IMPACT OF FARMER GROUPS ON CROP ENTERPRISE PRODUCTIVITY AND ECONOMIC WELFARE OF SMALLHOLDER FARMERS IN SOUTH KIVU TERRITORIES, DEMOCRATIC REPUBLIC OF CONGO

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A Thesis Submitted to the Graduate School in Fulfillment of the Requirements of the Master of Science Degree in Agricultural and Applied Economics of Egerton University

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DECLARATION AND RECOMMENDATION

DECLARATION

This thesis is my original work and has not been presented for award of any degree in this or any other University.

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RECOMMENDATION

This thesis has been submitted to the graduate school for examination with our recommendation as University supervisors.

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DEDICATION

I dedicate this work to my late dad Ochieng', mum Akoth and my sisters Apondi, Adhiambo and Anyango for their support and to research institutions in DRC for their participatory approach in disseminating technologies to improve agricultural productivity among smallholder farmers.

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ABSTRACT

In spite of the efforts and the emergence of numerous group based interventions for technology dissemination, the productivity and technology uptake levels of smallholder farmers of South Kivu, democratic Republic of Congo (DRC) still remain low. The objectives of this study were therefore to describe the changes in input use, value of production and incomes, determine changes in institutional linkages resulting from group based interventions, quantify the economic gains from the group interventions and finally to determine the factors that influenced the economic gain. Data was collected using structured interview schedule. Multi-stage sampling technique was used to obtain a sample of 360 smallholder farmers (120 farmers from each territory) .The three territories (Ngweshe, Mwenga and Kabare) were purposively selected because of the interventions that were implemented therein, their variability in productivity and income among smallholders. Descriptive statistics (mean comparisons) was used to address objective 1 and objective 2. Economic surplus model was used to address objective 3 and then OLS regression used to address objective 4.Data were analyzed using SPSS software. The findings revealed significant differences in the use of top dressing fertilizer, productivity (value of production) and number of meetings attended among the group and non group farmers(at $p<0.05$). From the OLS regression, it was established that the factors that significantly influence economic gain were credit (-0.415), radio farmer programmes (0.004) and off-farm income (0.561) at $p<0.05$.The differences in input use levels, value of production and economic gains between group and non group farmers underscore the importance of farmer groups in improving productivity and welfare of smallholders in Congo. The study therefore recommends policy interventions to increase credit access by farmers and information access via farmer radio programmes as well as promotion of projects that incorporate more income generating activities along with the technology package to make the new innovations affordable to the resource poor farmers.

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ACRONYMS AND ABBREVIATIONS

CAPRi	Collective Action and Property Rights
CBOs	Community Based Organizations
CIALCA	Consortium for Improving Agriculture-based Livelihood in Central Africa.
DRC	Democratic Republic of Congo
FBOs	Farmer Based Organizations
GBI	Group Based Initiatives
Km	Kilometers
Kg	Kilogram
MDGs	Millennium Development Goals
UN	United Nations
US$	United States dollar
MFIs	Micro Finance Institutions
CIAT	International Center for Tropical Agriculture
NIE	New Institution Economics
GOUPMENTs	The sub territories

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Over the past four decades (from 1960 to 1999) the estimated rate of agricultural productivity change was 0.83% annually in East and Central Africa countries, although the average rate from 1985 to 1999 was 1.9% annually. Former British colonies exhibited significantly higher productivity gains than others, while countries that had been colonies of Portugal or Belgium like the Democratic Republic of Congo, DRC exhibited significant reduction in productivity especially during political conflicts (Lilyan *et al.*, 2004; Cirimwami and Mashika, 1999).

Like most of Sub-Saharan Africa countries, DRC depends to a great extent on the growth of the agricultural sector, from which over 60% of the population derives its livelihood. According to the UN Millennium Project (2005a), the Millennium Development Goal (MDG) number one of poverty reduction forms an integral part of agricultural dependence in Sub-Saharan Africa and DRC in particular. Efforts to improve and sustain the sector's productivity therefore would be crucial to the nation's economic development and the welfare of her people.

For a long time, measures to alleviate poverty among smallholder farmers in Africa have focused on individual farmers all through the 21st century. However, these have not yielded much success, forcing research and development organizations to focus their efforts on technological innovations and other interventions through groups or community based approaches. The potential gain in productivity through group interventions is a major factor underlying the need for developing countries to promote groups. Group actions are analyzed within the concept of collective action. This concept is well developed under the theory of the New Institutional Economics (NIE). It is based on institutional approach to solving societal problems, and focuses on the conditions under which groups of people with common interests choose and act to achieve their respective interest (Clague, 1997), a concept that is important in a country like DRC where government institutions are generally weak and recovering from the second conflict (from 1997 to 2003) . The farmer groups fill some of the voids generated by this situation for example in input and output marketing.

Group networks are important because they create long-lasting relationships between individual farmers and expand the opportunity for the development partners to relax current liability limits. Among the most notable theories of moral hazard are models by Stiglitz (1990), Ghatak and Guinane (1999) and Ghatak (1999). Stiglitz shows how peer monitoring under joint liability mitigate moral hazardous behavior among group members. He observes that group members under joint liability reduce the cost of monitoring activities of the group and subsequent outcomes of its activities.

Group approaches to dissemination of innovations is preferred to farmer to farmer approach since it has helped in strengthening seed systems and tailoring them towards specific agro-ecological and socio-economic environments. This facilitates coordination in seed distribution, genetic management, monitoring performance and seed production by the known groups, seed rich in quality, germination and vigour. The group experiments allow farmers to explore new products with limited risks and expense as well as having more influence in the selection process.

The synergies in the group projects enable farmers, researchers and donors understand farmer strategies and practices of soil fertility management before developing appropriate technologies that fit various production micro-niches. Collective feedback of farmers' concerns are responded to. Besides, farmers also gain from information and trainings offered through the groups in their activities to even help them in output marketing.

1.2 Statement of the problem

South Kivu Province located in Eastern DRC in central Africa is recovering from the aftermath of political conflict. The DRC Government and international research institutions in collaboration with Non Governmental Organizations (NGOs) have been striving to productively engage the war returnees in agriculture. This has been implemented through several interventions (for example through community-based organizations, CBOs and Farmer –based organizations, FBOs). The interventions have been in form of group based introduction of improved technologies such as improved inputs and organization for markets. In spite of the efforts and the emergence of numerous group based interventions for technology dissemination, the productivity and technology uptake levels still remain low. For example the application or inorganic fertilizer use is less than 20 kilograms (kgs) per hectare while organic matter application rates are below 500 kgs per hectare. Overall crop production levels are relatively low with banana and cassava production per household consistently

below 6 tons per season, largely ranging between 0.5 – 2 tons. Grain legume production is consistently below 800 kg per season ranging between 100 – 500 kg per season. There is limited empirical evidence of the impacts of farmer groups on the rural farming households in terms of the differentials in incomes, and its contribution to poverty reduction by improving household welfare from the time the interventions were initiated (2007) to the present.

1.3 Objectives of the study

The general objective of the study was to determine the impact of farmer groups on smallholders' productivity and economic welfare in South Kivu territories of the Democratic Republic of Congo.

The specific research objectives were:

1. To compare input use, value of production and incomes between group members and non group members before and after the interventions.
2. To determine changes in the institutional linkages as a result of group interventions.
3. To establish the impact of group interventions on smallholder farmers' economic gains.
4. To determine the production and institutional support factors that influenced economic gains among smallholder farmers.

1.4 Hypotheses

1. There were no significant changes in input use, productivity and incomes resulting from the group interventions among smallholders.
2. There were no significant changes in institutional linkages resulting from the group interventions.
3. There was no significant impact of group interventions on economic gains of smallholder farmers.
4. The production and institutional support factors did not significantly influence economic gains of smallholder farmers.

1.5 Justification of the study

In trying to improve agricultural productivity, technological interventions have been introduced and adopted by farmers. This has been through individual efforts and collective (group) efforts. However, empirical evidence of the impacts of group efforts on productivity and economic welfare of smallholders of the South Kivu territories is limited to be able to

assist in bridging the information gap on whether there is need to upscale the efforts or not. The need to link with other institutions depends on the success of the existing group efforts and without impact assessment, it would be impossible to advocate for up scaling the group efforts even to other regions of the Democratic Republic of Congo. This study is a contribution to on-going research with policy implications on ways of improving productivity among smallholder farmers in DRC and the potential role of group approaches to technology dissemination among the farmers. Information on value of production, input use levels and economic gains from crop farming would be of much importance to the private sector and NGOs interested in linking with farmer organizations in value chains.

1.6 Scope and limitations of the study

Owing to resource limitations, the study only focused on smallholders in three South Kivu territories of DRC with analysis confined to farm level production interventions, institutional linkages and productivity to measure income and general welfare improvement both prior and after the project interventions. The data used was from 2007 to 2009 production years. The smallholders' production being predominantly subsistence with limited commercialization, there was limited record keeping thus the study relied on recall method to gather data of interest in cases where records were not kept.

1.7 Operational definition of terms

Collective action: The coming together of farmers to pursue a common interest that improve their welfare.

Group Based Interventions (GBI): Collective action that targets groups like producer organizations.

Group members: Farmers who are members of the group based initiatives.

Household: An independent farmer and the dependants who have lived with him or her for a period exceeding six months (Ellis, 1988).

Non group members: Farmers who are not members of any group based initiatives.

Productivity: Is the output per unit of input used (Kg/ha)

Smallholders: Refers to those farmers owning farms that are less than one hectare.

The consumer surplus: The amount that consumers benefit by being able to purchase a product for a price that is less than they would be willing to pay for.

Producer surplus: The amount that producers benefit by selling at a market price that is higher than they would be willing to sell for.

Economic surplus: Total surplus which is the summation of producer surplus and consumer surplus.

Economic welfare: The economic gains from engaging in the agricultural activities also referred to as Social Gains measured in monetary terms.

Social Capital: Informal norm that promotes cooperation between two or more individuals and can range from a norm of reciprocity between individuals.

Impact evaluation: It is a process of systematic and objective identification of the effects of an intervention on target groups.

Technology: Is the systematic knowledge and its application to production process.

CHAPTER TWO

LITERATURE REVIEW

The chapter discusses smallholder agriculture in Africa and its challenges to achieving the objectives of increasing productivity and reducing poverty and elaborates the theory underlying the role of collective action in improving productivity and welfare of smallholders. It emphasizes adoption of new technologies through the farmer groups, presents conceptual framework and empirical model for impact assessment and concludes with a discussion of alternative models to analyze impact assessment and their limitations.

2.1 Smallholder agriculture in Africa

Smallholder agriculture continues to play a key role in contributing largely to the GDPs and foreign exchange earnings of most African economies. This is evident in the populations and their distribution as smallholders and importance of food expenditures for people (Kirsten *et al.,* 2009). The potential contribution of expansion of agricultural activities to poverty reduction beyond the agricultural sector through spillover effects is also recognized in recent literature (World Bank, 2008). Arguments in favor of agricultural projects are therefore valid although the projects yield mixed results.

