Uptake of technology and competitiveness of legume production in small scale farming in South Kivu, Democratic Republic of Congo

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A research thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Agribusiness Management and Trade in School of Agriculture and Enterprise Development of Kenyatta University.

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DECLARATION

I declare that this thesis is my original work and has not been presented for a degree in any other university.

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DEDICATION

Dedicated to my family Tina Ernestine Nyenyezi Balangaliza, Francisca Balangaliza, Nicole Soki and my dear late mother Ernestine M Bashwere.

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ABBREVIATIONS AND ACRONYMS

BNF	Biological Nitrogen Fixation
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultural Tropical (International Centre for Tropical Agriculture
DIOBASS	Démarche Interactive des Organisations de Base et Autres Sources de Savoir (Interactive approach of Basis Organizations and Other Sources of Knowledge)
DRC	Democratic Republic of Congo
GCP	Generation Challenge Program
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
N	Nitrogen
N.d	No date
NGO	Non-Governmental Organization
PAD	Programme d'Appui au Développement durable (Programme support for sustainable development)
SARCAF	Service d'Accompagnement et de Renforcement des Capacités d'Autopromotion de la Femme (Support service and strengthening self promotion capacity of women)
MINAGRI	Ministere National de l'agriculture(Ministry of Agriculture, Livestock and Fisheries)
SENAFIC	Service National de Fertilisants (national fertilizer services)

SENAMA	Service National de Mecanisation national machanization services)
SNV	Service National de vulgarisation (national extension services)

OPERATIONAL DEFINITION OF KEY CONCEPTS AND TERMS

N2Africa: improved legume cultivation practices for smallholder farmers through the use of improved seeds, mineral fertilizers, rhizobium inoculation and best agronomic practices (spacing patterns).

Uptake: the use of various aspects (spacing patterns, improved seeds, mineral fertilizer and rhizobium) in the initial stages of legume production as recommended by N2Africa project.

Competitiveness: the comparative profitability and returns on capital of various farm enterprises investments. In this study competiveness of legume, potato, maize and cassava have been assessed.

ABSTRACT

Legumes are considered vital for achieving food and nutritional security for both poor producers and consumers. Despite their importance in human nutrition and role in sustainability of agriculture systems, grain legume yields are low and unstable across seasons and environments with declining per capita availability, there is an immediate need to address their production. As in other parts of SSA, Legumes constitute a major part of the population's diet in Democratic Republic of Congo. Although there is evidence that DR Congo has adequate land for legume production, the yields and adoption of new varieties of legume still remains low. The country has recorded an average yield of 0.2 to 0.5 ton ha-1 over the years compared to potential of 1.6-2.0 ton ha-1 .This has necessitated various stakeholders such as CIAT to be at the forefront in the promotion of legume productivity in Eastern DR Congo through the N2Africa project, focusing on common beans and soya beans. However, the level of knowledge and degree of uptake of the technology disseminated by N2Africa project, the profitability of legume production compared to other principal crops available to smallholder farmers (cassava, sweet potato and maize), factors that influence uptake and had not been assessed in Eastern DR Congo. Therefore, this study investigated the competitiveness of legumes compared to other principal crops to bridge the existing knowledge gap. Data was collected using a structured questionnaire from a randomly selected sample of 291 farmers in Eastern DR Congo; Kabare, Kalehe, Mwenga and Walungu territories. A combination of descriptive and inferential statistics was used to determine the level of knowledge and the degree of uptake of the technology disseminated by N2Africa project. Gross margin and Tobit models were used for analysis of the profitability of various crop enterprises and the factors influencing the uptake of the technology disseminated by N2Africa project. The results of the study showed that the technology knowledge level was high in spacing (76%) and improved seeds (73%) aspects but was low in fertilizer (32%) and rhizobium (30%) aspects. The degree of uptake was high in spacing and improved seeds aspects but was moderate in rhizobium whereas fertilizer uptake was low. The study found that legume farming experience, gender, head of household, total farm size, farmer group membership and profitability of beans significantly influenced the uptake of technology disseminated by N2Africa project. In addition, the study found out that common bean had the highest profitability compared to other principal crop enterprises in Eastern DR Congo. It is recommended that policy makers in DR Congo should focus on pioneering effective institutional structures that would enable establishment of extension services systems to promote uptake of farming technologies. It is also recommended that as much as legume production is being promoted, the government and NGOs should work towards emphasizing on the importance of farm enterprise suitability mapping. Finally, facilitation by agricultural sector stakeholders should be rendered towards forming services oriented farmer groups to enhance uptake of technology disseminated by N2Africa project.

CHAPTER ONE: INTRODUCTION

1.1 Background

Grain legumes represent an important component of agricultural food crops consumed in developing countries, especially in Sub-Saharan African (SSA) countries. They also complement cereal crops as a source of protein, minerals and vitamins (Comlanvi, 2011). The legumes are considered vital for achieving food and nutritional security for both poor producers and consumers (Sitou and Mywish, 2011). Grain legumes are mostly grown as mixed crops, intercrops or in rotation with cereals. Legumes fix nitrogen and hence enhance soil fertility and sustainability of agricultural production systems globally (CGIAR, 2012).

Grain legumes are currently grown on about 195 million ha globally, mostly in developing countries where the majority of poor and malnourished people live (CGIAR, 2010). According to Tilahun (2003), legumes are important components of various farming systems in Africa. They are measured as engines of sustainable farming as they intensify the productivity and interaction of the soil, crop, livestock, people and other components. In the largest part of Africa, where livestock products are high-priced, legumes, especially beans, cow peas, peas, chickpeas and faba beans are the major sources of protein. Overall, increasing legume production, trade and consumption should help reduce food and nutrition insecurity, improve livelihoods of resource-poor farmers, and ensure availability of grain legumes at affordable prices to the poor rural and urban consumers (CIAT *et al*., 2010).

Despite their importance in human nutrition and role in sustainability of agriculture systems, grain legume yields are low and unstable across seasons and environments (FAO, 2011). With declining per capita availability of grain legumes, there is an immediate need to address their production constraints to raise productivity, quality and stability of production to ensure their increased availability to the poor at affordable price (CGIAR, 2010). In light of the foregoing a consortium of research organizations including International centre for tropical agriculture (CIAT), International Center for Agricultural Research in the Dry Areas (ICARDA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Institute of Tropical Agriculture (IITA) and Generation Challenge Program (GCP) have come together to address the challenges to grain legumes production to impact on the livelihoods of the smallholder farmers in developing countries. The goal is to enhance productivity and yield stability leading to increased food, nutrition and increased income to resource poor farmers especially women farmers.

In DR Congo, the agricultural sector has been facing various constraints. In fact, many crops have been destroyed and farms completely abandoned because of socio-political instability in Eastern DR Congo, thus resulting in a drastic decrease in areas under cultivation. Farmers who have been able to pursue agricultural activities, have turned to traditional subsistence agriculture which is carried out with minimum agricultural inputs and hence relatively unproductive. Furthermore, lack of appropriate incentives for private investments has seriously deprived the agricultural sector of capital and limited its value added (Kane *et al.*, 2004).

Grain legumes are grown in all provinces of the DR Congo. They are generally produced in the traditional sector, a sector characterized by low use of agricultural inputs, and the very small size of farms. The production of legumes in the country has significantly reduced compared to the past sixty years (Kadima, 2006).

According to N2Africa project proposal (2012) "Agricultural production in most parts of sub-Saharan Africa is dominated by smallholder farming systems of low productivity. Although inclusion of legumes has the potential to improve system productivity, often less than 5-10% of cultivated land is currently planted with field legumes. Grain legumes are often included as minor intercrops in fields of cereals and other staple crops. This is because smallholder farmers operate under diverse socio-ecological constraints that limit the productivity of legumes and farmers' ability to scale up the integration of legumes into their farming systems."

As in other parts of SSA Legumes constitute a major part of the population's diet in Democratic Republic of Congo. Although there is evidence that DR Congo has adequate land for legume production, the yields and adoption of new varieties of legume still remains low. The country has recorded an average yield of 0.2 to 0.5 ton ha^{-1} over the years compared to potential of 1.6-2.0 ton ha^{-1} (Kadima, 2006). This has necessitated various stakeholders such as CIAT to be at the forefront in the promotion of legume productivity in Eastern DR Congo through the N2Africa project, focussing on common beans and soya beans. A new initiative is proposed in which legumes are used as a basis for improving cropping systems and household well-being, increasing inputs from biological nitrogen fixation (BNF) that will link family protein supply and farm nitrogen inputs directly to the atmosphere, will improve soil health and will increase household incomes (Chianu *et al*., 2010).

The project entitled 'Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa', better known as the N2Africa project, is an initiative in which legumes are used to revitalize productivity of cropping systems and to improve the well being of smallholder farmers in sub-Saharan Africa. The project is working to increase farm nitrogen (N) input through Biological Nitrogen Fixation (BNF), from the current 8 kg to 46 kg/ha on 225,000 farms in eight countries including the DR Congo. This additional N is expected to increase the yield of grain legumes as well as companion crops to about 2 tonnes/ha on average, resulting to excess production which when sold is capable of increasing household income by about USD 465. To be able to achieve the above goal, the project is implemented following a step-wise approach, which involves selection of superior legume and rhizobia genotypes with enhanced potential for BNF; evaluation of selected legumes and rhizobia under different agronomic practices that enhance BNF; integration and scaling up best fit agronomic technologies to smallholder farmers in different farming systems and agro-ecologies in the project impact zones (Baijukya and Vanlauwe, 2011).

Despite of the interventions to promote legume farming, literature shows productivity and uptake of new varieties still remains low. Several factors could be responsible for this low productivity and uptake of new varieties that need to be investigated to unlock this potential. This study hypothesizes that socio-demographic and economic factors are responsible for the low uptake and productivity of legumes in the region. Consequently, it proposes to asses these factors in order to provide policy advice to support legume promotion.

1.2 Problem statement

Whereas there is evidence that various stakeholders such as CIAT are at the forefront in the promotion of legume productivity and creating an enabling environment for farmers to access high yield varieties in Eastern DR Congo, the uptake of technology disseminated N2africa project (rhizobium inoculation, seeds, fertilizer application, spacing patterns) and productivity still remains low. Several factors could be responsible for this situation; however this study hypothesizes that socio-demographic and economic factors hold key to raising productivity. Literature search revealed that economic factors especially the profitability of legume production compared to other principal crops available to smallholder farmers (cassava, sweet potato and maize), and the socio-demographic factors that influence initial uptake and later on adoption has not been assessed in the study area. Therefore, this study evaluated the competitiveness of legumes specifically common bean and soya bean among such crops as cassava, potato and maize. It provided also factors that influence the uptake of the legume technology disseminated by N2Africa project, the degree of uptake and the farmer's knowledge level to bridge the existing knowledge gap.

1.3 Objectives

1.3.1 General objective

To assess the competitiveness of legume production and socio-demographic and economic factors that influences the uptake of legume production using the technology disseminated by N2Africa project among small-scale farmers in the East of DR Congo.

1.3.2 Specific objectives

1. To evaluate the level of knowledge in N2Africa disseminated technology among legume farmers as an indicator of the potential technology uptake in the study area.
2. To determine the degree of uptake of legume production technology disseminated by N2africa project in order to foresee the likely scenario for adoption of the technology upon completion of the project in the study area.
3. To identify and analyze socio-demographic and economic factors that influence uptake of legume production with the technology disseminated by N2africa project in order to identify avenues for intensifying the technology uptake in the study area.

4. To assess competitiveness of legume production amongst small-scale farmers in Eastern DR Congo as an indicator of legume importance among farm enterprises.

1.4 Hypotheses

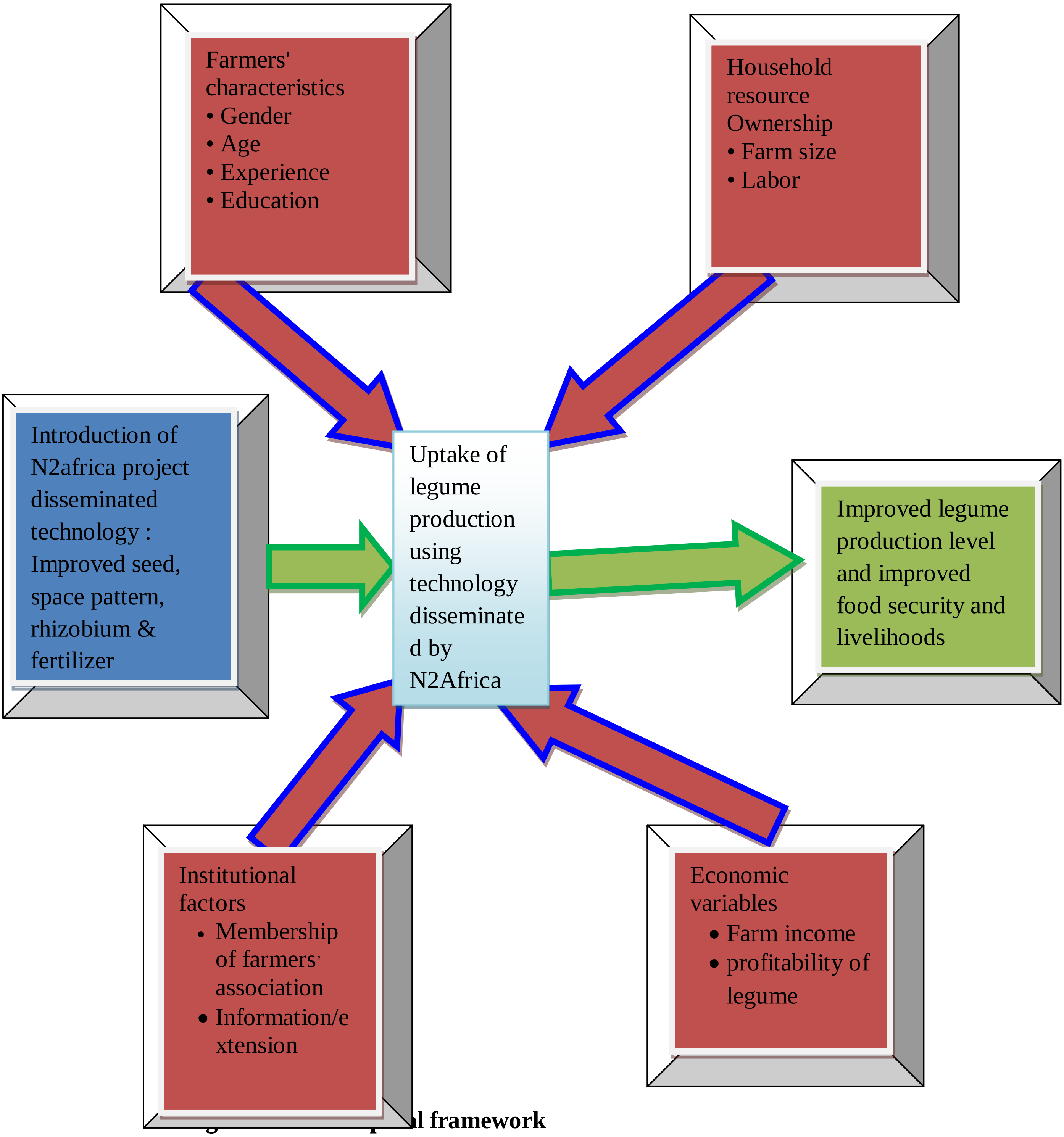
1. That socio-demographic and economic characteristics do not significantly influence the uptake of legumes production using the technology disseminated by N2Africa project in the study area.
2. That N2Africa-supported legume production technology has not led to significant changes in profitability among small scale farmers in the study area

1.5 Conceptual framework

The study was based on the adoption theory and theory of competitiveness as explained by Caldeira and Ward (2001) in the study of using resources to interpret the successful adoption and use of information systems and technology in small and medium sized manufacturing enterprises. According to Feder *et al.* (1985) uptake of a technology is the degree of acceptance and consequential use of a new technology in the long run equilibrium whereby the farmer has all the information about that specific technology and its potential. In this study, the uptake of legume at farm level was a reflection of the farmer's decision to incorporate spaces patterns, improved seeds, mineral fertilizer and the rhizobium inoculation in their production process.

