary		
4. University		
5. Other, specify:		

A.10. Does the household grow beans? Yes ☐ No ☐

The first part of the questionnaire should be answered by all farmers. The sections afterwards are additional and cover specific questions on the information disseminated by radio and demonstration plot.

All Delivery Methods

Part B: Timing

B.1. What is the best time of the year to plant beans and why?

_____

_____

Part C. Land Preparation

C.1. When should you prepare the land before planting?

_____

_____

C.2. How should you prepare your land before planting?

_____

_____

C.3. If organic manure applied, how and when?

_____

_____

Part D: Fertilizers

D.1. Which industrial fertilizer should be applied when growing beans and why?

_____

_____

D.2. What other fertilizer can be applied on the field to make the soil more fertile?

_____

_____

D.3. What is the best fertilizer combination to boost soil fertility and bean production?

_____

_____

Part E: Seeds

E.1. What kind of bean seeds should you be using? _____

E.2. What are the benefits of using improved seeds? _____

E.3. How many bean seeds should be put into one hole? _____

E.3. Is it preferable to plant beans by hands or with the help of cows? Please explain your answer.

_____

_____

Part F: Mono-cropping

F.1. In what distance should bean rows be planted to one another?

_____

F.2. In what distance should bean plants be planted to one another in one row?

_____

Part G: Harvest

G.1. How many bags/buckets/kg of beans do you normally harvest per acre? _____

G.2. How many bags/buckets/kg of beans extra can you harvest when using improved seeds versus local/not improved seeds?

_____

_____

This part of the questionnaire should be answered by the farmers who listened to the radio.

Radio

Part H: Intercropping

H.1. With which crop should beans be intercropped? _____

H.2. What is the benefit of intercropping beans and maize compared to conventional farming?

_____

_____

H.3. How long after having planted the maize should the beans be planted and why?

_____

_____

H.4. How many centimeters should be left between two rows of maize? _____

H.5. In what distance to each other should the maize plants be planted in one row? _____

H.6. How man rows of beans should be planted in between two rows of maize? _____

H.7. In what distance to each other should be bean plants be planted in one row? _____

Part I: Terraces

I.1. When planting on terraces, how many centimeters above the ground should the terraces be? _____

I.2. What should be width of the terraces? _____

I.3. How many rows of beans can be planted on one terrace? _____

I.4. What does planting beans in “zig-zag” fashion mean when planting on terraces?

_____

_____

I.5. What are the benefits for beans of planting in "zig-zag" fashion?

_____

_____

Part J: Pesticides

J.1. Which pesticide should be used when the bean plants are covered with white flies? _____

Part K: Seeds

K.1. After how many seasons should bean seeds be renewed ideally in order to gain a high yield? _____

This part of the questionnaire should be answered by the farmers who saw the demonstration plot.

Demonstration Plot

Part L: Fertilizer

L.1. How should NPK fertilizer be applied on the field?

_____

_____

Appendix IV

Evaluation of Information

Name of the interviewer: _____

Date of interview: _____/_____/2015

Country: _____ Region: _____

District: _____ Ward: _____

Village: _____

Information received via: _____

Introduction

Introduce yourself and the Maharage Bingwa Campaign. Explain the purpose of the survey and assure the interviewee of the confidentiality. Please check if the farmer has any questions at this time.

Part A: General Information

A.1. Name of the farmer: _____

A.2. Sex of the farmer: Male ___ /Female ___

A.3. Age: _____ years

A.4. Phone number of farmer or contact person: _____

A.5. Is farmer head of the household: Yes ___ / No ___

A.6. If no, head of household is Male ___ / Female ___; Age _____ years

A.7. Member of the household: Total number of people in the household: _____

Age	# females	# males
0 – 16 years		
17 – 35 years		
35-60 years		
Over 60 years		

A.8. Education level of interviewee: _____ years

A.9. Education level of person with the highest education in household and the education level of the households head (years)?

Schooling level	Within household	Household head
1. Primary		
2. Secondary		
3. Post-secondary		
4. University		
5. Other, specify:		

A.9. Does the household grow beans? Yes ☐ No ☐

Part B: Evaluation of the Information

Please involve the farmer into a conversation and find out about his/her opinion on the different aspects of the information received. Tick the appropriate answer for each of the statements below.