Success stories of African agriculture have been seen for example in the cultivation of new cash crops like cocoa and cotton across African countries (Carr, 2001 and Tiffen, 2003), the development, dissemination and adoption of high yielding crop varieties (Smale and Jayne, 2003). The most notable success in research include the control of cassava mealbug and cassava mosaic, development of new rice for Africa (Gabre Madhin and Haggblade, 2003) and the tissue culture bananas. The need to intensify the use of these new technologies has been of essence in most African countries, including DRC due to the inevitable need to respond to rapid population growth and also the changes in socio economic systems. Both institutions and institutional changes are therefore vital in determining smallholder's capacity to positively respond to new challenges and opportunities, either in production or marketing of the yields (UN Millennium Project, 2005b).

2.2 Technical and institutional challenges in smallholder agriculture in Africa

Attempts to increase agricultural productivity and welfare of smallholders in Africa have had challenges partly unique to other parts of the world. For example, fertilizer use per hectare in Africa from 1980 to 2005 on average was lower at 9kg/ha compared to 70-150kg/ha in the Caribbean and South East Asian countries (Crawford, Jayne and Kelly, 2005; Crawford *et al.*, 2003). This could be partly attributed to poor implementation of agricultural policies. From an institutional perspective, free market has failed in yielding expected returns due to weak institutional support for market and private sector development, with cultural, political and legal factors undermining enforcement of property rights and contracts (World Bank, 2008, 2003 and 2002).

Some African States like DRC are weak as evidenced by lack of strong institutions to foster exchange and property rights together with lack of capacity to implement policies efficiently. Besides these weaknesses, some of the States also fail to provide both soft and hard public goods like communication infrastructure, feeder roads and access to information that shape the institutional environments in which smallholder farmers need to operate (Pande and Udry, 2005). The problem is most significant in countries currently experiencing or have experienced conflicts that lead to displacement of populations and infrastructural breakdowns.

There are high transaction costs especially in service delivery to smallholders in the developing countries thereby stifling the supply and access to input and output markets, management and technical information (Dorward, Kydd and Poulton, 2005ab; Bardhan, 2001). The solutions to these problems in smallholder agriculture point towards nurturing farmer organizations (collective action) to allow smallholders and their service providers to realize economies of scale in service access and delivery (Peacock *et al.*, 2004). The arguments in favor of group approach to solving farmer problems forms the basis of this study on impact of farmer groups in disseminating technologies on productivity and economic welfare of smallholders in DRC.

2.3 Nature of Agriculture in South Kivu

According to CIALCA Baseline Survey Report (2007), the agricultural production system in South Kivu is entirely small scale. Despite the fact that agricultural mechanization forms the key to yielding high productivity and value addition, this area still relies on traditional agricultural system where mechanization is almost absent. This signals a glaring lack of

modern technology adoption which culminates into low returns for the small scale farmers in South Kivu. Indeed, the most striking feature is gender bias in agricultural enterprises where women are more involved in subsistence farming as compared to large scale production enterprises (Vandamme, 2008)**.** The role of agricultural input use has also been highlighted as major significant boost to small scale farmers in South Kivu. However, credit accessibility and utilization to the intended purpose has significantly deteriorated due to what is associated with moral hazardous behavior of smallholders whereby they use the cash credit for other unintended purposes (CIALCA, 2007).

In an attempt to increase productivity of crops such as cassava, beans, sweet potatoes, maize and bananas, the group system for credit access and farm management has been witnessed in South Kivu (Mastaki, 2006). This approach would upscale technology adoption since the smallholder farmers would be able to purchase inputs using the cash credit while at the same time benefit from the group trainings offered to them. The trainings mainly focus on integrated pest management practices and conservation agriculture which promotes integrated soil fertility management practices.

Approaches to technology dissemination

There are numerous approaches to technology dissemination. The popularity of these approaches is purely dependent on easy of adoption and sustainability. The reason is, the more sustainable an approach is, the more its ability to create wealth across the generations. Among the most common approaches is the Training and Visit (T&V) approach systems. The key aspect of this approach is its ability to put in more pressure toward participation of agricultural stakeholders and giving emphasis on "learners" (farmers) ability to acquire new skills and monitor the response of each and every technological dimension (Chirwa and Aggarwal, 2000). In order to incorporate the challenges experienced both at household and farm levels in driving agricultural productivity; a new group approach has been popular in the recent past. This system has been lauded to be the most effective in dealing with heterogeneous farmers who to a larger extent exhibit a complex behavioral response toward farm management (Chirwa and Aggarwal, 2000)

On the other hand, Action-Research approach has also been noted among the most responsive and dynamic approaches in agricultural production. The system enables a pure platform of communication between researchers and the farmers in understanding and analyzing the strategic agricultural issues in a practical manner. South Kivu has equally

embraced the Enhanced Rural Innovation (ERI) approach in its attempt to consolidate the gains in agriculture across the diverse groups. This approach has been fronted by CIAT research group; which argues that in order to capture the hidden challenges in rural development, there is need to place higher priority on research and extension. This approach augments other approaches by emphasizing adoption of appropriate productivity increasing technologies by smallholder farmers. Farmers are involved in development and selection of the best technologies therefore enhancing sustained utilization of the introduced crop varieties as well as other inputs.

Agricultural Technologies versus farmer groups' performance

The importance of agricultural technologies cannot be overemphasized since they contribute to increased productivity and consequently food security. South Kivu, given its agricultural potential especially in food crops has evolved from wide range of agricultural technologies. In order to embrace home-based production system, Integrated Pest Management (IPM) technology has been used tremendously in this region (Lunze, 2000). Additionally; uses of modern pest control methods have been adopted in order to confront the recent strain of crop pests and diseases. Murhula (2004) argues that attempts to increase crop productivity in South Kivu needs to be coupled by progressive technologies. As a result therefore, new varieties of Cassava, beans and maize among other cereals have been adopted with an aim of improving productivity. According to CIALCA report (2007), the sole medium to introduce and sustain these technologies is through farmer groups. It is envisaged that through this system, farmers' ability to borrow (groups forming the major collateral) and management funds are adequate since incidences of default are reduced.

2.4 Theoretical background

2.4.1 NIE and the concept of collective action

Collective Action concept is developed under the NIE theory based on institutional approach to societal problems where farmers form groups with collective interests and decide to act to achieve them (Ostron, 1965; Runge, 1984; North, 1990; Clague, 1997).The collective action through groups can be instituted through coordinated activities across individual farms like Integrated Pest Management (IPM) and moving from on-farm technologies to those that operate at larger spatial scales (Ruth *et al.*, 2004). The groups members can act individually or through an organization.

Voluntary collectivization of interests of community members also affects resource management and agricultural production systems in interaction with other factors like risk, labor, wealth, information and marketing. Social capital together with collective action among community members facilitate access to information and allow farmers to participate in technology development. It also provides access to credit, with social bonds anchored on trust, providing collateral (Owuor, 2008 and Owuor *et al.,* 2004 and Owuor, 2002).

The reciprocity arrangements, social capital and collective action offer ways to overcome labor shortage especially for farm activities that require intense labor effort in concentrated periods and are also interdependent with property rights which reinforces collective action among group members (Meinzen-Dick *et al.,* 2001).

New Institution economics explains how institutions change to influence individual performance (North, 1990 and Ostron, 1990) and by seeking to determine the impact of group interventions in crop enterprises on productivity, this study takes the role of institutional approach to solving problem of low productivity.

Several collective action based researches have been undertaken in the past. For example: Nelson *et al.,*(2004) analyzed collective action as an investment theory in the United States ; Paxton *et al.,*(2000) employed collective action in the analysis of success of group loan repayment behavior in Burkina Faso; Owuor (2008) used it in analyzing effect of groups on credit access and productivity in Kenya; Meinzen-Dick *et al.,* (2001), in the analysis of the role of collective action in natural resource management and Shiferaw *et al.,*(2008) in evaluating role of collective action forged between institutions and rural market imperfections in Kenya.

Studies on impacts of collective action in farmer groups in crop enterprises on productivity and welfare of smallholders in Sub Saharan Africa are limited particularly in the DRC, the study area.

In view of the above literature, it is evident that despite the fact that collective action is an integral component of ways to improving agricultural productivity, limited information exist on its contribution in disseminating technologies within farmer groups to influence productivity and household welfare.

The basis of this study therefore was on the effect of groups through theories that combine social capital and collective action to access information, production technologies and markets to maximize household welfare. Given that farm households are both producers and consumers, maximization of their welfare implies gaining through both producer and

consumer surpluses. Based on this, the theoretical model within which farm households would maximize both their consumption and production hinge on agricultural household model as exemplified by Strauss (1986a) within the utility maximization framework.

The maximization of producer and consumer surpluses as an effort to improve economic welfare over time can be appropriately analyzed using economic surplus model which is instrumental in evaluating the impact of interventions among households over time.

2.4.2 Theoretical Model

Agricultural production in South Kivu is predominantly subsistence with limited commercialization. The agricultural households therefore combine two units of microeconomic analysis- the firm and the household. The household is both a consumer and a producer thus integrating production and consumption decisions is the appropriate approach to modeling economic behavior of agricultural households.

There is multiplicity of relationship between production and consumption activities of households. This study used utility theory within the agricultural household model (Singh, Squire and Strauss, 1986) to analyze impact of farmer groups in crop enterprises on productivity and welfare of smallholders. Household commodity consumption and labor supply decisions are based on the maximum earnings realized from profit maximizing production. A recursive model with profit and utility maximizing components forms the framework for analysis of household production and consumption behavior, which becomes tractable in empirical analyses (Strauss, 1986b).

In any production cycle, the household is assumed to maximize utility over a set of consumption variables: generated on-farm (X_a); market purchased goods (X_m) and leisure (X_l).The utility maximized is dependent on the household preferences that is also influenced by household characteristics(R_{hh}) like member's composition, subject to consumption (cash and time constraints) and production constraints.

The utility function is:

Max U = $U(X_a, X_m, X, R_{hh},)$ ……Equation 1

Subject to:

i) Cash constraint: $p_m X_m = p_a (Q_a - X_a) - p,(L - F) - p,V + Z$ ……Equation 2

ii) Time constraint: $X_l + F = T$ ……Equation 3

iii) Output constraint: $Q_a = Q(L,V \setminus A,K)$……Equation 4

Where T is total stock of household time; L is total labor input; F is household labour input so that L – F, if positive is hired labour, otherwise off-farm labour; p_m and p_a are prices of market purchased goods (X_m) and staple (X_a) respectively; Q_a is a vector of staple production such that $Q_a - X_a$ is the vector of marketable surplus; p_l is the wage; V is the vector of variable input (For example pesticides and fertilizers); c is a vector of variable input's market price; Z refers to any nonfarm and non-labor incomes such as remittances and transfers; A is fixed acreage of land while K is fixed stock of capital.