It is anticipated that the decision to adopt a technology is influenced by socio-demographic and economic arrangements that legume farmers operate in Eastern DR Congo. As noted by Alemitu (2011), farmers' uptake behaviour of the technology, especially in low–income countries (such as DR Congo), is predisposed with different factors, especially socio-economic, demographic, institutional and technical factors. The sequence and degree of uptake determinants are not homogeneous; they depend on the nature of technology and the environmental context of areas where the technology is to be introduced.

Liberio (2012) emphasized that both economic and non-economic reasons are essential motives for determining farmer's attitude towards the new technology and its final uptake. In this study the socio-demographic and economic characteristics factors that could influence the uptake are hypothesized to be age, farm size, education, farming experience, member of farmer group, profitability of legume and gender of the farmers. Upon the uptake of legume production using the technology disseminated by N2Africa project it was expected that farmers would attain higher gross margins compared to other principal crops (cassava, maize and potatoes). Legume production would become more competitive while providing incomes to smallholder farm households as well as improving livelihoods which would influence farmers to retain the technology upon the project completion. Therefore, the technology-uptake is one of the elements that can lead to improved legume production in the study area and to improve livelihood at the farmer level.



l framework

Source: Modified from Feder *et al.* (1985) and Dalrymple (1978).

1.6 Scope of the study

The study was conducted in four territories (Kalehe, Kabare, Mwenga and Walungu) in South Kivu, DR Congo. The study included small-scale farmers who are and/or were involved in the N2Africa project for at least 2 years. The study was limited to small-scale farmers that were producing soya beans and common beans in the study area.

1.7 Significance of the study

Despite the importance of legume production, the profitability of legumes compared to cassava, sweet potato and maize which are the principal crops in south Kivu is unknown. The study was crucial in establishing the competitiveness of legumes (common bean and soya) compared to other principal crops (cassava, sweet potato and maize) in south Kivu at small scale farmers level and thereby inform various stakeholder who are promoting legume in the study area and provide recommendations. The study also assessed socioeconomic and institutional factors that influence the uptake of legume. Knowledge generated will be communicated to various stakeholders through reports and publications, conferences, seminars and workshops. This study also has policy implications upon the analysis of the effect of analyzed influences to the adoption of the technology disseminated by N2Africa project which will bring out the entry points for policy interventions. Once the appropriate recommendations are availed it is expected that farmers would utilize them to improve their yields thus increased uptake. In addition, the study availed information to input suppliers on the likely opportunities for investment and extension service providers on the existing advisory gaps that would assist in improving legume production in Eastern DR Congo. Information generated through this study also contributed in filling the existing knowledge gap.

CHAPTER TWO: LITERATURE REVIEW

2.0 Overview

This chapter presents a review of literature from a number of studies that are related to competitiveness of farms enterprise and the uptake of the new technology. The first section provides information about factors that influence the uptake of the new technology, the strengths and weaknesses of the technology acceptance and uptake and the challenges faced by small scale farmers in the legume technology uptake. The second section acknowledges the theory of competitiveness and the tool to calculate the profitability from the farm enterprise.

2.1 Determinants of technology acceptance and uptake

Fernandez-Cornejo, (2007), studied and farm economic performance in the United States. He found that farm size, human capital, land tenure, risk and risk preferences, credit access, and location to be the main factors that influenced a farmer's uptake decision. Uptake of an innovation took place earlier in larger farms than in considerable smaller farms. Also innovations with large information and fixed transaction costs were less likely to be adopted. The perception of increased risks in a given innovation acts as a limiting factor to its uptake. Fernandez-Cornejo, (2007) used an input distance function approach to represent the firms' technological structure in terms of minimum input use required to produce given output levels, because farmers typically have more short-term control over their input than output decisions. This approach is recommended when the study is focusing on the interaction of technology uptake and off-farm employment decisions.

Yengoh *et al*. (2009) undertook a study on technology adoption among small-scale farmers in Ghana and Cameroon. The study identified several factors that the farmers considered when deciding whether to adopt a technology which included ability to pay, vulnerability, long term considerations, scale of production, adaptability to local conditions, scale of production, access to information, and endorsement by opinion leaders. However the most important determinants that were key to farmers' decisions were ability to pay for the new technology, long-term considerations (sustainability), vulnerability and risk involved, and farmer's scale of production.

According to Mussei *et al*. (2001) and Kotu *et al*. (2000), the influence to adopt improved varieties among farmers depends mainly on the environmental factors, farmers' objectives as well as the specific varietal attributes. Adoption of new agricultural technologies can be into three major categories; attributes associated to the new technology, farm and farmers' associated attributes, and the farming objective. The first category varies with technology type, for example the characteristics and benefits associated with a technology, for example high yield, pests and diseases resistance, weather changes adaptation, maturity, and quality of grain in bread making. The second category includes farmer's age, education level, household size, and farm size. The third category involves assessment of various strategies as used by farmers such as commercial versus subsistence farming thus influencing adoption of a technology.

2.2 Dissemination and adoption of technology disseminated by N2Africa project

Dissemination is one of the five key pillars of N2africa project. According to Dashiell (2010) N2Africa is a research and development project targeting eight African Countries (Ghana, Nigeria, DR Congo, Rwanda, Kenya, Malawi, Mozambique and Zimbabwe). Within four years this project is expected to directly empower 225,000 African smallholder farmers to use state-of–the-art legume and rhizobial inoculants technologies to triple the inputs of free atmospheric nitrogen by biological nitrogen fixation, thereby improving crop and livestock productivity, human nutrition and farm income, while enhancing soil health.

The general approach of dissemination within N2Africa project is focusing on promoting legumes production using lead farmer approach; involves training of master farmers who then disseminate the technology information to their farmer organizations. This coincides with development and emerging availability of several improved grain legume varieties. The seed technologies are completed by rhizobial inoculants and mineral fertilizer. In DR Congo there are no extensions services, in South Kivu dissemination of legume and inoculants technologies is done by three NGOs supported by TSBF- CIAT office in Bukavu. The NGOs are Service and Capacity of Self Promotion of Women in South Kivu (SARCAF), Program Support to

Sustainable Development (PAD) and PLATFORM DIOBASS. The NGOs are platforms of smallholder community organizations (CBOs) that struggle to solve agricultural challenges in their ecosystems (Woomer e*t al.,* 2010).

2.3 Empirical studies on adoption

Technical change requires the acquisition of new husbandry skills; acquisition from non-traditional sources of additional sources such as new seeds, new chemicals and new equipment and development of new skills in dealing with both natural resources and input and product market institutions linking agriculture with non-agricultural sector (Ruttan and Hayami, 1984). There are several factors that can help explain why the uptake and impact of legume technology is less well documented than is the case for some other major staples. Some are related to the relative importance of legumes and hence the absolute contribution of changes in legume technology and the importance that farmers may accord to opportunities for innovation. A second set of factors is related to the mechanisms for promoting legume technology and particularly the limitations of national seed systems for diffusing new varieties. A third set of factors relates to the way that statistics are collected about legume technology use (Tripp, 2011).

Several studies on understanding factors that influence adoption of the technology have been done but few of them were focussed on the uptake of the legumes especially common bean and soybean. In wide-ranging, the variables documented as having relationship with adoption are categorized as household, personal and demographic variables, socio-economic, economic and institutional.

The study conducted by Floyd *et al*. (1999) to understand the adoption and associated impact of technologies in the Western hills of Nepal, analyzed seven factors hypothesized to influence adoption. Those factors are agro-ecological zone, extension input level, access, food self-sufficiency, ethnic group, sex of respondent and sex of household-head. Most of these factors are socio-demographic factors. Therefore, the study failed to include economic factors in the influence of adoption. From this study it was found that sex of respondent, or of household head, had a relatively small effect on reported adoption. While there was a consistent and significant effect of ethnic group on adoption, access and consistent pattern across all technologies of decreasing adoption levels with decreasing food self-sufficiency. Extension input levels played a significant role to influence strongly the awareness; this was decreased consistently and significantly with decreasing extension input. Agro-ecological zone was strongly associated to access levels.

Tenge *et al*. (2013) in their study of analyzing the options to increase adoption of lowland rice and legume technologies in Morogoro, Tanzania, pointed eleven factors that could influence the adoption of different crops. Those factors are high yield, drought tolerant, early maturity, late maturity, disease tolerant, good taste, high prices, market availability, improve soil fertility and not attractive to birds. This study did not take in account the socio-demographic aspect like gender, age, education, farm size, membership in farmer groups that might increase the adoption of legumes. From this study it was found that 3 factors were the most important in increasing adoption. Those factors are high yield characteristic, market availability and drought tolerance.

Agwu (2004) in the analysis of factors influencing adoption of improved cowpea production technologies study in Nigeria selected six factors that could influence the adoption. Those factors were age, family size, educational qualification, membership of farmer organization, farm size and farmer experience. This study failed to analyze some other important factors that influence the adoption of legumes, such as gender and profitability. The results of this study showed that only 2 factors from the six selected were positively influencing the adoption of improved cowpea technologies; farm size and educational qualification.

Bonabana-Wabbi (2002) in the study assessing factors affecting adoption of agricultural technologies in Kumi District, Eastern Uganda, classified factors that influence adoption into three categories. The factors were grouped into economic factors under which there was farm size, cost of technology, level of expected benefits and off-farm hours. The second category with social factors under which there are age, education and gender. The third category with institutional factors contains; information and extension contact or service. Similar studies had classified also the factors that influence adoption of the technology in three categories. This is the case of FAO (2001) in the study to understand the support of transfer, adoption and dissemination of labour saving technologies in Masaka and Wakiso. The three categories are socio-cultural factors, economic factors and institutional arrangements and policy issues. Studies by FAO (2001), Bonabana-Wabbi (2002), Sanginga and Woomer (2009) and Alemitu (2011) agreed that institutional factors especially the extension services are most important to increase or to decrease the degree of adoption. Unfortunately many developing countries do not have efficient extension systems and in some instances they are nonexistent altogether services to support the adoption of improved technology. This is the case of Republic Democratic of Congo. Woomer *et al.* (2010) in the analysis of general approaches and country specific dissemination plans found that the weakness of the dissemination system in D. R. Congo is the extension service and input access. The extension service is weak across the country, does not exist in South Kivu and the inoculants use in the country is manufactured in Kenya and imported to D R Congo.

Ragasa *et al.* (2013) in the study of assessment of the capacity, incentives and performance of agricultural extension agents in Democratic Republic of Congo noted that D. R. Congo requires an urgent extension system to deliver much needed technical advice to the rural population. In 1988 the National Extension Services (SNV) was created to harmonize various extension services and to integrate them in the ministry's day-to-day activities, but activities for this service go through many operational difficulties. The major problem of this service is that it has not received any government funding for its operations since 1997. Further Ragasa *et al.* (2013) noted that due to the absence of an active public agricultural extension system, churches and NGOs have been active in providing agricultural services to the rural population. However, the coverage of NGOs and church-based organizations in terms of agricultural extension services is limited thus making extension services inaccessible especially in war afflicted zones such as Eastern D. R. Congo. The biggest challenge faced by decision-makers in DRC is how this ineffective extension system can be turned around to support the government plan and minister of agriculture effort to reform and transform the agriculture and food sector in D. R. Congo. Ki-Munseki (2003) in the study on science and technology strategies for improving agricultural productivity and food security in Eastern and Central African countries noted that the most important institutional constraints of the agriculture sector in D. R. Congo include the inefficiency of specialized services of the ministry of agriculture; extension, seeds, input procurement and credit.

To overcome the institutional constraints of the agriculture system in D. R. Congo, the agriculture extension system below was establish in 1989. But as noted by Ragasa *et al*. (2013), this system did not receive any support from the national government since 1997.

