EFFECT OF CROP INTENSIFICATION PROGRAME: ANALYSIS OF ITS CONTRIBUTION TO INPUT USE AND EXTENSION SERVICES IN NYAGATARE DISTRICT, RWANDA

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Effect of Crop Intensification Programe: Analysis of its Contribution to Input Use and Extension Services in Nyagatare District, Rwanda

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DECLARATION

This Thesis is my original work and has not been presented for a degree in any other University.

Signature …….. Date ……..

Eugene Rwibasira

This thesis has been submitted for examination with our approval as the university supervisors

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Signature …….. Date ……..

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DEDICATION

This work is dedicated to my wife Mrs**.** Elizabeth Dusabe, my children Aggrey, Richard, Alex, Alice, Alan, Aline as all those that contributed to my studies.

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It is also with high pleasure to express my gratitude to different lecturers especially those of the school of Agriculture and Applied economics. I address my gratitude to class mates for their incomparable encouragement during this work. I would like to express my gratitude to Nyagatare District authorities and farmers for their crucial support in data collection without them this work would not be accomplished. Last but not least, I owe much gratitude to my classmates, siblings and all those of the same intake for their cooperation and support during and before of the thesis.

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LIST OF ACRONYMS

ASWG:	Agriculture sector working group
AFAAS:	African Forum for Agricultural Advisory Services
CAADP:	Comprehensive Africa Agricultural Development Program
CIP:	Crop Intensification program
EDPRS:	Economic development for poverty reduction strategy
EWs:	Extension workers
FAO:	Food agriculture organization
GDP:	Growth domestic product
IFDC:	International fertilizer development center
LUC:	Land use consolidation
MDGs:	Millennium Development Goals
MINAGRI:	Ministry of agriculture
MINECOM:	Ministry of commerce and trade
MINALOC:	Ministry of local government
N &K:	Nitrogen and Potassium
NGO:	Non-Governmental Organization

NPK:	Nitrogen, phosphorous and potassium
OPV:	Open Pollinated Varieties
PSTA:	Strategic plan for agriculture transformation
RAB:	Rwanda Agricultural Board.
RDO:	Rwanda Development Organization
REMA:	Rwanda environment management authority
RSSP:	Rural Sector Support Program
SPSS:	Statistical Package for Social Sciences

DEFINITION OF KEY TERMS

Agricultural Inputs: These are known as the factors of production. For producing agricultural products, a large number of inputs are needed such as: Seeds, Fertilizers, pesticides and Agro- implements because these products are widely used in the agricultural sector.

Agro dealers: These are typical agents in is a rural or urban shop engaged in agri -business skills, product knowledge, safe handling and use of modern technology in order to stimulate the commercialization of agricultural inputs, seed production and networks for distribution and marketing.

Cooperatives: A cooperative is an enterprise in which individuals voluntarily organize to provide themselves and others with goods and services via democratic control and for mutually shared benefit. Members generally contribute to, and control via a democratic process, the cooperative's capital. Moreover, cooperatives often provide education and training to their members.

Crop intensification program (CIP): The CIP program was initiated in September 2007 by the government of Rwanda to increase the agricultural productivity of high potential food crops and to provide Rwanda with greater food security and self-sufficiency. The CIP focuses on six priority crops namely maize, wheat, rice, Irish potato, beans and cassava. Under this program, the farmers synchronize the cultivation of

crops in lands that are consolidated and rearranged to form larger and more rational holdings. Farm inputs such as improved seeds and fertilizers were imported and distributed to farmers through public-private partnerships, and extension services on the use of inputs and improved cultivation practices are rendered to farmers. As a result, the crop productivity has increased (MINAGRI, 2013).

Extension services: Agricultural extension is the application of scientific research and new knowledge to agricultural practices through farmer education. Birkhaeuser, Evenson, and Feder (1991) cited in (Davis et al., 2012) and Owens, Hoddinott, and Kinsey (2003) cited in (Sonne et al., 2016) and others have argued that agricultural extension represents a mechanism by which information on new technologies, better farming practices and better management can be transmitted to farmers.

Land consolidation (LC): it is a procedure of putting together small plots of land in order to manage the land and use it in an efficient manner so that the land may give more productivity. It is also referred as a planned readjustment and rearrangement of land parcels and their ownership. It is usually applied to form larger and more rational land holdings. Land consolidation can be used to improve the rural infrastructure and to implement the developmental and environmental policies (improving environmental sustainability and agriculture) and increase opportunities for land use and business.