The underlying assumptions are that: household labour and hired labour are perfectly substitutable; labour is valued at market wage; producers are price takers and all the prices (p_a, p_v, p_l, p_m) are not affected by actions of the household. These are the assumptions of a perfect (ideal) market (Varian, 2006).

Equation 2 implies that the household requires a cash of $pmXm$ to buy what it does not produce and the cash is obtained from the marketable surplus, $pa\ (Q_a - Xa)$. The income is used to pay for the market purchased goods consumed ($pmXm$), hired labor (p_vV) and the material inputs $p_l\ (L - F)$. Any deficits can be met by the remittances and transfers (Z).

The time constraint in the third equation indicates the total time allocated among farm production, off-farm employment and leisure while equation 4 (production technology) indicates relationship between output and input. Agricultural innovations enter the production constrained household function indirectly through new technologies such as new input saving and high yielding crop varieties.

By substituting production constraint into income constraint for Q_a and time constraint into cash constraint for F, the consumption and production constraints collapse into a single constraint in equation 5.

$pmXm + paXa + p_lX_l = p_tT + \pi + Z$ ……Equation 5

Where π (farm profits) = $pa\ Q_a(L,V \setminus A,K) - p_lL - p_vV$ .The right hand side of equation 5 refers to the value of full income associated with profit maximizing behavior of the household (Becker, 1965) which is denotable as 'y' to yield equation 6.

$y = pmXm + paXa + p_lX_l$ ……Equation 6

The farm household maximizes net farm income conditional on expenditure and technology constraints and then allocates the income (remittances and transfers included) among the consumption commodities. This is possible with the assumption of a perfect market to enable separability of farm production and consumption decisions. Input and output

markets are however imperfect and producers (households) are not canonically price takers thus the right hand side of equation 6 can be reduced into output influencing factors like farm characteristics (R_f), household characteristics (R_{hh}), market characteristics (R_{mk}) and technology characteristics(R_t) outlined in equation 7.

$S = f(R_{hh}, R_t, R_f, R_{mk})$ ……....…Equation 7

New technologies influence output of the household and by extension productivity. The effects of new technologies disseminated through farmer groups on productivity and welfare is best evaluated via the economic surplus model. To capture factors that influenced economic gains, the model was estimated by Ordinary Least Squares routine that has been used in measuring economic gains in several impact studies.

2.4.3 Conceptual framework

In figure 1, farmer characteristics include level of education, age and gender that influence the farm management practices.

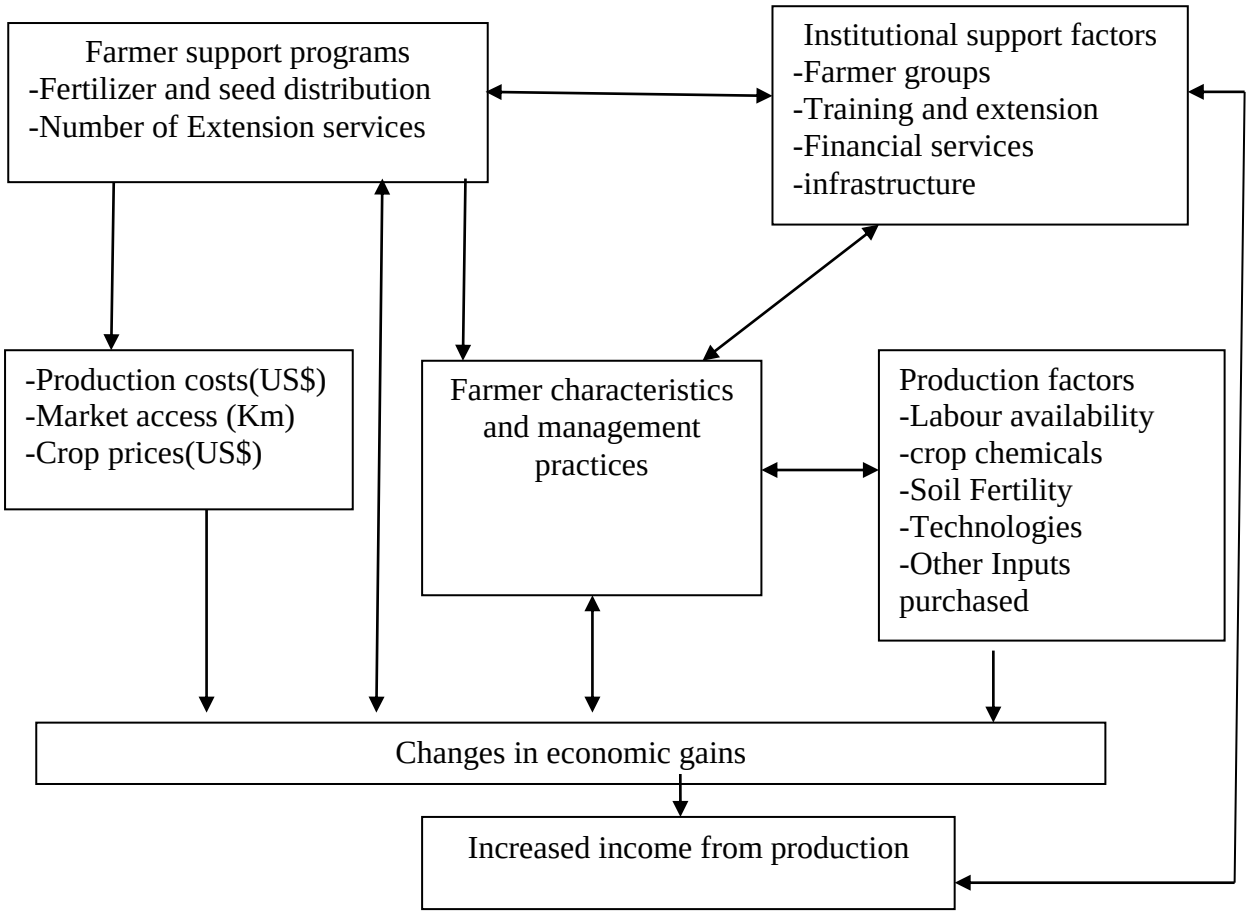

Figure 1: Conceptual Framework for the relationship between Intervention Linkages and productivity in crop enterprises.

Source: Own conceptualization, 2010.

It includes the decisions to use new technologies, purchase fertilizers, hire labour or use crop chemicals which influence productivity of crop enterprises. The management practices are also influenced by institutional factors like participation in farmer organizations where farmers are trained on the use of new technologies, crop varieties, ways to access financial services, input and output markets. The farmer support programmes in extension and seed distribution are carried out by research institutions and development partners particularly in DRC through the farmer groups. This influences production cost, market access and yield prices which in turn influences economic gains by smallholder farmers thereby increasing their incomes. The money income is used to improve the welfare of the farming households through the production and consumption activities.

2.3.4 The Empirical model

The main thrust of this impact study was to compare a situation before the intervention against the alternative situation after the intervention by using the concepts of supply, demand and equilibrium in transforming agronomic data on economic values. Supply represents producers' production values while demand represents consumers' consumption values whose interactions result in equilibrium quantity and price.

Production levels are dependent on a range and level of inputs used such as: land, labor, seeds, fertilizers and chemicals, each having a cost to the producer. The relationship between production cost and yield levels is depicted in equation 8 and that between purchase price and quantity consumed is illustrated in equation 9.

$p_d = a_d + b_d Q_s$……Equation 8

$p_s = a_s + b_s Q_s$……..Equation 9

Where (b_s) and (b_d) are slopes of supply and demand curves respectively; a_s and a_d are intercepts of the curves; p_s is the price of quantity supplied and pd is the price of quantity demanded; Q_s is the quantity supplied while Q_d, quantity demanded.

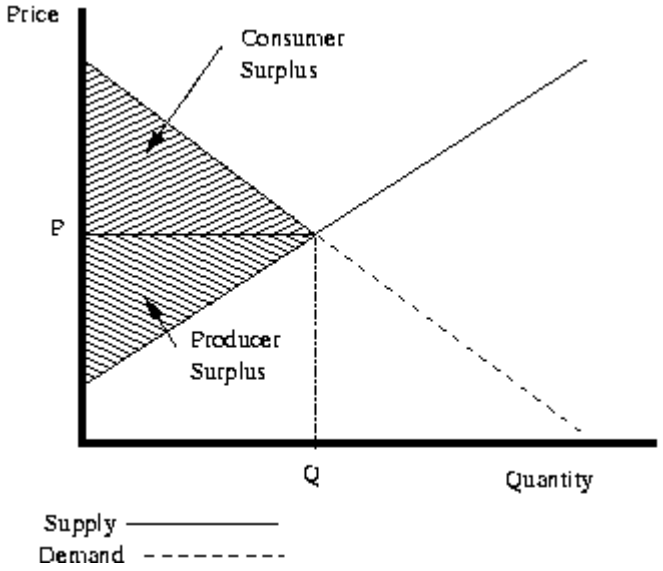

Figure 2:Equilibrium and Economic surplus

The consumer surplus shows up above the price and below the demand curve, since the consumer is paying less for the item than the maximum that they would pay. The producer surplus shows up below the price and above the supply curve, since that is the minimum that a producer can produce that quantity with.

The impact of innovation (new technology) on economic surplus

Any change in economic surplus is a measure of social gains derived from new innovation. Figure 3 below shows the area representing social gain in an ex- post impact assessment.

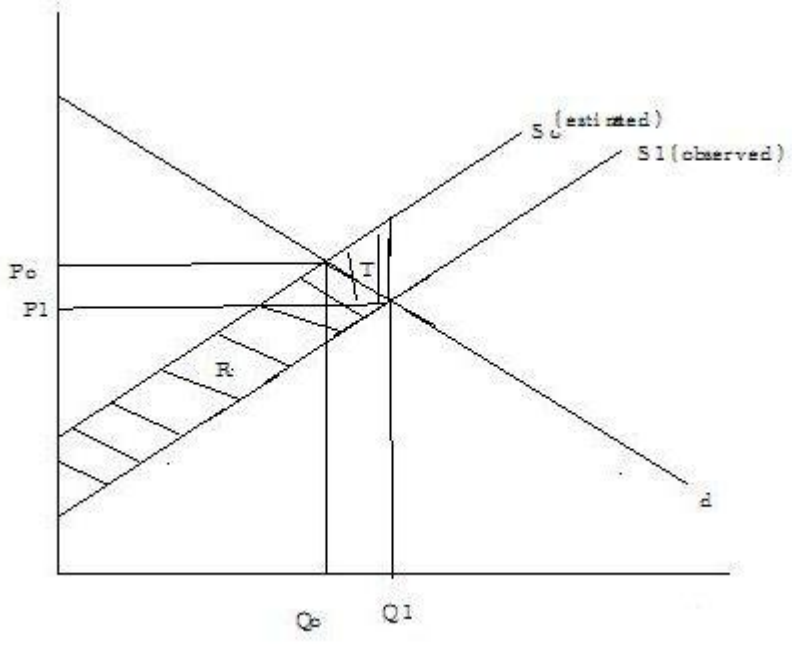

Figure 3: Effect of technology on supply

Area R represents the social gain due to reduction in production costs at the observed level of production (Q^1) and area T represents a correction for the change in quantity caused by the new technology (adjustment for change in quantity associated with price change). The height of R is measured in terms of money per unit of output since effects of group interventions are measured in terms of productivity, for example, increased crop yield per ha. Figure 4 shows a combination of data on input changes (vertical shift) and output changes (horizontal shift) to obtain a new shift.