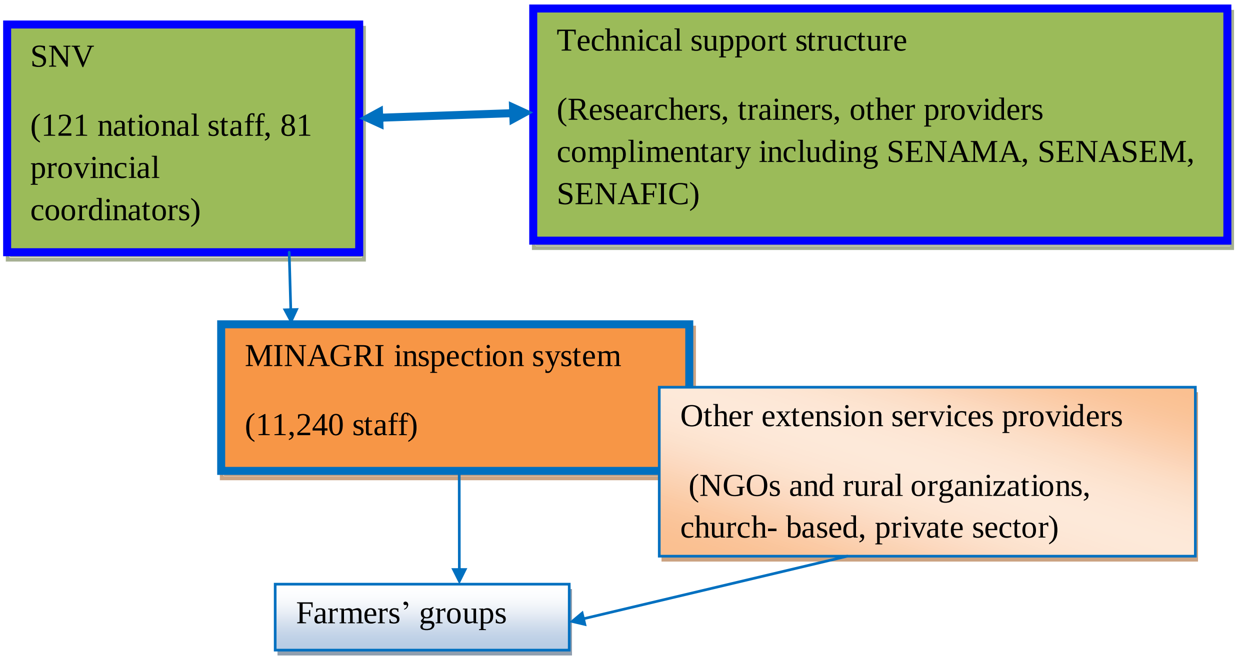


Figure 2.1: Agricultural extension system in D. R. Congo

Source: Ministry of Agriculture, Livestock and Fisheries (2005)

2.4 Empirical studies using Tobit and other models

The Tobit model was originally developed by Tobin in 1958. It is a statistical model to describe the relationship between a non-negative dependent variable Y_i and an independent variable X_i (Wendelin, 2005). This model can be described in terms of latent variable Y*. Y^*_1 is observed when $Y^*_1>0$ and not observed if $Y^*_1<0$, then the observed Y_i will be defined as $Y_i =$ $\{ ßx_i + u_i \text{ if } Y^*_i>0 \text{ and } 0 \text{ if } Y^*_i<0 \}$.

Different adoption and diffusion of agriculture innovation studies have been done across SSA using the Tobit model to determine factors that influence the adoption. Majority of these studies were not on legumes and thus, studies in legumes technology adoption using the Tobit model were very limited, particularly in common bean and soybean.

In the study conducted to understand factors affecting adoption of improved haricot bean varieties and associated agronomic practices in Dale Woreda, Alemitu (2011) used Tobit model to analyze factors influencing adoption and intensity of adoption of an improved haricot bean variety and its agronomic practices. In the study, the author argued that it was the best model since it has an advantage of indicating both the probability of adoption and intensity of use of the technology which other analytical models lacks; probit and Logit. Adebayo *et al*. (2010) in the study of characterization of maize producing households in the dry savanna of Nigeria emphasize that Tobit model is a more appropriate model used to give consistent output of both discrete and continuous variable combination. Further, Nchinda *et al*. (2010) in the study of to understand factors influencing the adoption intensity of improved yam seed technology in the western highlands and high guinea savannah zones of Cameroon, underline that if adoption and intensity decisions are assumed to be taken at the same time, the one stage Tobit model can be used based on the assumption that there is no selection bias. Several studies including those fitting and interpreting Cragg's Tobit alternative by Burke (2009) and analysis of panel data by Hsiao (2002) among others used Tobit model. They noted that Tobit model is well suited for the continuous dependent variable and the coefficients of the Tobit model can be disaggregated to assess the effect of transformation in an individual explanatory variable on the probability of adopting.

In the light of advantages of Tobit model, its limitations need to be considered. Hsiao (2002) represents the case of working hours as a limitation in using the Tobit model. He noted that the Tobit model relies on an accepted assumption that working hours differ continuously from zero to progressively larger positive hours with no jumps or discontinuity. While this assumption is consistent with labour supply theory, if a discontinuity is observed in working hours it would introduced empirical problems. Burke (2009), presented the key limitation of the Tobit model as the probability of a positive value and the actual value, given that if it is positive, it is determined by the same fundamental process or with the same parameters. He proposed a more flexible alternative, called a "two-tier" or "double-hurdle" model, which allows these outcomes to be determined by separate processes.

Various authors in different studies have agreed that several econometrics models can be used to analyze the uptake and adoption of a given technology but this will depend on the type of the data. Bonabana-Wabbi (2002) in the study of assessing factors affecting adoption of agricultural technologies in eastern Uganda, affirm that the choice of the econometrics models to analyze factors that influence the adoption depend on the type, quality and quantity of the data. He present the Logistic regression model to be the appropriate model when the measurement scale consists of a set of categories, this is the case of categorical dependent variables while in the case of the continuous analytic data the appropriate econometrics models can be Probit, Logit, or Tobit model.

Myoung (2010) in the analysis of regression models for binary dependent variables using Stata, SAS, R, LIMDEP and SPSS, stipulated that Probit and Logit are statistically equal. These are probabilistic dichotomous and qualitative models. However Probit model assumes a normal cumulative distribution function, with fatter tails, while the Logit model assumes a logistic distribution of the dependent variable. It requires enormous sample sizes to get significant differences between the two models and the use of either depend on the particular situation. According to Barungi *et al*. (2013) in the study of understanding factors influencing the adoption of soil erosion control technologies by farmers along the Slopes of Mt. Elgon in Eastern Uganda, noted that probit model lacks flexibility. The authors further noted that both probit and Logit models are limited in measurement of the degree of technology uptake. Considering; that limit of Probit and Logit models, Tobit is an alternative econometric model to overcome that limit as it is able to analyze the intensity of adoption. In the majority of the studies of adoption and where the dependent variable is forced to lie between 0 and 1, Probit and Logit models are appropriate econometric models to understand factors influencing adoption of the technology. However, probit and logit models can only assess the choice to use or not to use a technology (dichotomous choices of either 0 or 1) but not continuous choices. In filling in this gap, Tobit model can assess continuous choices ranging from 0 to 1.

2.5 Gross margin analysis

According to Woodend (2010), the total gross margin is defined as total revenues from crop production and subsidies minus variable costs. Gross Margin Analysis (GMA) is a tool to calculate the profit or loss made from an enterprise. In gross margin analysis, the positive gross margins are taken as profits and the negative gross margins are considered as the losses. In many cases the negative gross margins are attributed to variations of the climate (weather conditions) and to low yields due to bad weather conditions in the growing and harvesting seasons. But according to Bjornson and Sykuta (2002), at least part of the gross margin improvement is attributable to investments in store improvements meant to enhance and differentiate the consumer shopping experience as well as support higher value added products and services. Soren and Lars (2011) noted that per hectare gross margins are calculated for each crop for each farm for each year as income from crops minus the following variable cost elements: pesticides, fertilizer, manure, and phosphorus, calcium, sowing seed, energy for crop drying, tying string, machine station services, and tractor fuel.

2.6 Theory of competitiveness

According to Brislin (2002), competitiveness depends on the capacity to innovate and upgrade. The basis of competition has shifted more and more to creation and assimilation of knowledge. The success of competition can also depend on different factors: national values, culture, economic structures, institutions and history. Competitiveness has some potent signal: labor costs, interest rates, exchanges rates and economics scales. Innovations can lead to competitiveness by perceiving an entirely new market opportunity or by serving a market portion that others ignored.

Cho and Moon (2000) present 7 elements that should be taken in account to in measuring competitiveness. Those elements are: institutions, openness, government, finance, infrastructure, technology and labor. Cho and

Moon showed that the weight of those elements should vary across different environments and stage of economic development. For example, technology may be more important for developed countries, but natural resources may be more important for less developed countries.

According to Powell (2002), a gross margin for an enterprise is its financial output minus its variable costs. The gross margin method is a popular method of calculation in the retail store industry for farmer enterprise. This method estimates the difference between the revenue and the costs of sold products. What is included in the cost of goods sold varies depending on the situation but it is traditionally the direct cost associated a product (Berman *et al.*, 2006).

In cost accounting or complete enterprise costing, not only are the outputs and variable costs allocated to individual enterprises, as for gross margins, but the fixed costs are also allocated. This result in a net profit per enterprise and, with all costs allocated, enables the calculation of costs per tonne of grain produced on the farm and break-even budgets (Leake, 1999). The strength of such techniques is that they help to identify all costs involved in a particular enterprise. Despite its apparent simplicity, however, the full cost approach is fraught with difficulties. Sometimes arbitrary decisions have to be made concerning the allocation of overhead expenses between enterprises. For simplicity this is often done on a per hectare basis but for greater accuracy labour and machinery costs need to be recorded in great detail and allocated carefully (Barnard and Nix, 1979).

Net profit figures per enterprise tend to ignore the interrelated nature of enterprises, they are of most use where a farm has one core enterprise and the other enterprises are minor or could be thought to contribute to that core enterprise. One alternative is to apportion only the more easily allocatable costs, such as those related to field operations in crop production, to arrive a net margin per crop/enterprise. The retailer who uses the gross margin often calculates contribution margin to get a further more comprehensive picture of their business. This margin includes more costs than the cost of goods sold (Firth and Lennartsson, 1999). According to Kibet (2009), farm profitability can be determined by use of several techniques. Gross Margin Analysis (GMA) is one of the techniques. Gross margin is the difference between total revenues and total variable costs. The use of gross margin analysis depends on assumptions. Kibet applied gross margin to compare profitability of passion fruit *vis-à-vis* other farm enterprises. Further, Kibet (2009), used Gross Margins, returns to labor and capital for farm enterprise to determine whether passion fruit was the most profitable farm enterprise in Uasin-Gishu district, Kenya. Tsoho and Salau (2012), in studying the profitability and constraints to dry season vegetable production under Fadama in Sudan savannah ecological zone of Sokoto State in Nigeria included gross margin to determine the profitability of dry season vegetable production. Tsoho and Salau (2012) the gross margin was used because of its accuracy in estimating profit.

CHAPTER THREE: METHODOLOGY

3.0 Overview

This chapter describes the methodology used for this study in three sections. The first section presents the study area. The second section outlines the sampling design while the third and the fourth present the methods used to collect data and the summary of data analysis.

3.1 Study area

This research was undertaken in the Eastern part of DR Congo; South Kivu province, which is located approximately between 1 ° 36’, 5 ° South latitude and 26 ° 47’, 29 ° 20' east longitude. The province is bounded to the East by the Republic of Rwanda and Burundi, which is separated by the Ruzizi River and Lake Kivu. In the Southeast, it borders Katanga province; to the south west and northwest Maniema Province and in the North, the North Kivu Province. The province of South Kivu has an area of 69,130 Km^2 and its population was 3,028,000 in1997and is currently estimated at 3,500,000, an average density of 50.6 inhabitants per Km^2 (Cox, 2008).

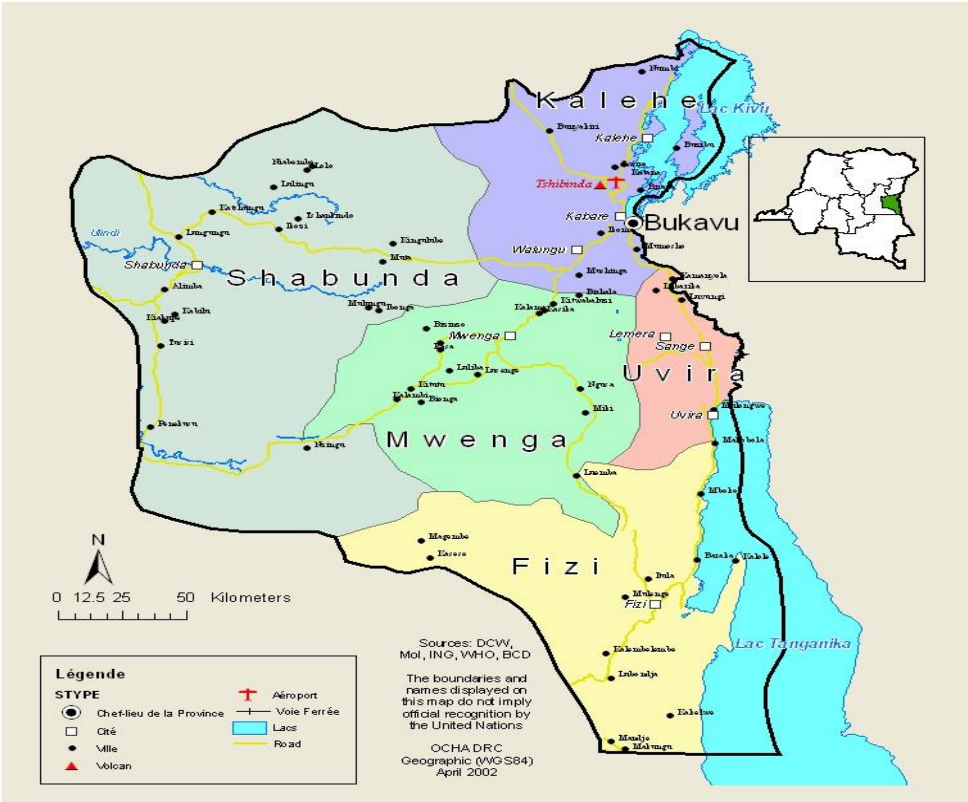
The Eastern border of South Kivu is the Western Rift Valley. The Land found in this region can be grouped into two major sets namely: the main grounds of the basement and the volcanic terrains. Near the town of Bukavu are volcanic regions, which have basaltic rocks or ancient lavas to Mulungu. Besides Mount Kahuzi is an extinct volcano. The high relief of the

East is the extension of the chain Mitumba sometimes exceeding 3,000 meters. However, a low relief is seen in the Ruzizi plain from Uvira to Kamanyola.

The main factors that determine the climate of South Kivu are latitude and altitude. The mountainous Kivu that is Eastern province has a mountain climate with mild temperatures where the dry season lasts from 3 to 4 months of June to September. For example Bukavu and Goma have an average annual temperature of 19 ° C.

South has two seasons: the dry season which lasts for 3 months from June to September and the rainy season which lasts nine months. During the dry season high temperatures and a scarcity of rain is experienced. This is the period when farmers cultivate the swampy areas. The rainy season has a high precipitation. However, the destruction of the environment has made the rains erratic. In forest areas such as Fizi, Mwenga and Shabunda located the entrance to the rainforest, it rains heavily all year.

In Kabare and Walungu, the soil is clayey and increasingly poor because of erosion and overpopulation. In Kalehe, the soils are rich and clayey mainly because of its proximity to the forest (Ministry of planning DRC, 2005). According to Wrong (2001) the dynamics of co-option and exploitation wrought on a large scale by plantation farming in South Kivu existed throughout the Zairean state at many levels. The colonial and post-colonial history of South Kivu is a story of shrinking access to land for farming households. During the half century of the Belgian Congo, the Bushi region developed into the heart of the so-called Savanne food economy zone, producing food for the city of Bukavu (Vlassenroot and Raeymaekers, 2004). It however soon became a centre for plantation crops such as cinchona for quinine, chrysanthemums for pyrethrin insecticides, tea, and coffee (Bashizi, 1978).