B.1. The source of the information is trustworthy.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

B.2. The information is credible.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

B.3. The information is relevant.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

B.4. The information is useful.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

B.5. The information is comprehensive.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

B.6. The information is understandable.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

B.7. The information incentivise farmers to change current bean farming practices.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

B.8. What is your overall evaluation of the information you received *Please make sure farmer is only evaluating the information received and tick appropriate box.*

Type of Approach	Rating				Reasons for rating & suggested improvements
	Very Good	Good	Fair	Poor	
Radio Program					
Demonstration					

Part C: Evaluation of Delivery Method

Please involve the farmer into a conversation and find out about his/her opinion on the different aspects of the information received. Tick the appropriate answer for each of the statements below.

C.1. The delivery method is appropriate given the information disseminated.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

C.2. The way the information is presented holds the farmer's interest until the end of the session.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

C.3. The information is accessible.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

C.4. The language spoken by the extension officer/presenter is understandable.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

C.5. The farmers are able to ask questions during the session.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

C.6. The extension officer/presenter summarizes key points made during or after the session.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Please explain your answer. Why do you say so?

_____

_____

C.7. Please indicate and rank via which delivery method you would prefer to receive information on bean planting and explain your ranking. Choose from the following options: radio program, SMS, comic, demonstration plot, flyer, poster with agro-dealers.

1. _____
2. _____
3. _____

_____

_____

C.8. Would you like to receive the information via a combination of different delivery methods?

If yes, which channels and why? If no, why not?

_____

_____

C.9. What is your overall evaluation of the presentation of the information you received? *Please make sure farmer is only evaluating the information received and tick appropriate box.*

Type of Approach	Rating				Reasons for rating & suggested improvements
	Very Good	Good	Fair	Poor	
Radio Program					
Demonstration					

Part D: Information

D.1. From which source do you normally receive information on bean farming?

_____

_____

D.2. Did the information received add certain information to what you knew about beans farming?

If yes, which information?

_____

_____

D.3. Would you like to know more about one or more of the topics? Yes ☐ No ☐

If yes, on which topic and what? If no, why not?

_____

_____

Part E: Technology Adoption

E.1. Are you already using one or more of the farming practices/inputs mentioned earlier?

If yes, which ones and why? If no, why not and which ones do you use?

_____

_____

E.2. If new farming practices/inputs used, how did you access (on your own or as group) the farming practices/inputs being used or introduced to you?

_____

_____

E.3. If new farming practices/inputs used, what were the challenges of accessing these?

_____

_____

E.4. Which of the inputs/farming practices will you be using in the future (if not being used now) on your own fields and why?

_____

_____

E.5. How are you planning to access the farming practices and inputs you intend to use in the future?

_____

_____

General remarks/comments by farmers on the evaluation of the content and the presentation of the information:

_____

_____

Appendix V

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Gender of respondent	Between Groups	2,216	2	1,108	4,838	,009
	Within Groups	37,332	163	,229		
	Total	39,548	165			
Gender of household head	Between Groups	,256	2	,128	1,068	,346
	Within Groups	19,557	163	,120		
	Total	19,813	165			
Education level of respondent	Between Groups	,609	2	,304	1,712	,184
	Within Groups	28,629	161	,178		
	Total	29,238	163			
Education level or HH head	Between Groups	,488	2	,244	1,115	,330
	Within Groups	33,436	153	,219		
	Total	33,923	155			
Household members category	Between Groups	,158	2	,079	,171	,843
	Within Groups	74,969	162	,463		
	Total	75,127	164			
Age category of respondent	Between Groups	,098	2	,049	,039	,961
	Within Groups	202,842	163	1,244		
	Total	202,940	165			
Age category of household head	Between Groups	1,216	2	,608	,516	,598
	Within Groups	192,134	163	1,179		
	Total	193,349	165			
Respondent has mobile phone number	Between Groups	,681	2	,340	3,015	,052
	Within Groups	18,404	163	,113		
	Total	19,084	165			

Appendix VI

Von: Mark Leclair <mleclair@farmradio.org>
Gesendet: Mittwoch, 17. August 2016 17:51
An: Mitschke, Verena
Cc: Baars, Edward (IITA); Godlove Nderingo; Karen Hampson; etemba@farmradio.org; Ampadu-Boakye, Theresa (IITA); Kanampiu, Fred (IITA)
Betreff: Re: thesis

Hi Verena,

Sorry for the delay. I looked into the data we have on Sauti ya Injili. Unfortunately this project was relatively small in terms of budget and we didn't do a full outcome evaluation for it. This means that we did not map out the coverage of the station in detail. The closest we came was doing some very preliminary work a few years ago (see the attached map). This was before we had finalized a method for estimating coverage of the population and the actual mapping technology we were using was not at all exact. So at this point I don't have population numbers to share with you.