The distance K (see figure 4) represented cost reduction in production (net gain) – the height of area R in figure 3.A new technology raises output for a given set of inputs by quantity J (in kg), a product of yield gain per ha and are planted with the new technology(in ha). However the new technology requires investment in new inputs like hybrid seeds and chemicals therefore I represented adoption costs ($/kg) per hectare divided by average yield (in Kg/ha).

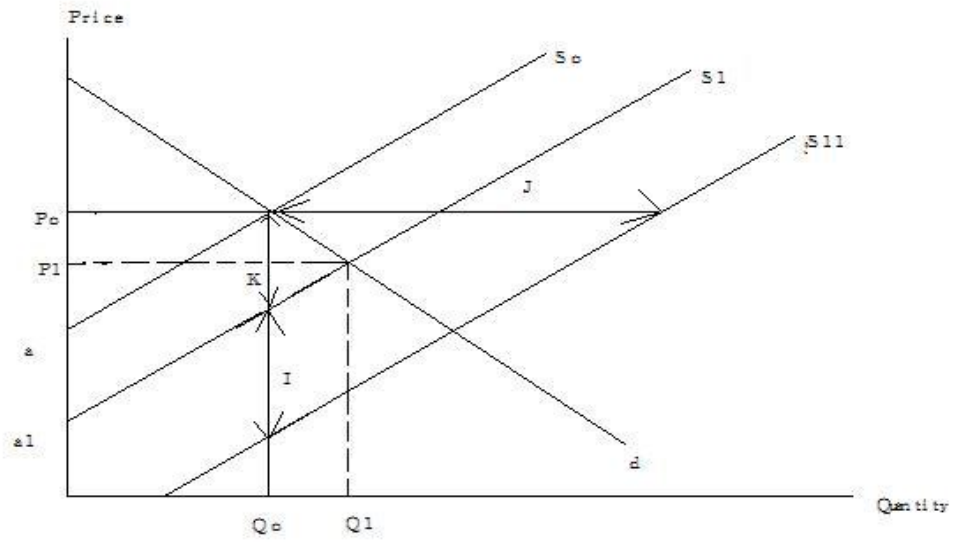

Figure 4:Diagrammatic representations of I, J and K parameters

Since parameters J, I, K and ΔQ are not directly observable, they were estimated using the formulas outlined in the subsequent equations.

$J = \Delta Y * t * A$ .....……...…….…..…...Equation 10

In equation 10, ΔY(kg/ha) was the yield increases resulting from adoption of the new technology, t was the proportion of total area under new technology (adoption rate) and A

was the total area in crop in hectares and J was measured in proportional terms (j) as the increase in quantity produced as a share of total quantity.

$j = (\Delta Y * t)/Y$……..……Equation 11

$c\ (\text{production cost}) = (\Delta Y * t)/(Y * p)$.....Equation 12

$I = \Delta C * t/Y$……..……...Equation 13

Where: ΔC was the adoption cost changes; per unit area switched to the new technology; t was the adoption rate in terms of area and Y is the average yield thus equation 13 estimated adoption cost, the parameter I.

$K = [J * b_s] - I$……..Equation 14

The supply elasticity was substituted for the slope b_s in equation 14 since it was independent of measurement units in equation 15.

$K = [Jp/\in Q] - 1$...……...……...Equation 15

The value of parameter K estimated the supply shifts and in proportional terms,

k = K/p= (j/e) – c. When$K < j - c$, a situation in which it is relatively easy to expand production, the social gains from the new technology will have a low economic value.

Ex post impact assessment like this study, in which actual survey was done, is more reliable than ex ante assessment which rely on trials and extrapolations. Besides economic surplus method for impact assessment, programming method aimed at identifying one or more optimal technologies could have been adopted. However this study did not intend to only compare the technologies in terms of their productivity but also economic welfare changes arising from their adoption thus programming methods were not appropriate. Econometric approach through the productivity model or Cobb Douglas production frontier model could have also been used in determining the changes in productivity due to the changes in the input levels but this would not capture the changes in economic welfare of the smallholders. The economic surplus model was therefore adopted to analyze changes in both productivity and economic welfare resulting from adoption of the disseminated new technologies and complemented by descriptive analyses between the two categories of smallholder farmers outlined in this study.

CHAPTER THREE

METHODOLOGY

3.1 Study area

South Kivu (SK) Province borders the provinces of Nord-Kivu to the north, Maniema to the west, and Katanga to the south. To the east it borders the countries of Rwanda, Burundi, and Tanzania. In official DRC categorization, the Province has one city, Bukavu with territories like Baraka, Fizi, Kabare, Katana, Kaziba, Lemera, Mwenga, Nundu, Nyangezi, Shabunda, Uvira and Walungu. SK Province has experienced civil strife that displaced the population, the immediate one ended in 2003 (the second Congo war).The study covered three territories namely Kabare, Walungu (Ngweshe) and Mwenga and their respective sub territories (referred to as groupments) as indicated in table 1.

Table 1 Tabular representation of territories and groupments under study in SK Province.

TERRITORIES	GROUPMENTS
Kabare	Bugorhe
	Mudaka
Mwenga	Mushinga
	Burhinyi
Ngweshe	Nyangezi
	Kamanyola

The highlands of the region are densely populated area with up to 300 persons per square kilometer in some rural areas (Mühlenberg et al., 1995). The population comprises 83% of farmers with mean household acreage of 0.8 hectares (ha), 58% of them are below the mean and a paltry 10% having up to 1.5ha (Murhula, 2004). Annual decline in productivity has been estimated at 0.98% while low annual increment in agricultural production is estimated at 2% compared to the population growth rate of 3.3% (Vandamme, 2008 and Mastaki, 2006)

Most farmers have limited access to improved crop varieties of major crops like maize, cassava, sweet potatoes, bananas and common beans. The decline in productivity has also been partly attributed to reduction in soil fertility and high levels of soil erosion such that an estimate of 80 kg/ha of nitrogen, Phosphorus and Potassium nutrients are lost annually

(Kasereka, 2003).There is shortage of animal manure from reduction in livestock holdings (Lunze, 2000), that could be used as organic fertilizer. Family manpower has reduced following the emigration of active men and women to urban centers in search of alternative opportunities and internal displacement in conflict areas (Cirimwami and Mashika, 1999).

Limited institutional support has been offered to farmers since independence in 1960 in terms of information, supply and credit regarding fertilizers. Transaction costs cover 53% of the costs of which 15% is State levies and 38% is cost of other service providers, much of which is spent in transport (Mastaki, 2006). Currently, collective efforts are being made to link farmers to input and output markets by government, CIAT and other stake holders such as Plateform-DioBass, an NGO.

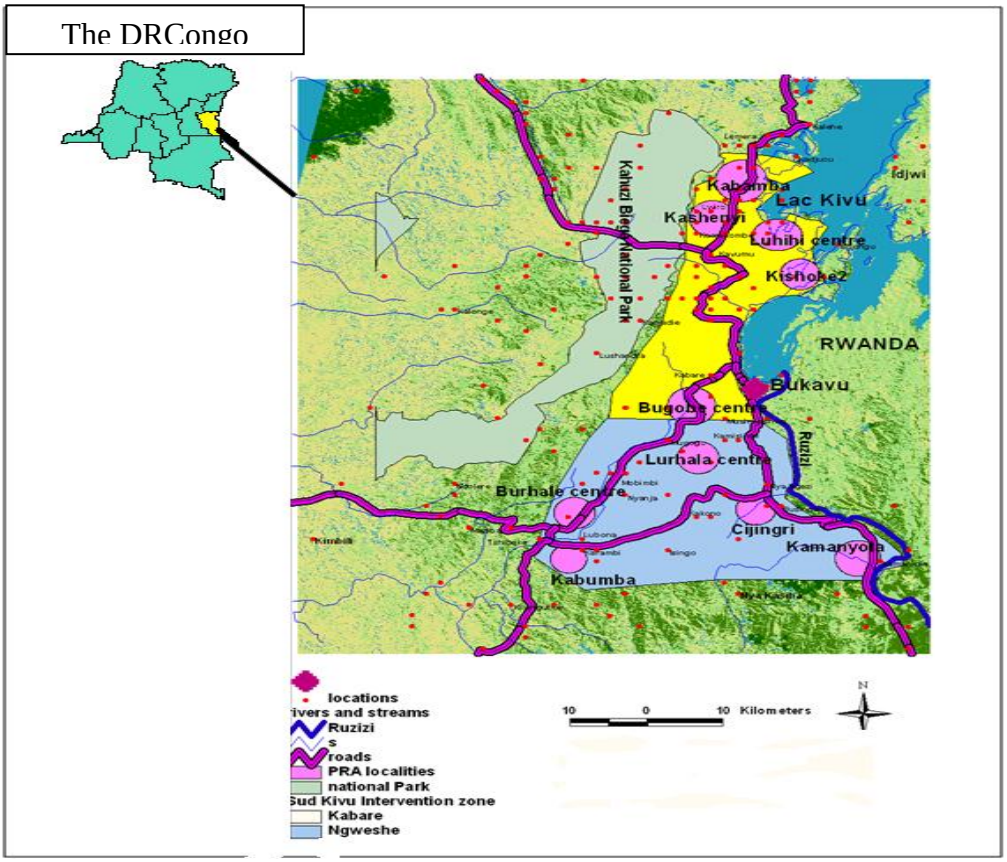

Figure 5: Map of South Kivu province, DRC.

Source: adopted from CIALCA GIS Database (2006).

3.2 Sampling design and techniques

All the smallholders in South Kivu territories constituted the sampling frame. Multi-stage sampling technique was used to arrive at a sample of 360 smallholders. The territories were purposively selected and the six groupments formed the strata. The chance of being a member or non member of a group was therefore equal in all the groupments. The groupments were used as sampling points for the farmer groups, with an average of 10 groups per groupment, making a total of 60 groups.