3.2 Sampling design

The sampling frame of the study is made up of small scale legume farmers who were involved the N2Africa project for at least 2 years in South Kivu. The sampling unit was the farm household. For sampling purposes a multistage sampling technique was employed. In the first and the second stages, purposive sampling was used to select territories and counties. In the third stage systematic random sampling was employed to select the required sample size. Four territories (Kabare, Kalehe, Mwenga and Walungu), and one county in each territory was selected. The sample size of 289 was chosen proportionately (Kabare 103, Kalehe 51, Mwenga 23 and Walungu 112). The small scale farmers sample size have been identified using a systematic random by dividing the small scale legume farmers population with the sample size of each territory (Kabare 1328/103, Kalehe 166 /51, Mwenga 192/23 and Walungu 1339/112) interval of 13, 3, 12 and 8 that is kth+13/3/12/8 from the list provided by CIAT for Kabare, Kalehe, Walungu and Mwenga respectively.

Table 3.1: Population of the territories

Territories	**Total population**	**Small scale legume farmers population**	**Sample size**
Kabare	496,169	1,328	103
Kalehe	125,141	166	51
Walungu	456,660	1,339	112
Mwenga	31,747	192	23

Source: CIAT (2011)

The sample size was calculated using a formula by Anderson *et al*. (2008) as follows:

$$n = \frac{Z^2 pq}{d^2}$$

Where *n* is the minimum sample size; *Z* is 1.96 at 95% confidence level; *P* is the population proportion i.e. the proportion of legume producers in the area. While *d* is the margin of error (acceptable error) which is assumed to be 0.01 and *q* is a weighting variable computed as (1-P). The total desired sample for the four territories was 289 households. Data collection was collected from 300 households to cater for any likely incomplete data. Only 9 respondents had incomplete data and were dropped thus remaining with 291 which were used for this study.

3.3 Methods of collecting data

3.3.1 Description of the data for the study

Quantitative data was used in this study and was collected through a household survey. The study targeted to capture information about level of knowledge in the technology disseminated by N2Africa project, the degree of uptake of this technology, the socioeconomic and institutional factors that influence uptake of legume production with this technology and the competitiveness of legume production amongst small-scale farmers for two seasons (February 2012-June2012 and September 2012-February 2013) in Eastern DR Congo.

Table 3.2: Description of the variables

Variable	Definition	Description of the variables	Measurement
Objective 1	Level of knowledge in the N2Africa technology (Rhizobium inoculation, seeds [improved varieties], fertilizer [mineral fertilizer] application, spacing patterns)	Knowledge in each of the four aspects of technology disseminated by N2Africa project was awarded 25%	Score out of 3 points 3 = full knowledge 2 = some reasonable knowledge 1 = no knowledge
Objective 2	Degree of uptake of N2Africa technology (Rhizobium inoculation, improved seeds], fertilizer [mineral fertilizer] application, spacing patterns)	For each of the four N2Africa technology aspects adopted, a farmer was awarded 25%. A farmer who has adopted the four aspects (fully adopted) was awarded 100%.	A farmer who applies one aspect scored 25% and the farmer who applied the four aspects scored 100%.
Objective 3			
Y	Uptake		
Z_1	Age	Years	Years
Z_2	Farm size	Area under legume production	Ha
Z_3	Education	Number of year spent in school	Years
Z_4	Gender	Male or female	Dummy variable 1=female, 2= male
Z_5	Farming experience	Years	Years

Z_6	Member of a farmer group	Member or not member	Dummy 1=member, 0= no member
Z_7	Profitability	Gross margin (Total revenue – total costs)	Profitability in Congolese franc (Fc)
Z_8	House hold size	All people living in the same household	Number of people
Objective 4			
Y	Gross margin	Gross margin (Total revenue – total costs)	Total cost and total revenue was determined for each crop. The gross margin calculated using the total revenue minus the total cost of each crop

3.3.2 Data collection methods

To achieve the objectives of this study, both primary and secondary data was collected. The primary data was collected through structured questionnaires and secondary data was collect through CIAT office in Bukavu and in the library to establish the profitability of legume producing traditionally (without the technology disseminated by N2Africa project) in D. R. Congo. The secondary data was used in assessing extension services and the implication on level of knowledge and uptake of the legume production technology promoted by N2Africa project in Eastern DR Congo. Further, secondary was important in enriching the discussion of the study by reviewing other similar studies across the world.

Enumerators were recruited to help with administering the questionnaire [these were able to speak French, Swahili, English and the local language (Mashi)].

Enumerators were trained on the objective of the study, the contents of the interview and interviewing techniques. Proper training of enumerators and supervision during the data collection process boosted the reliability of the data. The questionnaire was pre-tested in North Konge and South Konge villages in Kabare to know whether the instrument would be able to capture the required data to complete the study.

3.4 Summary of data analysis

The data was analyzed using STATA aided by Tobit model to identify factors that influence the uptake of N2africa technology, SPSS to test the significance of technology aspects on the overall knowledge and uptake, and Microsoft Excel software programs using percentage and graphic presentation to determine the level of knowledge and the degree of uptake of the technology disseminated by N2Africa project in the study area. Since agricultural information systems and extension are very important in technology dissemination and the literature available indicates that it is almost nonexistent in Eastern DR Congo, this study adopted an extension literature review approach from other studies to understand level of knowledge and uptake of legume production technology being promoted by N2Africa. This approach enabled this study to exhaustively explain the importance of extension as a likely entry point of commercial and non commercial support services providers.

3.4.1 Objective 1

Descriptive statistics using percentages were used to determine the level of the knowledge in N2Africa technology (Rhizobium inoculation, seeds [improved varieties], fertilizer [mineral fertilizer] application, spacing patterns) by farmers in the study area. Compared to the recommended of N2africa project the farmer who has knowledge in one aspect was getting the score of 0.25 and the one who had knowledge in the four aspects got the score of 1. To assess the level of knowledge of the various aspects of the N2Africa technology, the scores were converted to percentages and presented appropriately.

3.4.2 Objective 2

Descriptive statistics were used to assess the degree of adoption of various aspects of the N2Africa technology. The details of the estimation procedures of the parameters in the uptake context are given below.

Y_1 is estimated as the potential uptake of the new technology while Y_0 is considered as non potential uptake.

$Y_1=1$…………………………………………………………………………… (1)

$Y_0=0$……………………………………………………………………………. (2)

This is the case of dichotomous variables where the outcome can be either uptake or not, the user of the new technology and non user of the new technology.

Hence, the expected uptake is defined on the overall by average treatments (W), the uptake estimation level cannot be calculated using the expected Y_1 and Y_0 as in the case of dichotomous variables. In introducing the treatments (W), the estimation uptake level (Z) becomes:

$W=W_1$, W_2, W_x………………………………………………………………………… (3)

Then Z= 1/W…………………………………………………………………………… (4)

Farmers on the side of Y_0, does not apply any treatment of the new technology therefore the level of uptake is: $Z > 0$ and $Z < 1$ (Dibba, 2010).

Alemitu (2011), in the study of analysing factors affecting adoption of improved haricot bean varieties and associated agronomic practices in Dale Woreda, classified the adoption by zero to indicate the non adoption and 1 to indicate s the full adoption. Once he calculated the adoption index for improved variety, seed rate and fertilizer rate application, he classified respond into three categories: low adopter, medium adopter and high adopter.

For this study a score of 4 was awarded to the farmer who has adopted the four aspects (Rhizobium inoculation, seeds [improved varieties], fertilizer [mineral fertilizer] application, and spacing patterns) of N2Africa technology representing 100%. For each aspect of N2Africa technology adopted, a farmer was awarded 1 point representing 25%, 2 aspects adopted will be awarded 50%, and 3 aspects adopted will be awarded 75%. Therefore, a farmer was deemed to have full uptake of the N2Africa technology if he had attained 100% (uptake of the four aspects of the technology).

3.4.3 Objective 3

To analyze the factors that influence uptake amongst participants in the N2Africa project, a Tobit model was used. The model has the advantage that it provides both the influence of exogenous factors on the probability of adoption and the intensity of adoption in addition to estimating the marginal effects of the factors (Chukwuji and Ogisi, 2006). The study could also have used probit and logit models since the decision to uptake ranges from 0 to 1. However, probit and logit models are used in instances where the choice of uptake is binary; either uptake (1) or non-uptake (0). The decision to uptake the legume production technology disseminated by the N2Africa project was continuous; the farmer could only adopt 1 to 4 technology packages or none at all, where each package constituted 0.25 of the whole package. Therefore, Tobit model was most suited since it allows use of continuous decision variable (ranging from 0 to 1).

The dependent variable in this study was measured as the proportion of uptake of the four aspects of the technology disseminated by N2Africa. Farmers who were growing legume using improved seed with some of the recommended agronomic practices (mineral fertilizer, space pattern and rhizobium inoculation) were considered as uptake while those who did not use any of the aspects of the technology disseminated by N2Africa were considered as non uptake. The farmer who had full uptake of the technology disseminated by N2africa project (Rhizobium inoculation, seeds with improved varieties, fertilizer with mineral fertilizer application, spacing patterns) scored 1; the one who did not apply any of the elements of this technology got a score of 0. The rest of the farmers scored between 0 and 1; a farmer who has adopted only one aspect of the N2Africa technology scored 0.25 that is each aspect had a score of 0.25.

The utility for a farmer (i) that adopts the technology j=1 is not observed and depends on a set of observed exogenous factors. The utility associated with each technology is a function of the possible outcomes from adopting each technology, thus:

$U0=f\,(b\,[X0])$

$U1=f\,(b\,[X1])$

Where:

U_1, U_0, are the expected utility levels with and without the technology,

X_1, X_0, are socio-economic and other characteristics of farmers.

$b=b1\ldots bn$ are parameters that describe the effect of farmers characteristics

The Tobit model assumes that the observed dependent variables Y_j for observations on utility.

j = 1;… n satisfy

$Y_j = \beta X_j + u_j$

The following regression was used:

Y = F(Z_1, Z_2, Z_3, Z_4, Z_5,Z_6, e); Where, Z_1 = Age; Z_2 =farm size; Z_3 = education; Z_4 = gender; Z_5= farming experience; Z_6= group membership; Z_7= profitability of legume; Z_8= household size; e = Error term

$$Y = \beta 0 + \beta 1\text{Age} + \beta 2\text{farm size} + \beta 3\text{education} + \beta 4\text{gender} + \beta 5\text{farming experience} + \beta 6\text{group membership} + \beta 7\text{profitability of legume} + \beta 8\text{household size}$$

3.4.4 Objective 4

Gross margin analysis was used to assess the competitiveness of legume using the technology disseminated by N2Africa technology. GM of the production using the technology was compared to GMs of the legume without technology, cassava, potato and maize. The profitability of legumes was determined by calculating the average gross margin, average labour cost, average variable cost, the return on to the labour capital and the return to overall capital compared to other principal crops enterprises (cassava, potato and Maize) undertaken by smallholder households in South Kivu.

According to Legesse *et al*. (2005), farmers engage in production of a certain crop only if the net-returns are higher compared to other alternative crops. Crops often compete for limited inputs and a rational farmer engage in a production of a certain crop only if it remains relatively competitive. The gross margin analysis was estimated by using the formula below:

GM =TR – ΣTVC

Where;

GM = Gross Margin, TR = Total Revenue, ΣTVC = Total Variable Cost

To bring out the impact of the N2Africa project-disseminated technology, gross margins of legume production using the technology were compared to gross margin of the same without the technology as well as gross margins of competing enterprises (cassava, potatoes and Maize). Data from baseline study of N2Africa, office of minister of agriculture in South Kivu and other related studies was used for the GM of legume production without the technology.

Legume production using improved seed, mineral fertilizer, space pattern and rhizobium inoculation was considered as uptake while failure to use these aspects of the technology disseminated by N2africa project was considered as non uptake.

CHAPTER FOUR: RESULTS

4.0 Overview

This chapter is presented in five sections. The first summarizes the socioeconomic and demographic characteristics of small scale farmers in the study area. The second section presents the level of technology knowledge disseminated by N2Africa project among the sampled farmers. The third section presents the degree of uptake of various aspects of the technology. The fourth section summarizes the factors influencing the uptake of N2Africa technology in the study area and the fifth section presents the profitability of legume compared to other principal crops in South Kivu.

4.1 Descriptive results of the household sample

4.1.1 Comparison of age and gender

The results of the study (Table 4.1) showed that majority of the small scale legume farmers were middle aged (36 to 60 years) at 66% of the total sample followed by the elderly (61 to 86 years) at 18 percent. Only 16% of the farmers were in the youth group (17-35 years). Majority of youth and middle aged small scale legume farmers were women at 55 and 66% respectively. Under the elderly group most of the farmers were men (65%). On overall, more women (59%) were practising legume production than men (41%) in Eastern DR Congo. This implied that most of the farmers who were involved in legume production were mostly women and were at the child bearing age or upbringing their children.

Table 4.1: Comparison of age and gender of small scale legume farmers in Eastern DR Congo

	Gender					
Age	**Number of female farmers**	**%**	**Number of male farmers**	**%**	**Total**	**%**
17-35	26	55	21	45	47	16
36-60	128	66	65	34	193	66
>61	18	35	33	65	51	18
total	172	59	119	41	291	

Source: Survey Data

4.1.2 Comparison of education and gender

The results of the study (Table 4.2) showed that more women (72%) compared to men (28%) had no formal education. Approximately 32% of the sampled legume farmers had no formal education. On overall, 29, 37 and 2% of the legume farmers had at most attained primary, secondary and tertiary education respectively. The results of the study also showed that more men had attained secondary (49% versus 51%) and tertiary (29% versus 71%) education compared to women. The proportion of women with primary education was higher than that of men; 58% against 42 percent. The results implied that the non-educated women were more involved in legume production. In addition, legume production could be done by people with no formal education and or lowly educated.

Table 4.2: Comparison of education and gender of small scale legume farmers in Eastern DR Congo

	Gender					
Education	**Number of female farmers**	**%**	**Number of male farmers**	**%**	**Total number**	**%**
No formal education	66	72	26	28	92	32
Primary	49	58	36	42	85	29
Secondary	52	49	55	51	107	37
Tertiary	2	29	5	71	7	2
Total	172		119		291	

4.1.3 Socio-demographic and economic characteristics of legume small scale farmers

The socioeconomic characteristics of the small scale legume farmers are presented in (Table 4.3). Farmers' age ranged from 17 to 86 years. The farm household sizes ranged from 5 to 10 persons. Most of the legume farmers were under the 5 to 8 persons household category. The total farm size ranged from 0.01 to 4 hectares. Approximately 95% of the sample legume farmers had membership in farmer organisations. The result of the study showed that legume farming experience ranged from 4 to 66 years. Most of the legume farmers had a farming experience of less than 30 years. Only a few farmers, 3% of the total sample had legume farming experience of more than 51 years. This implied that legume production has been ongoing in Eastern DR Congo for quite a long time before the introduction of the N2Africa project which is likely to affect the uptake of the legume production technology.