Normally what we do is we take the potential coverage of the station from the map and then estimate listenership by using metrics gathered through randomized cluster-sampled face-to-face surveys in the coverage area. Again, this project was not large enough to warrant that level of analysis. We did do an evaluation via automated phone survey with people who had called in to the program at some point. But this only gives us data on those we already know listened to at least one episode.

However, we HAVE done larger evaluations with several other projects and pretty consistently come up with a figure of about 30 - 60 cents (Canadian) per listener (to reach them with at least one episode of the program). As well, we see it costs about $1 - $1.50 per listener that applies a promoted practice from the radio. Obviously this varies a good deal depending on the country and the actual nature of the radio program, but perhaps this can help. We don't have anything published with these figures yet but we intend to do something soon.

I hope this helps. Thanks,

Mark Leclair,
Knowledge Management Team Lead | Chef d'équipe de la gestion du savoir
t: 1.613.761.3711 | e: mleclair@farmradio.org<mailto:mleclair@farmradio.org> | skype: markjleclair

Farm Radio International / Radios Rurales Internationales
1404 Scott | Ottawa, ON | Canada | K1Y 4M8
www.farmradio.org<http://www.farmradio.org/> | twitter:
@farmradio<http://www.twitter.com/farmradio> |
www.facebook.com/farmradio<http://www.facebook.com/farmradio>

Appendix VII

Dear Edward & Verena,

Kindly have a look on the 2 tables below. The first table shows number of demos and adaptations established and the second table shows the cost estimate per demo and adaptation plots.

Table 1. Number of demos and adaptations established in 2015

Location or partner	Number of demos with respect to crop (year 2015)				Adaptations (2015)	
	Bush bean	climbing bean	Soybean	Groundnut	Bush bean	Soybean
Lushoto	20	11	0	0	441	NA
Moshi	10	0	0	0	375	NA
Kongwa	10	0	0	11	0	NA
Mvomero	5	0	5	0	0	NA
RUDI	24	0	24	0	0	NA
CRS	0	0	35	0	0	NA
Clinton Foundation	0	0	39	0	0	NA
Total	**69**	**11**	**103**	**11**	816	NA

Table 2: Cost estimate per single demo and adaptation

Activity	Cost estimate per demo (Tsh)				Cost estimate per Adaptation (Tsh)	
	Bush bean	climbing bean	Soybean	Groundnut	Bush bean	Soy
Land preparation	20,000.00	20,000.00	20,000.00	25,000.00	7,000.00	7,
Seed input	18,000.00	13,500.00	5,000.00	39,600.00	4,000.00	3,
Fertilizer input	6,000.00	3,000.00	4,000.00	6,700.00	2,000.00	2,
Crop management	20,000.00	20,000.00	20,000.00	30,000.00	10,000.00	10,
Harvest	20,000.00	20,000.00	20,000.00	25,000.00	7,000.00	7,
Total	**84,000.00**	**76,500.00**	**69,000.00**	**126,300.00**	**30,000.00**	**29,**

*Note: the exchange rate during the demos establishment was 1USD=1820 Tshs

Kind regards,

Abubakari.

Appendix VIII

Dear Verena,

The number reached by demos in Lushoto from 2014 to 2016 is summarized in the table below

Year	Demos	Farmers reached
2014	10	250
2015	31	400
2016	32	480
Total	73	1130

Kind regards,

Abubakari.

Appendix IX

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Test Score	Equal variances assumed	,174	,677	2,490	114	,014	,069405	,027870	,014194	,124615
	Equal variances not assumed			2,492	113,651	,014	,069405	,027856	,014220	,124590

Bibliography

ASARECA & KIT (2014). Tanzania Seed Sector Assessment. Participatory National Seed Sector Assessment for the Development of an Integrated Seed Sector Development (ISSD) Programme in Tanzania. Entebbe, Uganda.