In determining sample size, proportionate to size sampling methodology was used as developed by Groebner and Shanon (2005) and Poate and Daplyn (1995):

$n = z^2pq/ e^2$

Where:

n = sample size

P = proportion of the population of interest

q = 1-P (the weighting variable)

z = standard variate at confidence level (α = 0.05)

e = margin of error.

The area under the normal curve corresponding to 95% confidence interval is 1.96 (z value in the statistical tables). Using a p value of 0.5 and acceptable error of 8.95%, a sample size of 120 smallholders was obtained. This was replicated in each territory.

Table 2: Sampling procedure for group and non-group members

Stage	List used	Sampling method	Sample size
One	Regions	Purposive sampling	Three
Two	Farmer groups	Stratified proportionate sampling	Sixty
Three	Households	Random sampling within groups	Ten

3.3 Data collection method

This study used primary data that was collected using structured interview schedules.

3.4 Model Specification and Statistical Analysis

3.4.1 Comparative statistics

Comparative statistics was used in the mean comparisons of input use, value of production (productivity) and economic gains between group members and non group members in 2007 and 2009 (objective 1) and to determine the changes in institutional linkages resulting from the group interventions (objective 2).

3.4.2 Economic Surplus model

Economic surplus model was used estimate economic gains (objective 4) from crop production as developed by Masters *et al.,* (1996). This is a proxy measure of economic welfare changes over time resulting from the group interventions. Equation 16 below was the formula for estimating economic gains:

$$\mathrm{EG(Economic\ Gains)} = \mathrm{KQ} - \mathrm{K}\Delta\mathrm{Q} \quad \text{.....Equation 16}$$

Where Q is the observed quantity produced; K being the vertical shift in supply and ΔQ ($Q^1 - Q_o$) is change in quantity due to the new innovation(expressed in equation 17).

$$\Delta\mathrm{Q} = \in e\mathrm{K}\left(\frac{\mathrm{Q}^2}{\mathrm{p}^2}\right)/[(e + \in) * (\mathrm{Q/p})] \quad \text{.....Equation 17}$$

Where ΔQ is the equilibrium; *e* is the demand elasticity; p is the produce price and ϵ is the supply elasticity. The values chosen for the elasticity has less influence on the results of the analysis than the other parameters therefore *e* and ϵ are assumed to be zero (0) and one (1) respectively. This results in the canceling out of the ΔQ term in the formula for Social Gains thereby reducing to equation 18.

$$EG = kpQ \quad \text{.....Equation 18}$$

Economic gains were the measure of economic welfare of the smallholders.

3.4.3 Ordinary Least Squares regression

In determination of the factors that influenced the economic gains, Ordinary Least Squares regression was used whereby the explaining variable was economic gain while the explanatory variables were the changes in the institutional factors and production factors.

The variables selected explained the changes in the dependent variable (economic gain) thus used in the censored OLS regression that was specified as:

$$Econgain = \beta_0 + \beta_1 Pchange + \beta_2 GMchange + \beta_3 creditchange + \beta_4 TLRchange + \beta_5 EXTchange + \beta_6 REMchange + \beta_7 OFFINchange + \beta_8 OFFIT\ change + \beta_9 Pricechange + \beta_{10} GRPmem + \varepsilon \quad \text{.....Equation 19}$$

Where:

Pchange= changes in production resulting from the intervention

GMchange-change in the number of group meetings attended

Creditchange=change in farm credit offered in cash to the smallholders

TLRchange= change in frequency of listening to radio farmer programmes

Extctchange = changes in number of extension contacts in equation 12

ε = is the error term which is independently and normally distributed with zero mean and constant variance (Greene, 2003).

REMchange= change in amounts of remittances

OFFINchange= change in off-farm income

OFFITchange= change in time spent in off-farm activities

Pricechange= change in produce prices

GRPmem= change in group membership

CHAPTER FOUR

RESULTS AND DISCUSSIONS

INTRODUCTION

This chapter presents a discussion of results on: the general household profile; the differences in factor use (production and institutional support factors) between the group and non-group farmers before and after the interventions; the value of production across the territories; difference in economic gains between the group and non-group farmers and finally the determinants of the economic gains. Before the interventions (2007), only inorganic fertilizer use (planting and top dressing fertilizers) was significantly different between group and non-group farmers. However, after the intervention the difference persisted although with an increase in use of fertilizers among group farmers and a decrease among independent farmers. There was significant difference in economic gains and value of production between the two groups of farmers, with the group farmers having a greater magnitude of the latter variables than independent farmers. The changes in the use of production factors (credit and off-farm income) and institutional factor (radio farmer programmes and group membership) significantly influenced economic gains by smallholder farmers of South Kivu province.

General Characteristics of Households in the Regions

The overall mean age of the household head was 45 years. The mean number of schooling years of the household heads was 5 years implying that most household heads did not go beyond primary school level. The average number of children per household was 6 (see appendix 3) with the lowest number observed in Mudaka (5). Of the sampled household heads, women and men constituted 47 % and 53 % respectively (see appendix 4). Higher proportions of women were noted in Burhinyi (73%) and Mushinga while lower proportions of women were observed in Bugorhe at 27%.

Farm income constituted a major source of income for farm households and was supplemented by off farm incomes. The mean farm value of production ranged from USD 182 in Mudaka to 1132 in Nyangezi in 2007 (see appendix 5). While in 2009 it ranged from USD 205 for Bugorhe to USD 1092 for Kamanyola. The variation in value of production was greater between the six regions assessed with the two regions in the northern axis (Bugorhe and Mudaka) reporting relatively lower values. The regions in the south west (Nyangezi and Kamanyola reported higher production values. The variation in production valuesin 2009 was lower than in 2007. However, the mean value of production was lower in 2009 relative to

2007. Other than Mudaka and Kamanyola, all regions recorded decreased production values. The harvest for 2009 long rain season was expected the following year, which explained the consistently lower values of production.

The average expenditure on agriculture in 2007 ranged between USD 21 to USD 67(see Appendix 6). The mean expenditure in 2009 was USD 59, an amount higher than that expended in 2007. With regard to non-agricultural expenditure, expenditure in 2007 was relatively higher than in 2009. Wealth status of households was computed by estimating the monetary value of various assets owned by the households in 2007 and in 2009. During the 2007 period, the mean wealth level of the households was USD 209 (appendix 7). In the regions, the averages ranged from a mean low of USD 100 in Nyangezi to a mean high of USD 308 in Mushinga. In the year 2009, the mean wealth level was USD 247, an increase of about 20%. The lowest mean wealth level was realized in Mudaka and the highest in Nyangezi. Mushinga and Burhinyi show declines in wealth levels while the rest of the regions show increases in wealth levels

Fertilizers included planting fertilizer and top dress fertilizer that farm households used in their production activities. Their costs were computed for each crop enterprise that the household applied the fertilizer per year. Organic fertilizers were also evaluated for their usage by the households. Organic fertilizers include farm yard manure and compost manure. The table below presents the findings on fertilizer use in the regions and over the two year period (see appendix 8). In the earlier period of 2007, the mean quantity of inorganic fertilizer used by the households was 115 kg. The amounts varied from USD 6 in Kamanyola to 196 kg in Mushinga in 2007 (appendix 8). For the current period, the mean value of fertilizer used was 122 kg, ranging from USD 10 in Kamanyola to 183 kg in Nyangezi. This shows an increase in the use of fertilizer used between the two periods except for Mudaka and Mushinga which showed declines.

With regard to organic manure, the average quantities of the manure used in 2007 were 1400 kg. Once more Kamayola had the lowest use of the organic manure whereas Bugorhe had the highest usage at about 4.6 tons. In 2009, there was an increase in the organic manure used in the regions to about 1.9 tons. Higher usage was reported in Bugorhe and Mudaka. Market access was captured by distance and time to various facilities such as major roads, markets or urban centers. With regard to input markets, the mean distance to the nearest market for inputs was 9.5 km (see appendix 9). This ranged from 1.2 km for Bugorhe to a high of 15km for Nyangezi.. The average time to reach the input markets ranged from a low of 17 minutes in Mushinga to a high of 48 minutes.

4.1 Factor use among group and non-group farmers.

The 2007 results in Table 3 showed that there was significant difference in factors use between group and non-group members. The first five factors were production factors while the rest were institutional factors. Significant difference in factors use was noted in the use of fertilizers where the p-value was 0.001 and t-value was -2.719. The results indicated that non-group members used more fertilizer at 112kg/ha compared to the group members used 19kg/ha on average. The non-group members similarly used more top dressing fertilizer than group members at 109kg/ha compared to the group members who used a paltry 3kg/ha (at 0.001 p-value and t-value of-3.945). The group members however used more organic manure at 1847kg/ha compared to 910kg/ha by non group members. This could be attributed to the availability and affordability of the organic manure compared to the inorganic fertilizer by the poor farmers who dominated the groups.

The non-group members were observed to have had more extension contacts, an institutional factor (five times a month) than group members who had three contacts per month on average. The non group farmers attended farmer meetings only twice in a month and this could be linked to their sizable resource endowment that they afforded new technologies thus did not value the meetings. There were however no significant differences in the use of other factors such as new varieties, credit, group meetings among both group and non group members.

Table 3.Mean comparisons for 2007 between group and non-groups on factor use

Variable	Group	Nongroup	T	P
Production factors				
total planting fertilizer earlier period	19.1601	111.7379	-2.719	0.001
total top dress fertilizer earlier	2.4913	109.3409	-3.945	0.001
organic manure earlier period	1847.251	909.4731	2.203	0.001
number of new varieties in 2007	1.6667	1.7308	-0.067	0.947
technology received in 2007	1.713	2.1441	-0.37	0.712
Institutional support factors				
number of times attended training 2007	2.77	5.37	-2.269	0.024
number of extension contacts in 2007	2.3956	5.8377	-2.246	0.026
number of times listened to agric programs on radio 2007	5.2303	6.5349	-0.495	0.621
number of farmer group meetings attended in 2007	7.9322	5.5948	1.183	0.238
borrowed funds in 2007	0.3904	4.1681	-1.333	0.184
Value of production	716.11	752.84	-0.100	0.241

The 2009 results in Table 4 indicated that there were differences between group and non group farmers in terms of the use of fertilizer, number of new technologies adopted and number of farmer group meetings attended (p=0.001).