Table 4.3: Summary of socio-demographic and economic characteristics of small scale legume farmers in Eastern DR Congo

Variable	Category	Minimum	Maximum	Median	Mean	Std. Error	Std. Dev	Percentage
Age	17-35	17	35	30	29.53	0.721	4.943	16
	36-60	36	60	50	49.66	0.511	7.096	66
	61-86	61	86	66	67.55	0.789	5.637	18
Education	None	0	0	0	0	0	0	32
	Primary	1	6	5	4.46	0.164	1.508	29
	Secondary	6	12	10	10.04	0.167	1.732	37
	Tertiary	13	15	14	13.86	0.261	0.69	2
Gender	Female	-	-	-	-	-	-	59
	Male	-	-	-	-	-	-	41
Household size	5-8	5	8	6	6.67	0.081	1.128	66
	9-10	9	10	10	9.67	0.048	0.471	34
Farm size		0.01	4	0.6	1.07	0.476	0.812	-
Group membership	Non-members	-	-	-	-	-	-	5
	Members	-	-	-	-	-	-	95

4.2 Farmers' knowledge on technology aspects

4.2.1 Aspects of the technology disseminated by N2Africa

Farmers' knowledge in improved seed and spacing patterns were higher compared to the farmers' knowledge in rhizobium and fertilizer. The results (Figure 4.4) show the farmers' knowledge on technology disseminated by N2africa.

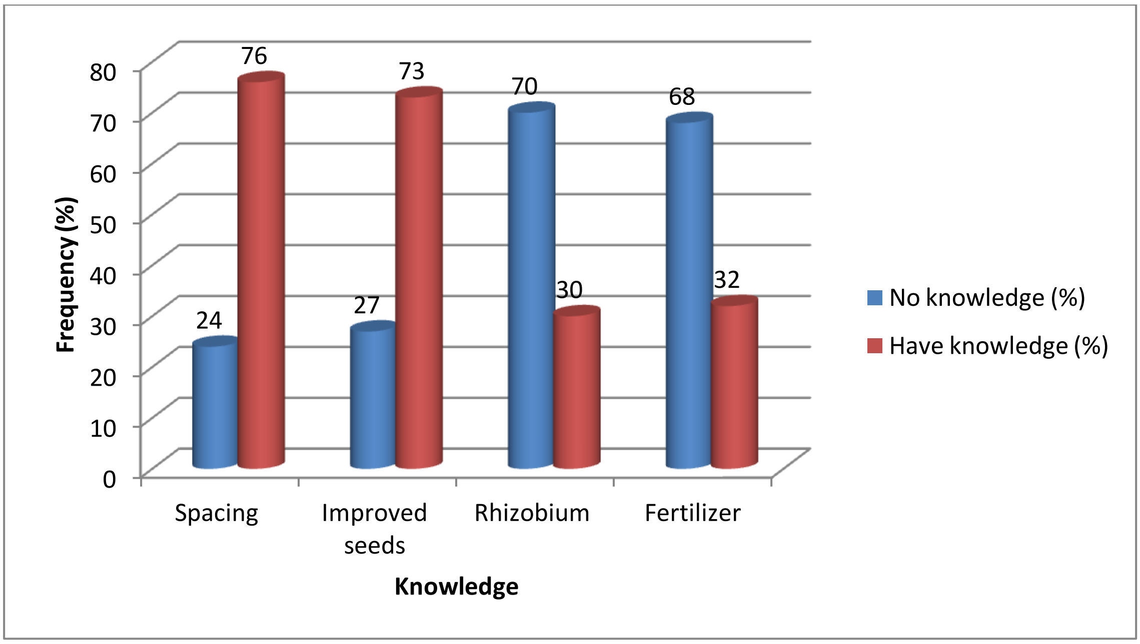


Figure 4.3: Legume farmers' knowledge on N2Africa technology aspects

4.2.2 Knowledge level on the technology disseminated by N2Africa

The results of the study (Table 4.4) showed that the level of N2Africa technology aspects knowledge had significant influence (at 1% level) on the overall N2Africa technology knowledge. The four aspects of the technology disseminated by N2Africa project contributed significantly on the overall knowledge of N2africa technology. The average knowledge level was 0.53

implying that at least every legume farmer had knowledge of 2 N2Africa technology aspects.

Table 4.4:N2Africa technology aspects knowledge

N2Africa knowledge	N	Score	Mean score	Std. Error	F	p
Spacing knowledge	291	0.25	0.191	0.006	146.455***	< 0.001
Seeds knowledge	291	0.25	0.181	0.006	55.109***	< 0.001
Rhizobium knowledge	291	0.25	0.076	0.007	115.447***	< 0.001
Fertilizer knowledge	291	0.25	0.079	0.007	140.185***	< 0.001
N2Africa knowledge level	291	1.00	0.529	0.014		

Knowledge of one aspect=0.25; two aspect=0.50; three aspects=0.75; four aspects=1 and no knowledge=0

4.2.3 Territorial comparison of knowledge level on technology disseminated by N2africa

In comparing the level of knowledge of the N2Africa technology aspects, the results (Table 4.5) showed that the mean knowledge difference was significantly different between Kalehe and Mwenga as well as between Kalehe and Walungu, at 1% significance level. Further, the results of the study showed significant difference between Kabare and Walungu at 1% significance level. These implied that there were differences in diffusion of knowledge on the legume production technology disseminated by N2africa project across territories which could eventually affect uptake.

Table 4.5: LSD territorial comparison results of N2Africa knowledge level in Eastern DR Congo.

Dependent variable		(I) Territory	(J) Territory	Mean Difference (I-J)	Std. Error	p
N2Africa knowledge level	LSD	1	2	-0.058	0.039	0.137
			3	-0.146***	0.056	0.010
			4	-0.154***	0.038	0.000
		2	1	0.058	0.039	0.137
			3	-0.088	0.051	0.088
			4	-0.096***	0.031	0.002
		3	1	0.146***	0.056	0.010
			2	0.088	0.051	0.088
			4	-0.008	0.051	0.873
		4	1	0.154***	0.038	0.000
			2	0.096***	0.031	0.002
			3	0.008	0.051	0.873

1=Kalehe, 2=Kabare, 3=Mwenga, 4=Walungu

*** The mean difference is significant at the 0.01 level.

4.2.4 Overall N2Africa Knowledge level in four territories of Eastern DR Congo

The results of the study (Table 4.6) showed that approximately 56 and 14% of small scale legume farmers in Kalehe and Walungu had no knowledge on spacing requirement as per technology disseminated by N2Africa project. The results of the study showed that 87, 89, 79 and 38% of the farmers had no fertilizer knowledge in Kalehe, Kabare, Mwenga and Walungu respectively.

Most of the small scale legume farmers had no knowledge on rhizobium; the results showed that in all the four territories more than 58% of the farmers had no knowledge. Majority of the sampled legume farmers had high knowledge on improved seeds except in Walungu. High spacing patterns knowledge was recorded in Kabare, Mwenga and Walungu; 83, 75 and 86% respectively.

The results for the overall knowledge of the technology disseminated by N2Africa project showed that only 4, 5, 0 and 4% of the small scale legume farmers had no knowledge in Kalehe, Kabare, Mwenga and Walungu respectively. Majority of the sampled legume farmers had moderate knowledge. The results of the four territories showed 42, 62, 71 and 34% of the farmers had moderate knowledge on N2Africa technology in Kalehe, Kabare, Mwenga and Walungu respectively. Only 27, 19, 29 and 46% of the sampled legume farmers had high knowledge on the technology disseminated by N2Africa project in Kalehe, Kabare, Mwenga and Walungu respectively.

Table 4.6:N2Africa Knowledge level in four territories of Eastern DR Congo

	Knowledge status	Kalehe (%)	Kabare (%)	Mwenga (%)	Walungu (%)
Spacing knowledge	No knowledge	56	17	25	14
Fertilizer knowledge	No knowledge	87	89	79	38
Rhizobium knowledge	No knowledge	71	83	58	59
Improved seeds knowledge	No knowledge	12	6	4	52
N2Africa knowledge level	No knowledge	4	5	0	4
	Low knowledge	37	14	0	16
	Moderate knowledge	42	62	71	34
	High knowledge	27	19	29	46

4.3 Degree of uptake of N2africa project disseminated legume production technology in the study area.

The study assessed the degree of uptake in uptake of the legume production technology disseminated by N2Africa project. Spacing, rhizobium, mineral fertilizer and improved seeds uptake among small scale farmers in various territories of DR Congo was assessed.

4.3.1 Degree of uptake of the four aspects of the technology disseminated by N2Africa project.

Farmers' uptake on spacing requirements/ recommendations and improved seeds was high (90 and 92%) compared to the uptake on rhizobium and mineral fertilizer. The uptake of mineral fertilizer was very low, less than 50% of the total sampled. The results in Table 4.8 show the degree of uptake on the four aspects of the technology disseminated by N2Africa in the study area.

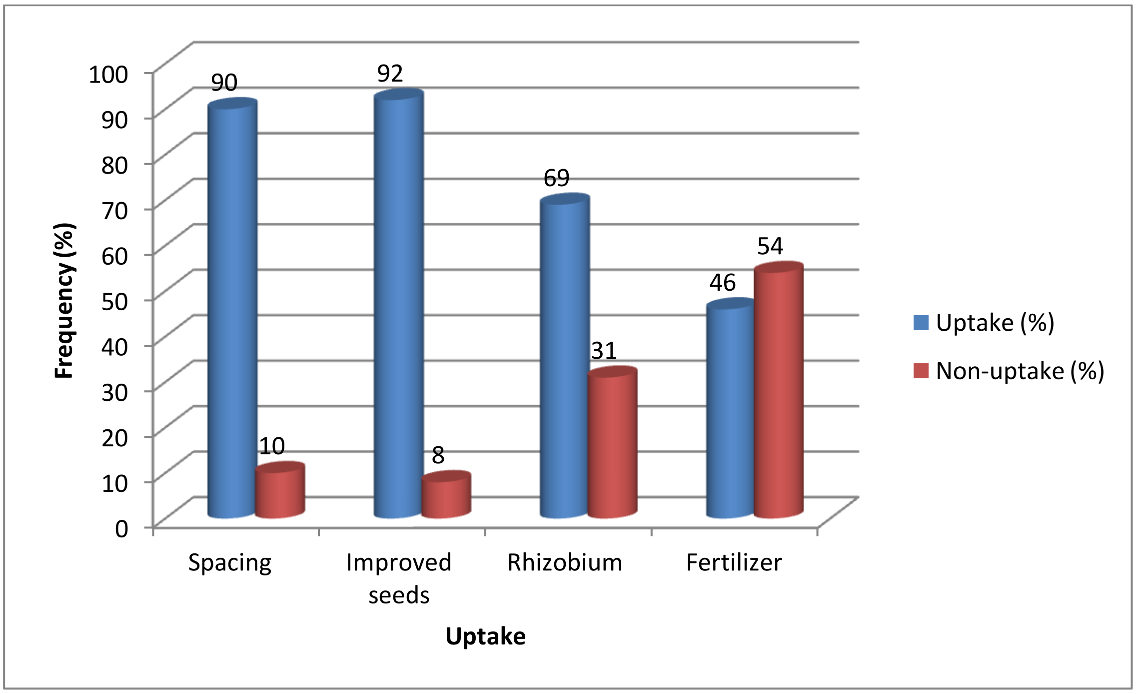


Figure 4.4: Uptake of N2Africa technology aspects in South Kivu, DR Congo.

4.3.2 Contribution of the four aspects of N2Africa technology on the overall uptake

The results of the study (Table 4.7) showed that the degree of uptake of N2Africa technology aspects had significant influence (1% level) on the overall uptake of legume technology disseminated by N2Africa project. Majority of legume farmers had an average degree of uptake of between 2 and 3 N2Africa technology aspects (average uptake degree was 0.74).

Table 4.7: Relationship between uptake of technology aspects disseminated by N2Africa and overall uptake

	N	score	Mean score	Std. Error	F	P
Spacing uptake	291	0.25	0.224	0.004	59.094***	< 0.001
Improved seeds uptake	291	0.25	0.230	0.004	37.204***	< 0.001
Rhizibium uptake	291	0.25	0.173	0.007	135.682***	< 0.001
Fertilizer uptake	291	0.25	0.114	0.007	147.110***	< 0.001
N2Africa uptake	291	1.00	0.741	0.014		

Uptake of one aspect=0.25; two aspect=0.50; three aspects=0.75; four aspects=1 and no uptake=0
*** Significant at 1%

4.3.3 Territorial comparison of uptake degree on technology disseminated by N2africa project

The results (Table 4.8) showed the comparison of the degree of uptake on technology aspects disseminated by N2Africa in the four territories of the study area. Comparing Kalehe and Walungu, and Kabare and Walungu the mean uptake difference were significant at 1% significant level. The mean uptake difference between Kabare and Mwenga, and Mwenga and Walungu were significant at 5% level. This implies that there were levels of uptake differences among legume farmers in the uptake of technology aspects disseminated by N2Africa in the territories of South Kivu.

Table 4.8: LSD territorial comparison results for uptake of the technology disseminated by N2Africa project

Dependent Variable		(I) territory	(J) territory	Mean Difference (I-J)	Std. Error	P
N2Africa technology uptake	LSD	1.00	2.00	0.02264	0.03858	0.558
			3.00	-0.08173	0.05596	0.145
			4.00	-0.19334***	0.03806	0.000
		2.00	1.00	-0.02264	0.03858	0.558
			3.00	-0.10437**	0.05140	0.043
			4.00	-).21598***	0.03096	0.000
		3.00	1.00	0.08173	0.05596	0.145
			2.00	0.10437**	0.05140	0.043
			4.00	-0.11161**	0.05101	0.029
		4.00	1.00	0.19334***	0.03806	0.000
			2.00	0.21598***	0.03096	0.000
			3.00	0.11161**	0.05101	0.029

1=Kalehe, 2=Kabare, 3=Mwenga, 4=Walungu

** and *** the mean difference is significant at the 0.05 and 0.01 level respectively.

4.3.4 Overall N2Africa uptake in four territories of Eastern DR Congo

The results of the study showed that the degree of uptake on rhizobium aspect for the majority of the small scale legume farmers was more than 55% in Kalehe, Kabare and Walungu while in Mwenga it was less than 50% of the total legume farmers sampled (Table 4.9). The degree of uptake on improved seeds was high in the four territories 94, 88, 100 and 93% in Kalehe, Kabare, Mwenga and Walungu respectively. The level of uptake of the spacing patterns was also high at 83, 89, 100 and 91% in Kalehe, Kabare, Mwenga and Walungu respectively. However, the degree of uptake on fertilizer was low in 3 territories that is 35, 19 and 54% in Kalehe, Kabare and Mwenga respectively.