ASHC (2015). Legume Alliance. Measurement, learning and evaluation workshop.

ASHC (2016). Available at: http://africasoilhealth.cabi.org/2015/09/25/what-constrains-bean-farmers/. [Accessed 15.11.2016].

ASHC (n.d.). Introduction to Legume Alliance.

Andreasen, A. R. (1997). Challenges for the science and practice of social marketing. In M. E. Goldberg, M. Fishbein & S. E. Middlestadt (Eds.), Social marketing: Theoretical and practical perspectives. 3-19. Mahwah, NJ: Lawrence Erlbaum Associates.

Atkin, C. K. & Rice, R. E. (2009). Public communication campaigns: Theoretical principles and practical applications. In J. Bryant & M. Oliver (Eds.), Media effects: Advances in theory and research (3rd ed). 436–468. Hillsdale, NJ: Lawrence Erlbaum.

Atkin, C. K. & Rice, R. E. (Eds.) (2012). Public communication campaigns (4th ed). Thousand Oaks, CA: Sage.

Bernard, H. R. (2011). Research methods in anthropology: Qualitative and quantitative approaches. Rowman Altamira.

Blair, M. W., González, L. F., Kimani, P. M., & Butare, L. (2010). Genetic diversity, inter-gene pool introgression and nutritional quality of common beans (Phaseolus vulgaris L.) from Central Africa. *Theoretical and Applied Genetics*, *121*(2), 237-248.

Bloomfield, C., Bommarito, R. K., Borden, L. M., Brown, S., Butler, B., Hawkey, K. R., Kuhl, M. W., Rea, J., Rudi, J. R., Sherman, M. D., Shortreed, T. (2015). Public Awareness Campaigns.

Bucheyeki, T. L. & Mmbaga, T. E. (2013). On-Farm Evaluation of Beans Varieties for Adaptation and Adoption in Kigoma Region in Tanzania. ISRN Agronomy.

CABI (n.d.). Available at: http://www.cabi.org/. [Accessed 30.10.2015].

Campbell, D. T., Stanley, J. C., & Gage, N. L. (1963). Experimental and quasi-experimental designs for research (No. 04; Q175, C3.). Boston: Houghton Mifflin.

Cellini, S. R., & Kee, J. E. (2010). Cost-effectiveness and cost-benefit analysis. *Handbook of practical program evaluation*, *3*.

CGIAR (n.d.). Available at: http://www.cgiar.org/our-strategy/crop-factsheets/beans/. [Accessed 15.11.2016].

CIAT (2008). Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/tz.html. [Accessed 30.10.2015].

City Population (2012). Available at: https://www.citypopulation.de/php/tanzania-admin.php?adm2id=0401. [Accessed 15.02.2017].

Coffman, J. (2002). Public Communication Campaign Evaluation. An Environmental Scan of Challenges, Crtiticisn, Practice and Opportunities.

Doss, C. R., Mwangi, W. M., Verkuijl, H., & De Groote, H. (2003). Adoption of maize and wheat technologies in Eastern Africa: A synthesis of the findings of 22 case studies.

FAO (2008). Available at: http://faostat.fao.org/faostat. [Accessed 02.11.2015].

FAO (2015). Available at: http://faostat3.fao.org/browse/Q/QC/E. [Accessed 05.01.2017].

Giller, K.E. & Amijee, F. (1998). Environmental constraints to nodulation and nitrogen fixation of Phaseolus Vulgaris L. in Tanzania. I. A. survey of soil fertility, root nodulation and multi-locational responses to rhizobium inoculation. African Crop Science Journal, 6(2), 159-169.

Google Maps. Tanzania, Tanga Region, Lushoto District. Available at: https://www.google.de/maps/place/Lushoto,+Tansania/@-4.7994364,38.2683418,14z/data=!3m1!4b1!4m5!3m4!1s0x18469508b765bc6d:0x956dcc365c633bd5!8m2!3d-4.7986675!4d38.2902184. [Accessed 03.04.2016].

Hillocks, R. J., Madata, C. S., Chirwa, R., Minja, E. M., Msolla, S. (2006). Phaseolus bean improvement in Tanzania, 1959-2005. Euphytica, 150(1-2), 215-231.