Table 4.Mean comparisons for 2009 between group and non-group farmers on factors use

Variable	Group	nongroup	t	P
Production factors				
total planting fertilizer current period	40.8514	141.3683	-1.875	0.063
top dress fertilizer current period	9.9317	107.2436	-3.58	0.001
Organic manure current period	18063.95	797.0665	1.041	0.001
number of new varieties in 2009	9.1311	4.7069	-1.112	0.271
technology received in 2009	4.7952	1.1333	1.715	0.088
Institutional support factors				
number of times attended training in 2009	3.9265	3.9005	0.02	0.984
number of extension contacts in 2009	5.1346	2.7029	1.466	0.144
number of times listened to agric programs on radio in 2009	7.5913	5.3377	0.778	0.437
number of farmer group meetings attended in 2009	8.0995	2.6532	5.463	0.001
borrowed funds in 2009	29.0986	28.4679	0.026	0.98
Value of production	798.28	272.14	3.502	0.001
Economic gains	50.20	14.02	1.710	0.001

The non group members on average used more planting fertilizer at 141kg/ha compared to 41kg/ha used by group members. Similarly, non-group members significantly used more top-dressing fertilizer at 107kg/ha compared to 10kg/ha by group members (p=0.001). Organic manure was however used more by group member at18064kg/ha compared to 797kg/ha used by non-group members on average, a situation also replicated in the earlier period (2007). This was the case because interventions in the project areas encouraged farmers especially those in the farmer groups to use organic manure for sustainable soil fertility management. Besides organic manure, other soil fertility management practices included terracing to mitigate soil erosion and mixed cropping was encouraged by the intervention through farmer groups. The significant difference in the use of organic fertilizer and subsequent increase from the earlier period (2007) is validated by the fact that the group members significantly attended more meetings compared to non group farmers and possibly learnt about these practices and embraced them. This relates to the issue of affordability and access to the inorganic fertilizers. The resource poor farmers could possibly not afford the inorganic

fertilizers (top dressing and planting fertilizers) thus used the organic manure available in their farm yards.

The group members adopted more technologies (five) than non-group members who adopted one technology on average. The group members could have had more knowledge on the existing new technologies through the group meetings they attended to discuss their experiences from implementing the technologies thereby increasing the adoption level among group farmers compared to the independent farmers.

The differences in the use of production and institutional factors influenced in the significant difference in the value of production between the group (US$792) and non group farmers (272) at p=0.001 and also the economic gains by the smallholder farmers. The economic gains were established to be greater among the group farmers ($50) than the independent farmers ($14) This could have resulted from the increase in the use of fertilizers, organic manure, new varieties and technologies among group farmers compared to the non-group farmers who heavily relied on inorganic fertilizers thereby increasing the value of production among group farmers. These results are similar to the study by Ochieng (2010) that observed that access to extension services, membership to farmer groups and off farm income influenced the adoption of full package of chicken management interventions to achieve higher flock productivity.

4.2 Value of production across Territories

The results in table 5 reveal that there was increase in the value of production (output in monetary terms) used as a measure of productivity across the three territories. Ngweshe experienced significantly greater productivity increase (45%) compared to Kabare (15%) and Mwenga (11%). From the study, it was also observed that there was active group participation in Ngweshe especially by women compared to the other two territories and this could have contributed to the variation in productivity.

Table 5 Mean of value of production in Kabare, Ngweshe and Mwenga

Territory	Mean(2007)	Mean (2009)	% change
Kabare	257.2106	296.1476	15%
Ngweshe	751.0494	1089.2697	45%
Mwenga	570.3954	632.8186	11%
Total	550.1583	730.6082	33%

4.3 Comparison of factor use within group and non group farmers in 2007 and 2009 production years.

Results in table 6 show that on average, the group members increased their borrowings by US$ 29 compared to US$ 24 by non-group members. From figures 6 and 7, majority of borrowers obtained credit from commercial banks (46.49%) and Cooperatives (41.34%) before the intervention. This situation was however reversed in 2009 where the farmers reduced their borrowings from commercial banks (to 20.89%) and began to source credit from other sources that included friends (53.93%), neighbours (7.49%), money lenders (4.79%) and NGOs. This could have been occasioned by the stringent lending regulations imposed by the commercial banks and cooperatives and the risk of default faced by farmers.

In the case of lending by MFIs, Cooperatives and commercial banks, the result could be because these financial institutions preferred group lending to individual lending as a way of overcoming moral hazardous behavior of default in repayment among borrowers. This also aimed at minimizing fungibility of funds meant for agricultural investment to improve productivity. The group members could also have been more informed about availability of funds through the farmer training programs as well as the monthly group meetings and the agricultural programs on radio.

The number of new varieties adopted increased among both group and non-group members in 2009 (means of 9 and 5 respectively) compared to 2 in 2007. The number of new technologies adopted and extension contacts however only increased among group members and decreased among non-group members. This could be because the latter group reduced their frequency of extension contacts, trainings on agricultural practices and also the times listened to agricultural programs on radio in 2009 compared to 2007. The group members also gain confidence in adopting technologies demonstrated on their experimental plots.

Table 6. Within group and within nongroup differences in factor use in before and after intervention

	Within Group		Within Non-group	
Variable	Change	Direction of change	change	Direction of change
Production factors				
Planting fertilizer	22	+ve	30	+ve
Top dressing fertilizer	8	+ve	-2.1	-ve
Organic manure	909.47	+ve	112.4	+ve
New varieties	7	+ve	0.3	+ve
Technologies	3	+ve	1	+ve
Institutional support factors				
Farmer training	1	+ve	1.5	+ve
Number of extension contacts	3	+ve	3.14	+ve
Number of times listened to Radio programs per month	3	+ve	1.2	+ve
Group meetings attended per month	0.2	+ve	2.95	+ve
Credit	28.71	+ve	24.3	+ve

4.4 Socio Economic Factors Hypothesized to Influence Economic Gains

This section presents the priori assumptions and results on changes in both production and institutional factor changes that influence economic gain. It seeks to partially address the 3rd objective which was to determine economic gain by discussing the factors that influenced the gains, with an aim of directing policy intervention to increase productivity among smallholder farmers in Congo, DRC. Finally the section ends with interpretation and discussion of the Ordinary Least Squares estimates of the hypothesized factors.

Priori assumptions of factors that influence economic gains.

The study hypothesized that changes in production, number of group meetings attended, amount of credit, frequency of listening to radio programmes, number of extension contacts, number of farmer trainings attended, and amount of remittances, off farm income, prices and time spent in off farm activities were most influential in determining economic gains among the smallholder farmers.

The increase in production and by extension, productivity could increase the value of production in monetary terms thereby increasing the gains. The increase in the number of group meetings attended, extension contacts, farmer trainings, group membership and frequency of listening to radio programmes would increase access to information necessary for the farmers to access input and output markets as well as improving the agricultural practices. This could promote sound crop husbandry thus increasing productivity and consequently increase the economic gains (social gains). The remittances and off farm incomes realized by the farming households were hypothesized to augment their net income that could be invested in agricultural and non agricultural activities therefore resulting in economic gains. Credit from commercial banks, cooperatives, MFIs, NGOs, input stores, SHGs, money lenders, friends and neighbours was also assumed to influence positively the yields through input purchases and investment in off-farm enterprises to generate incomes thus increasing economic gains.

4.5 Factors that influenced economic gains of smallholder farmers in South Kivu, DRC.

The economic surplus model was used in the analysis of economic gain that was hypothesized to be positively influenced by increase in productivity (value of production) after the intervention. This involved the computation of total farm and nonfarm income, the summation then subsequent difference of which constituted economic gains. Economic gain (dependent variable) was hypothesized to be influenced by the changes in explanatory variables like: yield, price, extension contacts, remittances, number of group meetings attended, and number of times listened to agricultural radio programs, group membership and time spent in off farm activities in censored Ordinary Least Squares regression (OLS).

The model indicated a Durbin Watson value of 2.367 and f-value of 5.367 which was significant at 0.001%. The Durbin Wu test for serial autocorrelation validated the model as fit since the calculated value of 2.367>2. The correlation coefficients were observed to have values less than 0.8 thereby confirming that there was no multicollinearity between the explanatory variables. The R^2 value of 55% meant that 55% changes in economic gain was explained by the changes in the explanatory variables at $p<0.05$.

Credit, Off -farm income and Economic Gains

Credit and economic gains

From the results in table7, credit change was observed to be counterintuitive ($p<0.05$). This however could have resulted from high fungibility of the credit borrowed by the farmers for

agricultural investment. Majority of borrowers could possibly have used the funds for consumption and non-farm investment as also observed by Owuor (2008) the higher the amounts borrowed, the higher the fungibility rate. This was common given the nature of agricultural production in South Kivu province that was characterized by high risk of crop failure, erratic rainfall, low productivity and market risks due to poor infrastructure that increase transaction costs.

Table 7. Regression results for factors that influenced Economic Gains.

Model	**Std Error**	**Beta**	**T**	**sig**
(Constant)	0.417	0.347	0.287	0.776
Production change	0.052	0.015	0.152	0.88
Change in number of group meetings	4.213	0.086	0.804	0.426
Total credit change	0.091	-0.42	-4.17	0.001
Change in frequency of listening to radio farmer programmes	0.807	0.430	0.036	0.001
Change in number of extension contacts	1.576	-0.03	-0.33	0.743
Change in number of trainings attended	1.393	0.006	0.055	0.957
Change in remittances received	1.783	0.02	0.198	0.844
Change in off-farm income	0.178	0.561	5.593	0.001
Change in time spent in off farm activity	0.525	0.08	0.81	0.002
Change in average yield prices	0.555	0.022	0.219	0.828
Change in group membership	0.10	0.136	0.274	0.001
R^2	0.545			
Adjusted R^2	0.449			
F change	5.637			
Sig F change	0.001			
Durbin Watson	2.367			

Off-farm income and Economic Gains

Off farm income also had a significant impact on economic gains ($p<0.05$) as reflected in the changes observed. The households depended greatly on off farm income and this could be related to the credit use. The amounts borrowed for agricultural investment however could have been invested in non-farm engagements that generated more income to the households. Conversely, the off farm income generated could have been reinvested in agricultural

enterprises through purchase of inputs to increase productivity and consequently economic gains among the smallholder farmers.

Farmer Radio Programmes and Economic Gains

From the results in table 7, it was observed that the changes in the number of times farmers listened to the radio programmes had a positive and significant influence on economic gains (p=0.001 and t= -4.152). There are various common media used to transmit agricultural information to farmers in South Kivu Province. The media mainly comprise leaflets, magazines, pamphlets, newspapers, radio and television but radio was the main channel of communication because of its affordability, timeliness and capability of disseminating information to farmers within a wide geographical area. Given the poor state of infrastructure in Congo for example the road network and electricity, radio had the potential of being used as the medium of communication since topography, time, road network and distance could not hinder dissemination of information. Besides, Nwuzor (2000) also observed that radio programmes had an advantage of being done anywhere through the use of compact disks and tapes using local languages therefore illiteracy is not an impediment.