In comparing the four territories in Eastern DR Congo, the results on overall uptake showed that farmers with high uptake were less than 38% in Kalehe, Kabare and Mwenga that is 29, 10 and 37% respectively. Legume farmers in Walungu recorded the highest degree of overall uptake (61%) compared to other territories. Further, the results showed that farmers with moderate degree of uptake were less than 50% in the four territories. Kabare had a large number of farmers with moderate degree of uptake while Walungu had most of its legume farmers with high uptake.

Table 4.9:N2Africa legume technology uptake in four territories of Eastern DR Congo

	Farmers uptake	Kalehe (%)	Kabare (%)	Mwenga (%)	Walungu (%)
Rhizobium uptake	No uptake	44	39	54	12
Improved seeds uptake	No uptake	6	12	0	7
Spacing uptake	No uptake	17	11	0	9
Fertilizer uptake	No uptake	65	81	46	27
N2Africa Uptake	No uptake	17	8	0	6
	Low uptake	27	33	38	4
	Moderate uptake	27	49	25	29
	High uptake	29	10	37	61

4.4 Socio-demographic and economic factors that influence uptake of legume production using technology disseminated by N2africa project.

4.4.1 Test for multicollinearity

In order to ensure the reliability of data used for the study, multicollinearity test was done. The results for testing multicollinearity showed that all variables had variance inflation factors (VIF) of less than 2. Gender had the highest VIF of 1.55, while the member of the farmer group had the lowest VIF of 1.01. The mean variance inflation factors was 1.24 confirming absence of multicollinearity (Appendix 3).

4.4.2 Factors influencing the uptake of the technology disseminated by N2Africa

The results for the Tobit regression (Table 4.10) show the factors influencing the uptake of the technology disseminated by N2Africa in Eastern

DR Congo. These results shows that 6 factors (gender of the farmer, head of the household, total farmer size, legume farming experience, farmers membership in farmer groups and beans profitability) significantly influenced the uptake of the technology disseminated by N2Africa. The results showed that gender and head of household variables were significant at 5% level. Total farmer size, farmers' membership in farmer groups and beans profitability was significant at 10% level. Only legume farming experience was significant at 1% level. A detailed discussion of the implications of these factors in influencing uptake is in the discussion chapter.

Table 4.10: Factors influencing uptake of the technology disseminated by N2Africa

Log likelihood=3.6858519		Prob > Chi-square=0.000		
Adoption	Coefficient	Standard Error	T	P>t
Age	-0.00016	0.00124	-0.14	0.892
Gender	0.07534**	0.03442	2.19	0.029
Head of the household	0.06865**	0.03513	1.95	0.052
Education of the household	0.00263	0.00324	0.81	0.417
Household size	0.01405	0.00853	1.65	0.101
Total farmer size	0.03314*	0.01829	1.81	0.071
Legume farming experience	-0.00365***	0.00099	-3.66	0.000
Farmer group membership	0.12024*	0.06400	1.88	0.061
Profitability of soybean	5.09E-07	5.88E-07	0.87	0.388
Profitability of beans	1.87E-06*	9.99E-07	1.87	0.062
_Cons	0.4412817	0.1075271	4.10	0.000

***, ** and * are significant at 1, 5 and 10% respectively

4.5 Competitiveness of legume production amongst small-scale farmers in Eastern DR Congo

4.5.1 Average gross margin of legume compared to other principal crops

The results of the study (Table 4.11) showed that the average gross margin of legume (common and soy beans) was higher compared to other principal crops. However, the average labour cost and the average variable costs were higher for legume production than other crops. In comparing among various enterprises, the results of the study showed that common beans had the highest returns to labour capital followed by potato, maize and soya beans respectively. Cassava had the lowest return to labour capital. Further, the results showed that the return to overall capital was highest in potato followed by maize and common beans. The result showed also that common beans and soybean producing with the technology disseminated by N2africa technology had the highest average gross margin, return to labour capital and return to overall capital compared to the legume producing traditionally that is without the use of the technology disseminated by N2Africa.

Table 4.11: Competitiveness of legume compared to other principal crops

Farm enterprises	Average gross margin (FC/ha)	Average labour cost (FC/ha)	Average variable costs (FC/ha)	Returns to labour capital (GM/labour costs)	Returns to overall capital (GM/Variable costs)
Common beans	985708	467773	755640	2.107	1.304
Beans without techno	132393	162391	217607	0.82	0.608
Soy beans	669869	538040	629455	1.245	1.064
Soybean without techno	417090	558475	582910	0.746	0.715
Cassava	203797	364744	461098	0.559	0.442
Potatoes	259023	145339	164663	1.782	1.573
Maize	280438	188087	215358	1.491	1.302

FC: Congolese Franc

4.5.2 Territorial comparison results of average gross margin of legumes compared to other principal crops.

4.5.2.1 Average gross margin of legume compared to other principal crops in Kalehe

The results of the study (Table 4.12) showed that in Kalehe soybean had a high average gross margin as well as the average labour cost and average variable cost. In comparing the returns to labours capital, maize had the highest return followed by cassava and common beans. Further, the results showed that in comparing the returns to overall capital, maize had the highest return followed by potato and soybean.

Table 4.12: Profitability of legume compared to other crops in Kalehe

Farm enterprises	Average gross margin (FC/ha)	Average labour cost (FC/ha)	Average variable costs (FC/ha)	Returns to labour capital (GM/labour costs)	Returns to overall capital (GM/Variable costs)
Common beans	529824	201504	346254	2.63	1.53
Soybean	770099	328479	346954	2.34	2.22
Cassava	290320	86344	162949	3.36	1.78
Potatoes	182335	71767	72344	2.54	2.52
Maize	85460	15385	16987	5.55	5.03

4.5.2.2 Average gross margin of legume compared to other principal crops in Kabare

The results of the study (Table 4.13) showed that legume had a high average gross margin, while beans and cassava had a high average labour cost as well as in average variable cost. Further, the results showed that comparing the returns, maize had a high return to labour capital followed by bean and soybean as well the return to overall capital.

Table 4.13: Profitability of legume compared to other principal crops in Kabare.

Farm enterprises	Average gross margin (FC/ha)	Average labour cost (FC/ha)	Average variable costs (FC/ha)	Returns to labour capital (GM/labour costs)	Returns to overall capital (GM/Variable costs)
Common beans	1427374	708596	1153039	2.01	1.24
Soybean	609310	546979	621175	1.11	0.98
Cassava	49290	727275	770282	0.07	0.06
Potatoes	164623	268707	353009	0.61	0.47
Maize	571973	194797	250126	2.94	2.29

4.5.2.3 Average gross margin of legume compared to other principal crops in Mwenga

The results of the study (Table 4.14) showed that soybean had the highest average gross margin, average labour cost and average variable cost followed by maize and common beans. Further the results showed that comparing the returns, common beans had the highest return to labour capital and return to overall capital followed by cassava.

Table 4.14: Profitability of legume compare to other principal crops in Mwenga

Farm enterprises	Average gross margin (FC/ha)	Average labour cost (FC/ha)	Average variable costs (FC/ha)	Returns to labour capital (GM/labour costs)	Returns to overall capital (GM/Variable costs)
Common beans	478296	253863	367086	1.88	1.30
Soybean	1275208	1500324	1648269	0.85	0.77
Cassava	49591	42703	48245	1.16	1.03
Potatoes	57942	59083	73692	0.98	0.79
Maize	503789	777115	809253	0.65	0.62

4.5.2.4 Average gross margin of legume compared to other principal crops in Walungu

Comparing the profitability of legume and other crops in Walungu, the results of the study (Table 4.15) showed that legume and cassava had the highest average gross margin as well as the average labour cost and average variable cost. In comparing the returns, potato had the highest return to labour capital as well as returns to overall capital followed by common beans and cassava.

Table 4.15: Profitability of legume compared to other principal crops in Walungu

Farm enterprise	Average gross margin (FC/ha)	Average labour cost (FC/ha)	Average variable costs (FC/ha)	Returns to labour capital (GM/labour costs)	Returns to overall capital (GM/Variable costs)
Common beans	899923	415766	663508	2.16	1.36
Soybean	549309	420913	549914	1.31	0.99
Cassava	482251	229610	403439	2.10	1.20
Potatoes	281042	84527	53808	3.32	5.22
Maize	54995	135879	148221	0.40	0.37

CHAPTER FIVE: DISCUSSION

5.0 Overview

This chapter is divided four major sections. The first section discusses the results of the level of the knowledge in N2Africa technology among farmers in Eastern DR Congo. The second section discusses results of the degree of uptake of legume production technology disseminated by N2Africa project in Eastern DR Congo. The third section discusses the results of the Tobit model that include socioeconomic factors that influence uptake of legume production using technology disseminated by N2Africa project. The fourth section discusses the results of gross margin specifically the competitiveness of legume production amongst small-scale farmers in Eastern DR Congo.

5.1 Level of the knowledge in N2africa technology among farmers in Eastern DR Congo.

The awareness of the four aspects of the technology disseminated by N2Africa project influenced significantly the overall knowledge of the technology among the legume farmers. Small scale legume farmers had high knowledge on improved seeds and spacing pattern in all the territories. The high level of knowledge in these two aspects could be explained by similar activities in Kabare, Walungu and Mwenga undertaken by CIAT in CIALCA project where some farmers had been trained on improved seeds and spacing technologies before the N2africa project initiation.

In CIALCA project, improved legume germplasm was taken as a starting point to improve agriculture-based livelihoods. Improved varieties of bush beans and climbing beans were tested. Selected varieties were tested by a minimum of two farmer associations who were trained in seed multiplication. An improved legume–cassava intercropping system was developed for the purpose of maximizing productivity by combining a number of components: improved germplasm, organic matter management and adapted agronomic practices and crop spacing (CIALCA, 2008). Further, the ease of use of the spacing patterns and the benefits of improved soy and common bean seeds may have driven the interest of the farmers on improved knowledge in these aspects.

However, the level of knowledge on chemical fertilizer and rhizobium was low in Eastern DR Congo. The low knowledge on chemical fertilizer application could be attributed to the many years of organic fertilizer use among legume farmers in contrast to the N2Africa project approach in promoting chemical fertilizers. Additionally, the low knowledge in chemical fertilizer application among the farmers could also be attributed to the high cost of chemical fertilizers compared to organic fertilizers which usually have negligible cost in their preparation. Therefore, farmers prefer the organic fertilizers. In addition, the low knowledge of chemical fertilizers technology disseminated by N2Africa project to legume farmers could be attributed to the nature of legume crops in nitrogen fixation. Thus farmers consider them as being fairly productive without fertilizers. Further, inadequacy of information on the benefits likely to emanate from use of inorganic fertilizers in legume production in Eastern DR Congo could have led to low knowledge on this aspect. This could be explained by the findings of Foster and Rosenzweig

(1995) in the study of human capital and technical change in agriculture established that farmers could not use a new technology because of their inadequate knowledge about its management. In spite of this, through experience of its use, adoption of the new technology occurred. Farmers were thus able to either increase or decrease fertilizer application in order to experience higher profits depending on their neighbours outputs. Foster and Rosenzweig (1995) further explain that this indicated the importance of social learning. Similarly, in Eastern DR Congo it is expected that after several seasons of introduction and use of inorganic fertilizer by some legume farmers then their interactions with non users will influence them to uptake its use (due to increased knowledge of the legume production technology) upon confirmation of its productivity benefits.

On the other hand, rhizobium was introduced by N2Africa project in the Eastern DR Congo therefore it is fairly new to the farmers. According to Bala and Charma (2006), farmer's knowledge on a technology depends on many factors; farming situation, resource availability, needs and aspirations of the farmers, different socio-economic and cultural backgrounds. As noted by Bala and Charma (2006) education and extension contacts enable farmers to acquire access and avail new information, and evaluate benefits of alternative sources of economically useful information besides higher allocative and productive efficiencies. This is an indicator of importance of agricultural education and extension which can play a critical role in the transformation process to transfer technology, support learning, assist farmers in problem-solving, and enable farmers to become more actively embedded in the agricultural knowledge such as that of rhizobium use in legume production in Eastern DR Congo. Even when they are available, many women do not get access to extension officers because many of them are men and there may be cultural inhibitions for their interaction with women farmers (UNDP, 2012). Lack of extension service in DRC may be associated to low interest among farmers to improve their knowledge on fertilizer and rhizobium aspects.

As noted by various studies, (Odera *et al*., 2000; Okuro *et al*., 2002; Mugwe e*t al.,* 2008) farmers usually applied low amounts of mineral fertilizers because of high cost of the fertilizer, lack of credit, delays in delivery, poor transport and marketing infrastructure. According to Woomer *et al.* (2012) in Eastern D. R. Congo, there is no point of sale of rhizobium and no private investor appears interested in producing inoculants but MEA Fertilizers (Kenya) is currently developing a strategy to export BIOFIX inoculants to other countries including D. R. Congo. This absence of sale point can eventually lead to low interest and knowledge among the farmers.

5.2 Degree of uptake of legume production technology disseminated by N2africa project in Eastern DR Congo.

The study found out that the four aspects of the N2Africa technology contributed significantly to the overall uptake of the technology at 1% significance level. Legume farmers recorded high uptake levels in spacing pattern and improved seeds aspects of the technology disseminated by N2Africa project. The high uptake on those two aspects could be explained by the need by the farmers in improved seeds to improve their legume productivity. In the study area, improved legume seeds were available on credit from farmer organization and the NGO partners of CIAT. This access to credit of improved legume varieties seeds could have increased the probability of uptake of improved legume seeds in the study area. According to Hailu (2008) access to institutional legume seeds credit for legume small scale farmers stimulate them towards uptake of improved legume seeds. The uptake of the technology might be low for farmers with little available resources and without access to credit. It is expected that access to credit will increase the uptake of the technology and therefore improved agricultural inputs use.