Johns, R. (2010). Likert items and scales. *Survey Question Bank: Methods Fact Sheet*, *1*.

Karugia, J., Massawe, S., Guthiga, P., & Macharia, E. (2013). Agricultural Productivity in EAC Region (1965-2010) Trends and Determinants. In *International Symposium and Exhibition on the Agricultural Development in the EAC Partner States at the* (Vol. 50).

KIT (2015). Information Needs Assessment Tanzania.

Krouma, A., Drevon, J. J., & Abdelly, C. (2006). Genotypic variation of N 2-fixing common bean (Phaseolus vulgaris L.) in response to iron deficiency. *Journal of plant physiology*, *163*(11), 1094-1100.

Levin, H. M. (1975). Cost-effectiveness analysis in evaluation research. *Handbook of evaluation research*, *2*, 89-122.

Levin H. M. (1983). *Cost-Effectiveness: A Primer.* Sage Beverly Hills, California

Levin, H. M. (1988). Cost-effectiveness and educational policy. *Educational Evaluation and Policy Analysis*, *10*(1), 51-69.

Levin, H. M. (1995). Cost-Effectiveness Analysis. In M. (Ed.). (1995). *International encyclopedia of economics of education* (Vol. 2). Pergamon Press.

Lockheed, M. E., & Hanushek, E. (1988). Improving Educational Efficiency in Developing Countries: what do we know?. *Compare*, *18*(1), 21-38.

N2Africa (2014). Tanzania Country Report: January - December, 2014.

Ouma, J., DeGroote, H., & Gethi, M. (2002). Focused participatory rural appraisal of farmer's perceptions of maize varieties and production constraints in the moist transitional zone in Eastern Kenya. *IRMA Socio-Economic Working Paper*, (02-01), 1-37.

Prochaska, J. O., Norcross, J. C., & DiClemente, C. C. (2013). Applying the stages of change. Psychotherapy in Australia, 19(2), 10.

Rogers, E. M., & Storey, J. D. (1987). Communication campaigns. In C. Berger & S. Chaffee (Eds.), Handbook of communication science. 817–846. Newbury Park, CA: Sage.

Ronner, E. & Giller, K. E. (2013). Background information on agronomy, farming systems and ongoing projects on grain legumes in Tanzania.

Salmon, C.T, Post, L.A., & Christensen, R.E. (2003). Mobilizing public will for social change. Lansing, MI: Michigan State University.

Shiferaw, B. A., Kebede, T. A., & You, L. (2008). Technology adoption under seed access constraints and the economic impacts of improved pigeonpea varieties in Tanzania. Agricultural Economics, 39(3), 309-323.

Tran, M. (2012). Most children in Tanzania, Uganda and Kenya fail literacy and numeracy tests. Available at: https://www.theguardian.com/global-development/2012/aug/15/tanzania-uganda-kenya-literacy-numeracy. [Accessed 30.08.2016].

UNICEF (2013). Available at: http://www.unicef.org/infobycountry/tanzania_statistics.html. [Accessed 30.08.2016].

UNICEF (2015). Available at: http://www.unicef.org/infobycountry/tanzania_statistics.html. [Accessed 30.08.2016].

USAID (2016). Available at: https://www.usaid.gov/what-we-do/agriculture-and-food-security/food-assistance/resources/beans-commodity-fact-sheet. [Accessed 15.11.2016].

UWEZO (2012). Are our Children Learning? Literacy and Numeracy across East Africa.

Weiss, J. A., & Tschirhart, M. (1994). Public information campaigns as policy instruments. *Journal of policy analysis and management*, *13*(1), 82-119.

World Bank (2016a). Available at: http://data.worldbank.org/indicator/SE.ADT.LITR.ZS?end=2012&locations=TZ&start=1988&view=chart. [Accessed 30.08.2016].

World Bank (2016b). Available at: http://data.worldbank.org/indicator/IT.CEL.SETS.P2?locations=TZ. [Accessed 30.08.2016].

Yousafzai, S. Y., Foxall, G. R., & Pallister, J. G. (2010). Explaining internet banking behavior: theory of reasoned action, theory of planned behavior, or technology acceptance model?. Journal of Applied Social Psychology, 40(5), 1172-1202.