The radio farmer programmes enhance the extent of adoption of improved agricultural technologies like fertilizer application in cassava + beans + maize intercrop, weeding, planting of early season crops, modern land preparation and pest control in the food crop farms. Farmers also become knowledgeable on markets particularly the prevailing prices through the radio programmes. All the information given to farmers assists them in increasing their enterprises' productivity, value of production and consequently this translates to economic gains. Nevertheless, the adoption of the technologies were generally low as indicated in tables 3, 4 and 5 although productivity increased among group and non group farmers. Table 6 results reaffirm this situation as changes in new technologies adopted did not significantly influence economic gains. The result is similar to that of study by Agwu *et al.,* 2008 which observed that adoption of the improved agricultural technologies were generally low in Nigeria despite the use of radio farmer programmes particularly in Enugu State. They identified the possible major constraints to this as: the short duration of programmes and their appropriate scheduling, irrelevant questions asked and feedback from the presenters. A study in DRC on radio farmer programmes however has not been done.

CHAPTER FIVE

CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusions

In this study, economic surplus model was used to determine the economic gains by smallholder farmers from crop production and a comparison of the gains done between group farmers versus that of non-group farmers, and there was significant difference. Economic gains were positively influenced by productivity and in the analysis; productivity was higher among group farmers than the non-group farmers. The adoption of new varieties and other technologies was also higher for group farmers than non-group farmers and this influenced economic gains as well as the radio farmer programmes and group membership. The latter factors facilitated adoption of productivity increasing technologies especially among group farmers as also found in similar studies in Africa. The use of inorganic fertilizers however remained minimal largely due to unavailability and high prices.

. There has been widespread notion that farm credit in cash has positive influence on farm income by increasing farm input purchases thereby increasing productivity and incomes. This study however negated this notion since economic gain had a negative relationship with farm credit while off-farm income had a positive influence on economic gains. A plausible reason for this is fungibility of credit where farmers invested the farm credit in off-farm ventures to generate more off-farm income reinvested in agricultural activities to increase economic gains. Based on these findings, farmer groups appear to be influential in the dissemination of agricultural technologies that increase crop productivity thereby increasing incomes of smallholder farmers.

5.2 Policy implications

With respect to the results on input use levels and productivity, the Congolese Government needs to increase awareness on good agricultural practices that increase productivity and economic gains of smallholder farmers. This could be done by developing well functioning input and output markets as well as making the inputs available and affordable to farmers. The adoption of new technologies (inorganic fertilizers, crop varieties, pesticides) was observed to be low therefore there is need to focus on capacity building

approach as the best way in future projects to enhance problem solving capacities of farmers. The application of new technologies is one of the sure means of increasing productivity in subsistence farming where production factors are scarce. It has been established in most cases that adoption decision is strongly influenced by availability of credit, level of income and extension services therefore attempts to upscale activities that promote them is underscored.

Regarding information access through farmer radio programmes, there is need to allocate more air time to the programmes so as to improve the adoption of new agricultural technologies. The promising information access strategy revolves around vigorous promotional activities via radio and should be carried out by interested NGOs, development partners and research institutions and other stakeholders to encourage the formation of farmers' radio listening groups across the groupments. This is to allow for timely flow of information on good agricultural practices that improve productivity and economic welfare of smallholder farmers. There is also the need to support local organizations that can effectively offer extension services to farmers.

Time spent on off-farm activities influenced economic gain of the smallholder farmers through off-farm income realized. The smallholder farmers spent more time in off-farm activities like running small business enterprises to augment their income. The development partners should also initiate programs that promote the development of micro enterprises so that the smallholders realize more income which in turn could be reinvested in agriculture to increase productivity and enhance economic gains. The positive significant influence of off-farm income on economic gain could only be substituted if future interventions incorporate more income generating activities along with the technology package to enable the resource poor farmers afford improved technologies whose adoption seemed low.

Membership to farmers' organization was observed to have a positive significant influence on economic gain. It should be encouraged among smallholders in order to boost productivity and incomes as observed in the mean differences in these variables between group and non-group farmers.

In line with the regression results, more credit needed to be availed to the farmers to increase economic gains. This could be done through innovative ways to enable the resource poor farmers access cash credit for example credit in kind (input provision) given the risk averse nature of smallholder farmers. The financial institutions should however issue more cash credit in kind to reduce fungibility of the funds and this could be in form of material inputs necessary to increase agricultural productivity.

5.3 Suggestions for Further Research

The study focused on farm level productivity and economic gains from the interventions. It would however be important to evaluate the factors that influence group formation and socio-economic factors that influence adoption of new innovations by farmers on DR Congo. Agricultural policies in DRC have not been updated since 1974 therefore this would help in policy formulation aimed at up scaling technology uptake to increase agricultural productivity. There is also need to research on the nature and content of radio farmer programmes, their relevance and acceptability by the farmers to find ways of improving them.

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APPENDICES

APPENDIX ONE: INTERVIEW SCHEDULE

This survey is on the impact of farmer groups on crop enterprise productivity and welfare of smallholder farmers in South Kivu territories, DRC .It is carried out entirely for academic purposes as a requirement for the award of a Masters degree in Agricultural Economics. I will ask you questions related to you and your farm to gather general information on farming activities in South Kivu . Your responses are therefore valued and participation is voluntary. May I begin?

Section A: General Information

1. Date of interview_____
2. Name of enumerator_____
3. Name of supervisor_____
4. Territory_____
5. Groupment_____
6. Location _____
7. Name of Household head: first_____
8. Gender of household head_____
9. Name of the major decision maker (if different from household head_____
10. GPS of homestead: latitude (N/S)_____ longitude (W/E)_____ (in decimal degrees)
11. Altitude_____(meters above sea level)

SECTION B : Household profile before the interventions

	Relation to Head	Name	Age	Gender	Resident 0-No 1-Yes	Education (yrs)	% of time Working on farm	% of time Working	Wages Per Period In US $	period	Type work if any
1	Respondent										
2	Head										
3	Spouse										
4	Sibling:1										
5	2										
6	3										
7	4										
	5										
	6										
	Relatives: 1										
	2										
	3										
8	4										
	Relatives: 1										
	2										
	3										

Type of work: 1. Casual in Agriculture, 2. Casual in non agricultural activity 3. Permanent in agriculture 4. Permanent in non agric activity

SECTION B : Current Household profile after the interventions

	Relation to Head	Name	Age	Gender	Resident 0-No 1-Yes	Education (yrs)	% of time Working on farm	% of time Working	Wages Per Period In US $	period	Type work if any
1	Respondent										
2	Head										
3	Spouse										
4	Sibling:1										
5	2										
6	3										
7	4										
	5										
	6										
	Relatives: 1										
	2										
	3										
8	4										
	Relatives: 1										

	2										
	3										

Type of work: 1. Casual in Agriculture, 2. Casual in non agricultural activity 3. Permanent in agriculture 4. Permanent in non agricultural activity

Structure of land/business structure ownership (acres)

Total size		Tenure system (acres)			
		Owned	Rented in	Rented out	Communal
Acres	**Years ago**				
	Current				

Earlier Land use long rains

Enterprise(crop/livestock)	acres	Seeds/ feeds /fodder in kg used	Insecticides Crops US $	Vet drugs Value US $	planting (kg) & type	top dressing (kg) & type	FYM	Compost	Family labour hours	Hired labour hours	Production in litres/kg	Value per unit	Production in US $

Current Land use long rains

Enterprise(crop/livestock)	acres	Seeds/ feeds /fodder in kg used	Insecticides Crops US $	Vet drugs Value US $	planting (kg) & type	top dressing (kg) & type	FYM	Compost	Family labour hours	Hired labour hours	Production in litres/kg	Value per unit	Production in US $

Earlier average Land use in the short rains

Enterprise	acres	Seeds/ feeds /fodder in kg used	Insecticides Crops US $	Vet drugs Value US $	Planting fertilizer (kg) & type	top dressing fertiliser (kg) & type	FYM	Compost	Family labour hours	Hired labour hours	Production in litres/kg	Value per unit	Production in US $

Current average Land use in the short rains

Enterprise	acres	Seeds/ feeds /fodder in kg used	Insecticides Crops US $	Vet drugs Value US $	Planting fertiliser (kg) & type	top dressing fertiliser (kg) & type	FYM	Compost fertiliser	Family labour hours	Hired labour hours	Production in litres/kg	Value per unit	Production in US $

Earlier off-farm activities

Enterprise Name	No employees	Value of purchased daily	Value of sales daily	Employee pay daily	Rental expenses	Family labour hours	Permanent labour hours	Temporary labour hours	Leisure time in hours	

Current Off –farm Activities

Enterprise Name	No employees	Value of purchased daily	Value of sales daily	Employee pay daily	Rental expenses	Family labour hours	Permanent labour hours	Temporary labour hours	Leisure time in hours	

Average Annual Household Income sources

	Earlier Income		Current Income	
Type of earning	Amount	Time period in days	Amount	Time period in days
Employment income				
Income from business				
Income from farm produce sales (milk, crop produce)				
Income from sale of livestock and other assets eg land, vehicle				
Transfer earnings from relatives, sons, daughters etc				
Value of gifts				
Land rented out income				
Buildings rented out income				
Other structures rented out income				

Motor vehicle rented out income				
Other income				

Average Annual Expenditures

Category	Earlier Expenditure		Current Expenditure	
	Amount	Time period in days	Amount	Time period in days
Expenditure on fertilizer				
Expenditure on seeds				
Expenditure on livestock feeds				
Expenditure on veterinary drugs / services				
Expenditure on crop chemicals				
Expenditure on labour				
Expenditure on School fees				
Expenditure on Foods				
Expenditure on clothing				
Expenditure on rental				
Expenditure on Health				
Expenditure on Transport & fuel				
Expenditure on entertainment				
Expenditure on gifts, weddings ets				

Asset endowments (numbers)

	Earlier Asset Endowments		Current Asset Endowments	
Asset	Number	Value per unit	Number	Value per Unit
Oxen				
Dairy Cattle				
Other Cattle				
Donkeys				
Camels				
Goats				
Sheep				
Pigs				
Paultry				
Carts				
Vehicle				
Tractors				
Plough				
Wheel barrows				
Hoes/Jembes				
Pangas/Slashers				
TV				
Radio				
Bicycles				
Computer				
Furniture				
Other assets				

Access to market

		Km Tramarc road		Km Earth road	
		Earlier time	Current time	Earlier time	Current time
Input market	Nearest				
	Most important (urban)				
Output market	Nearest				
	Most important (urban)				

SECTION B: INSTITUTIONAL SUPPORT

1. Have attended farmer training school (y/n) ___ Number of days in the past : _____ Number of times current _____
2. Number extension contacts in the past _____Number current _____
3. Number of times per month you listen to agricultural programs on the radio in the past_____ number of times current_____
4. Frequency of attendance to farmer group meetings in the past----------, Current ____
5. Credit Access (Yes-1, No-0)___ in the Past_____Access Current _____
6. a) Borrowed (Yes-1, No-0) in the past time _____Borrowed Cuurent_____
7. If yes, source Earlier times

		borrowed 0-No 1-Yes	Credit type Money – 1 In kind-2	Amt Season one (US $)	Amount Season two (US $)	Total annual amount (US $)	If from SHG was group linked to MFI (0-No, 1-Yes)	If linked which MFI	Collateral guarantee? 1.Savings with group 2. Savings with MFI 1. Asset 2. Orher (specify)	If SHG, Current Money value in US $	If SHG Current assets