This study found out that majority (92%) of the respondents in the study area preferred improved varieties of legume (the varieties promoted by the legume production technology are CODMLB001 for common bean and SB24 and PK6 for soybean) disseminated by N2Africa project. This could be attributed to the improved varieties high yield, consumer preference thus high market demand, and price advantage, length of maturity, grain colour, grain size, disease resistance and storability. (CIAT, 2011)

The mineral fertilizer and rhizobium inoculations were considered as new aspects in the study area. According to Chiputwa *et al.* (2011) farmers go through an intermediary phase in uptake of new technologies that they are introduced to. Farmer's initial awareness is considered as an important phase in uptake of any technology. According to Sanginga and Woomer (2009) the major constraints to uptake of improved soil fertility recommendations comprise lack of awareness of technologies, insufficient adaptation of technologies to farmer conditions, poor research-extension-farmer linkages, land tenure, labor, unfocused institutional support and perversion of needed national policies. According to Sibiko (2012), the visits of extensions workers have a positive influence on the farmer knowledge and this can influence the uptake of the technology. Extension workers will provide farmers with information of new varieties and agronomic practices. Further, Sanginga and Woomer (2009) noted that agro-dealers and extension agents also play critical roles in distributing the correct types of fertilizer and participating in credit and voucher programs. Extension agents are responsible for advising farmers on production. In return, farmers may make good use of available information and training materials, but the tools are generally too few or out of date in African countries. Similarly Doss (2007) noted that access to information is an important ingredient in the uptake of a technology. Farmers who have information about new technologies in advance are likely to uptake. Extension services are important means for farmers to gain information on new technologies.

As noted above, in Eastern DR Congo there is no agricultural extension service and agro-dealers are extremely limited. According to the majority of respondents they do not use mineral fertilize because it is expensive and they do not know where to get it. They also said that it requires additional skill, therefore it is difficult for them to apply the recommended fertilizer and rhizobium inoculation.

Failure of uptake of a technology such as fertilizer and rhizobium use in Eastern DR Congo could be associated to the findings by Dercon (2004) that production risk is an important element in farming decisions, principally in the uptake of farm technology. Therefore, poor people are largely risk averse; they will be hesitant to invest in modern technology because of the perceived risk.

It was also noted by Mapiye et *al*. (2006) that the major constraints of the uptake of the technologies are the shortage of inputs, lack of capital and knowledge. The key limitation of the inputs in the study area was the high cost of the mineral fertilizer and low availability of rhizobium. Rhizobium and mineral fertilizer were imported from Rwanda and Kenya while legume was multiplied in the study area. Majority of the legume farmers in the study area were unable to afford high price of the fertilizer. It was also noted that the level of knowledge on mineral fertilizer and rhizobium was low which could affect the uptake of those two aspects of the technology. Makuch *et al.* (2004) emphasize that the uptake of a technology is often an investment decision and this decision presents a change in farmers' investment options. Further the authors noted that the uptake of a technology could be expected to be dependent on cost of a technology and whether farmers possess the required resources.

According to Butler and Sellbom (2002) there are three factors that impose barriers to the uptake of the technology. They argued that lack of institutional support, lack of financial support, and most importantly lack of time to learn new technology. The time between initial information and final uptake of the technology vary significantly depending on region, people and practice. In essence uptake of a technology depends on its compatibility with the existing practices by farmers; therefore the uptake of a compatible technology among farmers is likely to be higher compared to a technology that is perceived to be totally new.

It was noted by Uaiene *et al*. (2009) that the effort that a government makes in the technology innovation and their complementary efforts especially in facilitating the availability of inputs more easily and cheaply could allow faster uptake of the technology. The unfelt government efforts in Eastern DR Congo in provision of extension services towards easing agricultural technology uptake could explain the low availability of inorganic fertilizer and rhizobium in the area. Inadequate provision of enabling infrastructure such as roads, security and market structures in Eastern DR Congo could also explain low knowledge and uptake of some aspects of the legume production technology disseminated by N2Africa project. All these factors have cumulatively crippled the possibility of larger uptake of the technology disseminated by the N2Africa project and curtailed the likely returns from increased legume productivity. Similarly, Bonabana-Wabbi (2002) noted that the uptake of a technology is related to the government policies, market forces environmental concerns, institutional factors and delivery mechanism.

In comparing territories on the overall uptake Mwenga had the highest number of legume farmers with low uptake of the technology disseminated by N2Africa project (38%), the reason might be related to the mining activities in this region. People in the area are more interested in mining and business than in agriculture. These people prefer mining and other business undertakings since they can make quick returns as compared to agribusiness which take at least several months to years in realizing benefits. Liberio (2012) emphasize that none or low uptake of a technology does not necessarily mean rejection. Farmers are sometimes unable to uptake a technology, even though they have mentally accepted it, because of economic and situational constraints.

The highest number of farmers with moderate uptake (49%) as well as the high uptake (61%) was in Kabare and Walungu respectively. This may be explained by the NGOs partner of CIAT in N2Africa project in the study area. All these NGOs (PAD, DIOBASS and SARCAF) work in both territories thus more efficient compared to each NGO working alone in a territory. Similarly, Sanginga and Woomer (2009) noted that NGOs have emerged as powerful forces in rural development due to the shortcomings of the formal government in service delivery. These NGOs have strong farm liaison skills, excellent service and vast information and sample packages when it comes to farm inputs. They have assisted farmers associations in organizing field days, training courses and also farmer exchange programmes.

The study results showed that men were more educated than women whereas more women were involved in legume production than men. The results could imply that if women could be more informed than men then this would lead to uptake of legume production technology disseminated by N2Africa project. This would make women to be better decision makers and would eventually lead to improved legume production. Therefore, intensification of training and extension towards women would at least supplement and or compliment the education of women towards increased awareness. The result of the study is in conformity with the study conducted by Alemitu (2011) who reported that educated farmers are better able to process information and search for appropriate technologies to improve their production constraints.

5.3 Factors that influence uptake of legume production using technology disseminated by N2Africa project.

In testing multicollinearity, the variance inflation factors were less than 2 for all the factors that were taken into account in the study area as the factors influencing legume production. According to Liberio (2012) the variance inflation factors measure how the estimated coefficients are increased over the case of no correlation between the variables. In case where there are no two explanatory variables (Xs) which are correlated, all the variance inflation factors will be less than five. If the variance inflation factor for one of the variables is approximately or greater than five, there is collinearity. Similarly, Alauddin (2010) noted that, multicollinearity may not be a serious issue if the variance inflation factors do not exceed 10.

Alemitu (2011) emphasize that the variance inflation factors are checked to test the existence of multi-collinearity problem. He noted that the larger the value of variance inflation factors the more is the problem of multi-collinearity. Further, Rovny (2011) noted that when a predictor is much correlated with others multicollinearity exists. The consequence of the high correlation among predictors X1 and X2 is to limit the ability of determining the correct relationship between X1 and Y although controlling for X2 and vice versa, because X1 is not very independent of X2. This high correlation also means larger standard error, which leads to rejection of the relationships which may be true.

As per the study findings, six of the ten independent variables were significant (Table 4.11); legume farmer experience at 1% level, head of the household and gender at 5% level and total farmer size, farmer group membership and profitability of bean at 10% respectively. The total legume farming experience had a regression coefficient of -0.00365, significant at 1%. This negative regression coefficient implies that legume farming experience and the uptake of legume technology disseminated by N2Africa technology in the study area are negatively related. This is unexpected relationship because as the farmer gets more experience in farming the more the farmer is likely to uptake the technology. The findings were inconsistent with Mugisha, Ajer and Elepu (2012) in the study of contribution of Uganda Alliance to farmers' adoption of improved agricultural technologies who established that experience positively relate to technology adoption by increasing a decision maker's ability to assess whether a new technology will be profitable. Ofuoko, Egho and Enujeke (2009) in the study of integrated pest management adoption among farmers in Nigeria noted that long period of experience in the use of local or indigenous technology could not encourage the use of new technology. Owombo *et al.* (2012) emphasize that farming experience is usually hypothesized to have positive or negative influence on the uptake of the technology. The negative relationship among farming experience and the uptake of the technology is related to the confidence that farmers have in their long experience practices, although farming experience could enable farmers to use information about the new technology.

According to Ajewole (2010), farming experience can generate or grind down confidence in new technology because farmer with more experience can become more or less risk-averse in judging new technology. The legume farming experience could consequently have a positive or negative effect on farmer uptake decision. Similarly, Odendo (2011) found that farming experience retards the uptake of new technology. Farmers with long farming experience takes longer time to assess the potential of new technology before making the uptake decisions based on past experiences with new practices. Most of the respondent in the study area had a farming experience of 30 years; this long period of experience could be attributed to the negative influence of farming experience on the uptake of technology disseminated by N2Africa. Bisanda *et al.* (1998) found that ten-year increase in farming experience decreased the probability of the uptake of the new technology by 1 percent In contrast, Caswell *et al.* (2001) noted farming experience influence positively the uptake of the technology because farmers with long period of farming experience are exposed to more ideas and have high experience in making decisions and effective use of information. Further, Idrisa, Ogunbameru and Madukwe (2012) emphasized that farmers with long farming experience might enhance skill and access to new information about new technologies. The knowledge gained over time in the working environment may help to judge information thereby influencing their uptake decision of the new technology.

The gender of the farmer had positive significant influence of the uptake of technology disseminated by N2Africa; this implies that the gender of the farmer and the uptake of the technology disseminated by N2Africa technology are positively related. According to Morris and Doss (1999) gender might play a significant role in influencing the technology uptake decision. Similarly, it was found by Tadesse (2008) that gender difference is one of the factors influencing access to and utilization of agricultural information. In contrast Doss (2007) noted that the decision to uptake a technology is not based on the gender of the farmer because the farmer who is now farming the land may not have been the one who made the initial decision to uptake the new technology, this is the case when female head was not concerned in the decision of the uptake of new technology but may maintain the use of the established practices originally initiated by her husband and vice versa.

In this study, the positive value of the gender coefficient indicates that females are more likely to uptake the technology disseminated by N2Africa technology. The study found out that more women were involved in legume production than men. The findings were consistent with those of CIAT (2011) in a rapid appraisal value chain survey carried out in Rwanda and DR Congo where it was established that in terms of gender equity, legumes are traditionally women's crop. CGIAR (2012) further noted that grain legume cultivation benefits women because they are frequently the principal cultivators of these crops (especially in sub-Saharan Africa). It becomes more women-friendly for the reason of nutritious varieties amenable for processing and reduces hard work. Similarly, as noted by Bezner kerr *et al*. (2007) women smallholders in SSA tend to favour legume options because of improved food security. Negash (2007) found that women play an important role in legume cultivation. They are involved in the total legume production process such as cultivation, weeding, harvesting, transport, storage and preparation of fields.

The head of the household variable had positive significant influence on uptake, this positive coefficient implies that the head of the household and the uptake of the technology disseminated by N2Africa technology is positively related. It is easy for legume farmer to decide about the uptake of the technology if he is also the head of the household. In the study area, 36% of the legume farmers were the head of the household. The result showed that by increasing the numbers of head of the household involved in legume production by 5%, the uptake of the technology disseminated by N2Africa will increase by 6.8%. Kassie *et al.* (2009) found that whether the head of the household is man or a woman, the legume farmer to be the head of the household is assumed to be the primary decision-maker. Mignouna *et al.* (2011) further noted that beyond the sex of the household, the assumption is that the head of the household is the primary decision maker of the uptake of the technology. Motuma *et al.* (2010) emphasize that the participation of the household head in farm activities will increase the likelihood of the household to uptake and to continue using the new technology.

The total farm size variable had positive significance influence on uptake of the technology disseminated by N2Africa. The total farmer size in the study was between 0.01 and 4ha. The result of the study showed that by increasing the farm size by 1ha, the uptake of the technology disseminated by N2Africa project will increase by 3.3%. According to Alemitu (2011) the total farm size is often discussed as an important factor that affecting the uptake decision. From literature it has been generally established that farmers with larger farms are likely to uptake a technology than those with small farms (Hailu, 2008; Alemitu, 2011; Liberio, 2012). Further, Hailu (2008) noted that farm size has a positive influence on the uptake of the new technology. Similarly, Liberio (2012) found that farm size affects considerably the uptake of new technology. He emphasized that farmers with larger farms are likely to be better informed, be able to take larger risks which are associated with early uptake and have more opportunity to experiment.

It was also established that farmer group membership had positive significance which implied that the total farmer size and the uptake of the technology disseminated by N2Africa is positively related. Most of the respondents in the study area were members of farmers associations. Alemitu (2011) found that by a farmer being a member of farmers' association, they are likely to uptake a new technology. Similarly, Getahun *et a*l. (2000) noted that for the farmer to be a member of a farmer group is an important factor in the uptake of the technology because members of a farm association are in better position than others farmers in terms of access to information about a new technology. Mignouna *et al.* (2011**)** emphasize that membership of a rural group is an important aspect that could enhance social capital, confidence, idea, extension service contact and information exchange thus will increase the uptake of the technology.

The profitability of beans also had positive significance influence on legume production uptake using technology disseminated by N2Africa project, this implies that the profitability of beans and the uptake of the technology disseminated by N2Africa technology is positively related. The result of the study showed that bean was profitable compared to other principal crops in the study area. According to CIAT (2011) common beans play important roles in small scale households such as provision of incomes and food security; common bean is the most important legume for household consumption and for earning cash income in the Eastern part of DR Congo. CIAT further noted that beans are a marketable commodity. Rwanda, Uganda and Eastern Democratic Republic of Congo have some of the highest per capita consumption of common beans in the world.

5.4 Competitiveness of legume production amongst small-scale farmers in Eastern DR Congo

The result of the study (Table 4.12) showed that common bean had the highest gross margin and the highest return to the labour capital in the study area compared to others principal crops. For every 1 Congolese Franc (FC) invested in common bean labour it will result to a return of 2.1 FC while an investment of 1 FC as the overall capital in common bean production results to 1.3 FC for the overall return. In this study gross margin was used to compare the profitability of legume (common bean and soybean) with other principal crops (cassava, potatoes and maize) available to the farmer. Zulu, (2011) noted that gross margin analysis appears to be a frequent method used to find out the profitability for different crops in the farming management. Further Elad and Herbohn (2011) emphasize that farm gross margin provides a simple way for comparing the performance of enterprises. It is also an important and practical tool to indicate farm profit in terms of farm management, budgeting and estimating the likely returns or losses of a particular crop. Similarly, Erbaugh (2008) found that gross margin was more precise tool to estimate the profitability compared to other budgeting techniques because it includes a determination of costs of each farmer on a per hectare basis on the specific enterprise as well as the revenue earned for each farmer considering the differences in prices. Whereas other techniques such as total revenue or value of farm production include fixed costs of the whole farm, thus tend to underestimate the profit of each enterprise.

According to Negash (2007) the gross margins of the improvement technology can be influenced by the accessibility of labour. The farmers with access to high labour are expected to be in a position to try and continue using a potentially profitable new technology and it is expected to influence adoption positively. Further, Choudhary *et al.* (2011) noted that the gross margin is helpful for the farmer to pinpoint his enterprise issues and therefore to improve his specific farm program.