Formal	Commercial banks										
Semi-formal	AFC										
	Cooperatives										
	Micro-Finance institution										
	NGO project										
	Other										
Informal	Input-store										
	Self-help Groups										
	Moneylender										
	Neighbors										
	Friends										
	Family										
	Other										

8. If yes, source Current times

		borrowed 0-No 1-Yes	Credit type Money – 1 In kind-2	Amt Seasoon one (US $)	Amount Season two (US $)	Total annual amount (US $)	If from SHG was group linked to MFI (0-No, 1-Yes)	If linked which MFI	Collateral guarantee? 1.Savings with group 2. Savings with MFI 3. Asset 4. Orher (specify)	If SHG, Current Money value in US $	If SHG Current assets

Formal	Commercial banks										
Semi-formal	AFC										
	Cooperatives										
	Micro-Finance institution										
	NGO project										
	Other										
Informal	Input-store										
	Self-help Groups										
	Money lender										
	Neighbors										
	Friends										
	Family										
	Other										

For Group or community based organizations ONLY

	Earlier	**Current**
Number of group/CBO engaged in		
Number of members		
What orientation (farm based, based)		
Year formed		
Assets owned currently.		
Meetings per month		
Savings per month		
Collateral for loans		
Is group indigenous (0-No, 1-Yes)		
Is group (ROSCA, ASCRA, Or Savings and Credit only)		
Group linked (0-No, 1-Yes)		
If yes with which institution		
Linked on what? (credit, training, input supply etc)		

List enterprises that the group/CBO is engaged in :

Enterprises Earlier		Enterprises Current	
Crops	Livestock	Crops	Livestock
1.			
2.			
3.			
4.			
5.			
6.			

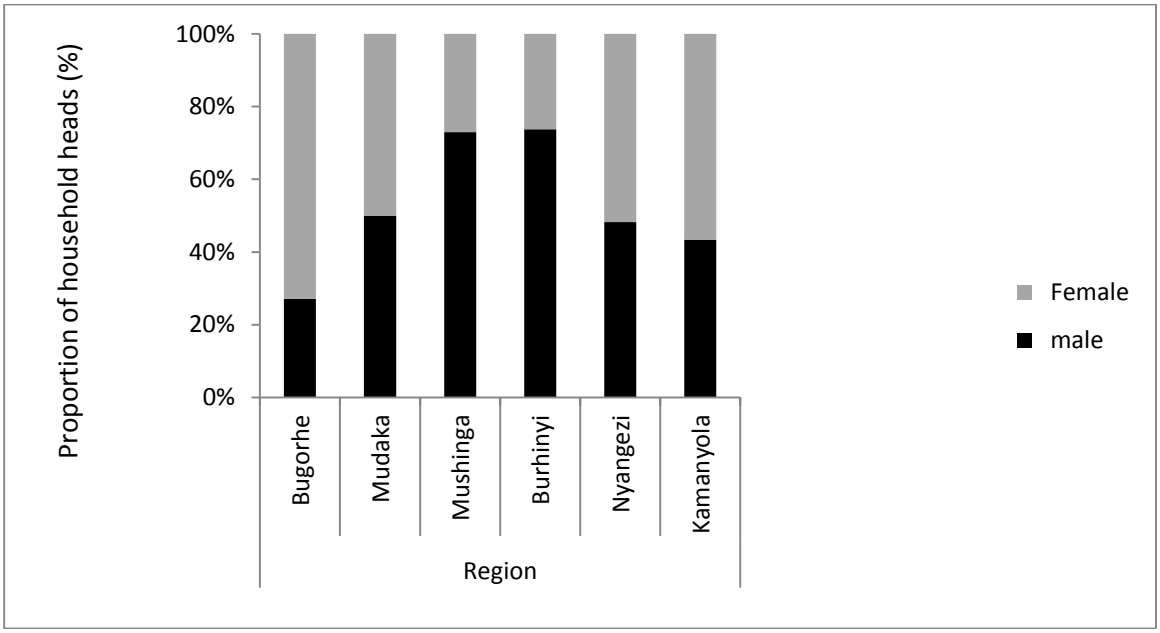
APPENDIX TWO : DESCRIPTIVE STATISTICS (2009)

Variable	Mean	Minimum	Maximum	Std. Deviation
Age of household head	46.6797	24	100.00	18.69656
Percentage of time working on farm by head of household	45.1656	.00	100.00	39.44762
Gender of household head	1.4688	1.00	2.00	.49973
number of children	5.5653	.00	18.00	2.89143
business income 2009	19.5966	.00	936.00	77.59860
income from sales of farm produce 2007	38.7443	.00	2432.80	215.94910
income from livestock and other asset sales 2009	14.6469	.00	2881.00	157.46356
transfers from relations in 2009	4.2636	.00	200.00	19.81230
expenditure on seeds in 2009	11.7775	.00	240.00	26.98300
average expenditure on fertilizer 2009	9.4884	.00	250.00	31.99535
expenditure on crop chemicals 2009	6.4067	.00	400.00	33.61474
expenditure on labor 2009	22.9870	.00	1500.00	122.49508
expenditure on veterinary drugs 2009	4.9397	.00	300.00	23.04671
value of other assets	3.5921	.00	183.00	17.19578
distance to nearest input market 2009	9.3764	.00	1000.00	57.69537

APPENDIX 3 Age of household head, education level and number of children

Region	Age of respondent, yrs	Educational level, years of schooling	Number of children
Bugorhe	45.7	3.6	5.7
Mudaka	48.7	4.7	4.9
Mushinga	49.1	5.6	5.4
Burhinyi	44.0	4.2	5.8
Nyangezi	43.9	5.5	5.7
Kamanyola	39.6	4.8	6.0

APPENDIX 4 Gender distribution among the sampled respondents



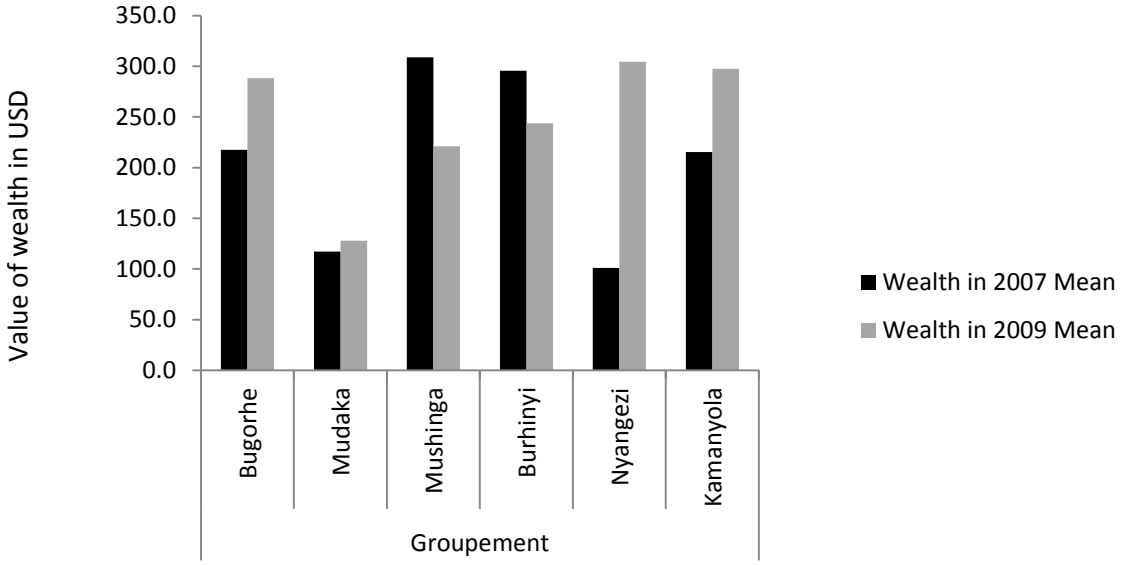
APPENDIX 5. Value of production and off farm income for households

	Total value of farm production in 2007		Total value of farm production in 2009		Off farm income in 2009	
Region	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean
Bugorhe	375.4	109.2	205.1	32.3	20.3	8.5
Mudaka	182.7	23.6	284.8	64.0	6.7	3.1
Mushinga	852.9	352.0	531.6	115.5	99.0	17.3
Burhinyi	860.4	268.8	787.8	294.3	138.3	31.3
Nyangezi	1132.7	762.2	445.7	107.7	41.0	10.1
Kamanyola	1000.4	263.2	1092.0	347.4	29.6	7.5

APPENDIX 6. Mean agricultural and non agricultural expenditure by households

	Agricultural expenditure in 2007		Agricultural expenditure in 2009		Non agricultural expenditure		Non agricultural expenditure in 2009	
Region	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean
Bugorhe	42.7	10.6	46.4	10.8	253.8	49.8	223.1	51.3
Mudaka	46.3	8.9	57.0	9.9	229.6	26.2	168.4	27.7
Mushinga	66.8	28.0	115.9	35.8	195.9	23.6	111.9	22.6
Burhinyi	21.2	4.3	42.3	7.3	341.2	71.6	186.7	59.3
Nyangezi	28.2	9.2	37.5	10.4	128.6	21.4	140.5	21.1
Kamanyola	31.3	12.6	59.7	26.1	129.0	18.3	165.0	16.8

APPENDIX 7 Household wealth in the regions



APPENDIX 8. Inorganic and organic fertilizer usage in the regions

	Inorganic fertilizer earlier period		Inorganic fertilizer current period		organic manure earlier period		Organic manure current period	
Groupement	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean	Mean	Standard Error of Mean
Bugorhe	85.2	28.6	103.0	51.9	2355.0	532.3	5636.0	1634.9
Mudaka	120.8	80.1	66.3	33.3	4678.1	976.3	4423.9	1329.8
Mushinga	196.2	50.9	170.5	44.5	297.2	43.7	324.4	50.1
Burhinyi	133.3	37.5	176.2	79.7	643.3	295.2	546.3	270.6
Nyangezi	131.5	85.4	183.3	113.5	118.4	43.9	70.7	25.9
Kamanyola	6.2	3.4	10.7	4.7	5.3	3.2	10.2	5.1

APPENDIX 9. Distance and time to nearest input market

	distance to nearest input market 2009		time to nearest input market 2009	
Groupment	Mean	Standard Error of Mean	Mean	Standard Error of Mean
Bugorhe	0.7	0.3	38.9	5.9
Mudaka	5.3	3.1	47.4	8.0
Mushinga	4.3	0.8	11.1	2.5
Burhinyi	24.5	16.8	24.9	5.6
Nyangezi	19.0	5.9	49.6	8.8
Kamanyola	2.4	0.6	20.8	2.7