The results of the study showed also that common bean and potato had high return on the overall capital. In spite the high return of potato on the overall capital, potato is not marketable in the study area. Most of the respondents said that potato takes long in the market and it is not considered as a staple food in the area. According to respondent in the study area, consuming potato 'is not eating', this means that even after eating, people can still eat potato and vice versa. According to Kibet *et al.* (2011) the farmer's profit maximization goal cannot be achieved if cropping chosen is not the most advantageous. Therefore, for farmers to make informed decisions regarding farm enterprise, it is important to understand gross margins of the different crops available to them.

The results showed that one 1 Congolese franc invest returns 2.1 and 1.3 Congolese franc on labour capital and overall capital respectively for common beans producing with the technology disseminated by N2Africa project. On the other hand, common beans producing traditionally (without the technology) 1 Congolese franc invested 0.8 and 0.6 Congolese franc returns for the labour capital and overall capital were realized respectively. Tshering (2012) in the study of profitability analysis of bean production in Honduras found that common beans produce with modern technology had a return of 118 US dollars per hectare while the beans producing traditionally had a return of 70 US dollar per hectare.

In comparing territories, the territories that had moderate and high uptake (Kabare and Walungu) are also the territories that had highest gross margin for beans. These results confirm the significant positive coefficient of the profitability of common beans in the study area. According to Chagwiza (2008) the use of gross margin allows the orientation of areas where significant improvement needs to be made in order to optimize production.

This is more helpful in the farm management for analysis and planning purposes.

In contrast the territory of Mwenga where there was high number of farmers who had low uptake of the technology aspects, common bean had high return on both the labour capital and on the overall capital. This could be explained by the fact that since production of common bean is low in these provinces supply tends to be lower; hence the price is higher thus raising the market value of common bean in this territory and consequently higher return compared to other principal crops. According to the laws of demand and supply, higher supply of a commodity leads to a lower price (Ahuja, 2006).

Finally, the differences in returns of various crops grown across the four territories (Mwenga, Kabare, Kalehe and Walungu) was a clear indicator of how each one of them is important in the livelihoods of the small scale farmers. By a farmer having diversifying their crop enterprises in their farms, it ensures compliment among these enterprises in terms of provision of the required nutrients and food security to the households. In addition, diversification of on-farm enterprises reduces production risks associated with agricultural production; in cases of crop failure. Further, diversification promotes monetary interdependence among the farm enterprises whereby one enterprise can raise capital for initiation of another enterprise or adoption of a new technology. This eases out the burden on small scale farmers who are mostly resource constrained and have limited access to credit (Msuya *et al*., 2008). It is noteworthy that sometimes farmers do not entirely undertake agricultural activities for profit purposes but rather for sustenance especially where production can be undertaken without incurring monetary costs by using family labour, household land and low external input technique among others. This practice is common in Eastern DR Congo.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.0 Overview

This chapter is divided into three sections. The first section presents the summary of the major findings of the study. The second section presents the recommendations for various stakeholders while the last section presents the areas for further research.

6.1 Conclusion

The aim of this study was to assess the competitiveness of legume production compared to other principal crops and the socioeconomic and institutional factors that influence the uptake of legume production among small-scale farmers in the East of DR Congo. The study was undertaken to assess the status of uptake of legume production technology disseminated by N2Africa project. This targeted small scale farmers who were involved in N2Africa project for at least for two years in South Kivu. The study was conducted in Kalehe, Kabare, Walungu and Mwenga based on a sample of 300 small scale farmers selected using a multistage sampling technique. Data collection was done using a structured questionnaire administrated to 300 small scale legume farmers but only 291 questionnaires had complete data. Descriptive statistics were used to determine the level of knowledge in N2africa technology among farmers and the degree of uptake of legume production technology disseminated by N2africa project in Eastern DR Congo. The Tobit model was used to identify and analyze socioeconomic and institutional factors that influence uptake of legume production while gross margin was used to assess competitiveness of legume production amongst small-scale farmers in Eastern DR Congo.

The findings further showed that majority of the sampled legume farmers had moderate knowledge of legume technology disseminated by N2Africa project. In Kalehe, Kabare, Mwenga and Walungu 87, 89, 79 and 38% of the farmers had no fertilizer knowledge while most of the small scale legume farmers had no knowledge on rhizobium. Majority of the sampled legume farmers had high knowledge on improved seeds and spacing patterns.

The assessment of the uptake of the technology disseminate by N2Africa project showed that farmers with high uptake were less than 38% in Kalehe, Kabare and Mwenga. Legume farmers in Walungu recorded the highest degree of overall uptake (61%). It was also found that farmers with moderate degree of uptake were less than 50% in the four territories while Kabare had a large number of farmers with moderate degree of uptake.

The Tobit model revealed that gender and head of household variables had positive and significant influence on uptake at 5% level. Total farm size, farmers' membership in farmer groups and beans profitability had positive and significant influence on technology uptake at 10% level. Only legume farming experience had negative significant influence at 1% level.

Finally, profitability assessment showed that common and soy beans had higher gross margins compared to other principal crops. The returns to capital showed variations in all the crops that were assessed in the four territories in Eastern DR Congo.

6.2 Recommendations

From the study it was evident that extension services are important in provision of information among farmers and influences the ability to make sound decisions in uptake of farming technologies. However, in Eastern DR Congo extension services provision remains almost non-existent with exception of some that are provided by NGOs. Therefore, the study recommends that policy makers in DR Congo should focus on pioneering effective institutional structures that would enable establishment of extension services systems to promote uptake of farming technologies. This would work towards filling the existing gap especially from the government side.

The study showed that more women were involved in legume production than men. However, men were more educated than women. As a result the study recommends that CIAT and other legume promoting stakeholders need to focus on women training towards increased legume production technology uptake and productivity of legume.

From this study, it was evident that various crop enterprises had varying returns on capital which was an indicator of the disparities in the importance of these crops from one territory to another. Therefore, the study recommends that as much as legume production is being promoted, the government and NGOs should work towards emphasizing to farmers the importance of farm enterprise suitability mapping which would determine diversification. This would avert the likely effects of legume production failure on small scale farmers.

Further, the importance of farmer groups was also established in the study. It is therefore recommended that facilitation by agricultural sector stakeholders should be rendered towards promotion of forming services oriented farmer groups. This would serve as platforms for farmers training and provision of important services such as credit, marketing and inputs. This is expected to promote improved farming practices and access to markets.

It was also noted that there was also a problem of availability of rhizhobium and mineral fertilizer. In Eastern part of DR Congo there is no sale point of rhizobium and only a few points for sale of mineral fertilizer. The study recommended the government to facilitate farmers to access mineral fertilizer and rhizobium. The government could introduce friendly policies for the promotion of legume inputs trade in Eastern DR Congo. As a result agro-dealers could invest in mineral fertilizer and rhizobium supply in the area.

6.3 Areas for further study

While this study covered only four territories over eight territories in South Kivu, it may be important for future research to assess the competitiveness of legume production using N2Africa project-disseminated technology in small scale farming in the other four territories.

The study also did not look at marketing challenges faced by small scale legume farmers in South Kivu. This study studied only common beans and soybeans, it will also be important for further research to take in consideration the others types legume available in South Kivu. Therefore, future research can undertake into this area not only in South Kivu but also in other legume producing provinces in DR Congo and other countries in Africa.

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APPENDICES

APPENDIX 1: Sample size for the four territories

Kabare = $\frac{1.96^2\ (1328/496169)\,(1\text{-}1328/496169)}{0.01^2} = 103$

Kalehe = $\frac{1.96^2\ (166/125141)\,(1\text{-}166/125141)}{0.01^2} = 51$

Walungu = $\frac{1.96^2\ (1339/456660)\,(1\text{-}1339/456660)}{0.01^2} = 112$

Mwenga = $\frac{1.96^2\ (192/317473)\,(1\text{-}192/317473)}{0.01^2} = 23$

The total simple for the four territories will be: 103+51+112+23=289

APPENDIX 2: Questionnaire

Competitiveness of Legume Production in Small-scale Farming in South Kivu Eastern DR Congo

The purpose of this study is to assess the competitiveness of legume production compared to other principal crops (cassava, sweet potato and maize) and the socioeconomic and institutional factors that influence the uptake of legume production targeting small-scale farmers in the East of DR Congo. The information needed is from the small-scale farmers who are and/or were involved in the N2Africa project. Your responses will be used for academic purposes only and are highly appreciated. The information provided herein will remain strictly confidential.

Fidele Barhebwa Balangaliza

Student Kenyatta University, Nairobi

Date: ______/_______/20_____ Enumerator: ______________________

Territory: ____________________ County: ____________________ Village: ____________________

Part A: General information

A.1. Name of the farmer: ____________________________

A.2. Sex of farmer: Male ___ /Female ___ Age: _____ years

A.3. Is farmer head of the household: Yes ___ / No ___

A.4. If no, head of household is Male ___ /Female ___ and Age _____ years

A.5. Members of the household:

Age	Total number	Nr. of females	Nr. of males

0 – 16 years			
17 – 35 years			
35 – 60 years			
Over 60 years			

A.6. Highest education level completed by the farmer:

____

A.7. Highest education level completed in the household:

____

A.8. Are you and/or another member of your household engaged in the N2Africa project? Yes ___ / No ___

A.9. If yes, please explain how?

____

____

____

A.10. Which partner(s) of CIAT operating in this area?			
A.11. How long that organisation has been working in this area:	…. years	…. years	…. years
A.12. Is this organisation implementing N2Africa project?	Yes _ / No _	Yes _ / No _	Yes _ / No _
A.13. Have you or another member of your household engaged with this organisation?	Yes _ / No _	Yes _ / No _	Yes _ / No _
A.14. If yes, for how long?	…. years	…. years	…. years

Part B: training and legume technologies competence

B.1.a) Have you been trained in legume technologies: Yes ___ / No ___

(Rhizobium inoculation, seeds(improved varieties), fertilizer (mineral fertilizer) application, spacing patterns;

b) Do you use rhizobium: Yes ___ / No ___ ; if yes which quantity__________________

c) Which type of legume seeds do you use? Local __/ improved__; if improved which one_________________

d) How do you plant, broadcasting___/ precision planting___/; specify the spacing: soybean______________common bean ____________

B.2.a) Have your farming skills improved with the use of legume technologies: Yes ___ / No ___

b) If yes, how____

c) If not why?____

B.3.a) Do you experience difficulties in using legume technologies: Yes ___ / No ___

b) If yes, give the major difficulty

____

Part C: Agriculture

C.1. Farming acreage

Acreage (indicate intercropping)	**Acres or Ha**	**Please rank the crops in importance in terms of (1 most important, 2important, 3 secondary,4 non-essentialetc):**		**Intercropping specify the acreage % of each crop**	
		Household food	**Cash income**	**Crop 1(legumes)**	**Crop2**

		security			(other)
Total farm acreage in use (owned, rented, borrowed, etc.)					
Acreage under legume: Groundnut					
Common bean (bush)					
Climbing bean					
Soybean					
Other: specify					
Acreage under potato					
Acreage under cassava					
Acreage under maize					
Acreage under any other crop(s), specify:					

C.2. Farming experience

Farming experience	**Years**
General farming experience	
Legume farming experience	
Potato farming experience	
Cassava farming experience	
Maize farming experience	

C.3.a) Productivity per season: Legumes

	Common	**Soya bean**	**Soya bean & common bean**

	bean		in intercropping
Area planted (Acres or Ha)			
Seeds (kg)			
Cost of seeds/kg			
Source of seeds			
Fertilizer applied Yes/No			
Land Cost			
Yield or Production in /kg			
Price/ Congolese franc			

C3.b) do you use fertilizer? Yes----/ No-------

If No why?____

____

If Yes fill the table below:

C3.c) type of fertilizer

type	**Common bean**		**Soya bean**		**Soya and common bean**		**Potato**		**Cassava**		**Maize**	
	quan tity	co st	quan tity	co st	quan tity	co st	quan tity	co st	quan tity	co st	quan tity	co st
Manu re												
Comp ost												

NPK												
DAP												
UREA												
SYMPAL												
TSP												
Other specify												

C3.d) Where do you get fertilizer (specify the source)____

C3.e) Labour cost (1:land preparation, 2: planting, 3:weeding, 4:harvest, 5:transport, 6:milling, 7: storage)

type		**Common bean**		**soyabean**		**Soya and common bean**		**Potato**		**Cassava**		**Maize**	
		quantity	cost	quantity	cost	quantity	cost	quantity	cost	quantity	cost	quantity	cost
Family	1												
	2												
	2												
	4												
	5												
	6												
	7												
hired	1												
	2												
	3												
	4												
	5												
	6												
	7												
Other specify	1												
	2												
	3												
	4												
	5												
	6												

	7													

C.4. Productivity per season: Other crops

	Cassava	**Sweet potato**	**Maize**
Area planted (Acres or Ha)			
Seeds (kg)			
Cost of seeds/kg			
Source of seeds			
Fertilizer applied			
Land Cost			
Yield or Production (unprocessed) in kg			
Yield or Production (processed) in kg			
Price of unprocessed/ in Fc			
Price of processed/Fc			

C.5.a) which crop do you prefer

legume	cassava	potato	Maize

b) can explain the reasons why you preferred that crop?____

____

____

c) If legume, can you explain the reason(s) why you cultivate one or more legume?

legume	High demand	climate	nutrition	Life cycle	More money	Fertilizer

Others____
____
____

Part D: Collective action

D.1. Are you currently a member of any farmers' group or local association in this village? Yes ___ / No ___ If yes, please give the name of group(s) or association(s) (include local institution):

1. ____
____
2. ____
____
3. ____
____
4. ____
____

Kindly fill the table with questions below referring to these group(s) / association(s) by the number above:

	Please indicate the primary objectives of association: 1=savings, 2=agriculture, 3=marketing, 4=welfare, 5=other, specify:	How long have you been a member of this group?	Your position in the group: 1=committee member 2=ordinary member	Was your participation different before 2009? Yes/No. If yes, please indicate the difference:	Does your wife or husband belong to the same group with you 1=Yes, 0=No
1					
2					
3					
4					

D.2. How often have you or members of your household joined with other farmers in this village to work collectively?

Type of activity	Frequency (How	Estimate number of people who	Were you engaging in the same activities

or occasion	often?) Per week	participated		before, if no, please explain why not?
		Male	Female	

If not member of any farmers group:

D.3.What is your position in the community:

____

D.4 Why don't you participate in any (farmers') group:

____

THANK YOU VERY MUCH FOR TAKING TIME TO COMPLETE THIS QUESTIONNAIRE

APPENDIX 3: Multicollinearity test

Variable	VIF	1/VIF
Gender	1.55	0.646
Head of the household	1.54	0.648
Age	1.37	0.729
Legume farmer experience	1.31	0.764
Total famer size	1.19	0.842
Education of the farmer	1.19	0.844
Household size	1.15	0.871
Profitability of beans	1.07	0.934
Profitability of soybean	1.06	0.942
Farmer group membership	1.01	0.991
Mean VIF	1.24	