Production: It is a process of combining various material inputs and immaterial inputs (plans, know-how) in order to make something for consumption (the output). It is the act of creating output, a good or service which has value and contributes to the utility of individuals.

Productivity: Is measure of the ratio of agricultural outputs to agricultural inputs. While individual products are usually measured by weight, their varying densities make measuring overall agricultural output difficult. Therefore, output is usually measured as the market value of final output, which excludes intermediate products such as corn feed used in the meat industry. Agricultural productivity may also be measured by what is termed total factor productivity (TFP). This method of calculating agricultural productivity compares an index of agricultural inputs to an index of outputs.

This measure of agricultural productivity was established to remedy the shortcomings of the partial measures of productivity; notably that it is often hard to identify the factors that cause them to change. Changes in TFP are usually attributed to technological improvements.

ABTRACT

The Crop Intensification Program (CIP) was initiated in September 2007 by the government of Rwanda to increase the agricultural productivity of high potential food crops, and to provide Rwanda with greater food security and self-sufficiency. This was to be through use of farm inputs such as improved seeds and fertilizers, land consolidation and extension services. 10 years after the introduction of CIP, maize productivity has remained at 3.2MT/Ha below targeted levels of 6MT/Ha, and application rates for fertilizers still remain at 38kg/ha/annum compared to the 2015 CIP targets of 50kg/ha/annum . The Objectives of the study was, to analyze the influence of CIP on use of improved maize seeds for enhanced maize production, to determine the influence of CIP on fertilizer usage for maize production in and to assess the influence of CIP on accessibility of extension services for increased maize production in Nyagatare District. The sample in the study included Adopters and Non-Adopters of CIP. The sample size was 164 respondents using Slovin Formula at 5% significance Level. It used qualitative approaches to generate the opinion of respondents and also quantitative methods where both primary and secondary data were used. Data analysis was performed by STATA version 13.0.Descriptive statistics like frequency, percentage, means and standard deviation were used. T-test statistics was used to compare means of variables. Probit model was used to indicate the effect of CIP on the targeted variables. Research findings revealed that access to improved seeds (Hybrid) influenced more than other independent variables (R-Square= 0.89) and use of fertilizers was the least variable that influenced CIP (R-Squared=0.70). The majority of respondents completed primary education (69%) while the median age for farmers was 40 years .The study recommends the public and private extensionists should ensure there are Farmer Field Schools established close to maize gardens ,that Government and Extension Agents sensitize farmers on use of fertilizers and to conduct sufficient training for farmers to adopt Good Agricultural Practices and make improved seeds accessible to farmers and to conduct their extension services beyond farms and across to the whole maize value chain.

Key words: *Crop Intensification program, Extension services, Land Use Consolidation, Production, Productivity, Probit model Agro-dealers, Agricultural inputs, Cooperatives, Rwanda*

CHAPTER ONE

INTRODUCTION

Introduction

This chapter focuses on the background of the study, statement of the problem, general objective, specific objectives, hypothesis, and justification of the study and limitations of the study.

1.1 Background to the study

As the Global population grows, there has been a corresponding increased demand for the agricultural products and space for habitation. This has remained a global concern whilst remedies and mitigation measures remained at their lowest. Worldwide, Crop Intensification or boosting productivity per unit area has been advocated as key strategy through which crop production can be improved under diminishing land sizes.

The global maize production trends show that although 68% of the global maize production area is in the developing world, only 48% of the world's maize is grown in developing countries ((Chapoto, Sabasi, & Asante-Addo, 2015)).This low average yield in the developing world is responsible for this gap between the global share of area under production and volumes produced. For example, the average maize yield in the developed countries is said to be on average around 8MT/Ha while it goes for 3MT/Ha in developing world. Disparities in climatic conditions and farming technologies account for this difference.

According to Zerihun, (2017) cited in (Bonan & Pagani, 2018), Crop Intensification Program (CIP) is key to addressing challenges in food production arising from diminishing size of arable land, expansion in urbanization and industrialization, tremendous increases in African population and gradual decrease in African population engaged in agriculture. From 2005 to 2008, average maize yields were estimated at

3.8T/Ha in Brazil, 3.1T/Ha in Mexico, 3.9T/Ha in Thailand, and 2.5T/Ha in Philippines compared to 1.4 T/Ha in Sub Saharan Africa. Yield variability is more pronounced in Sub Saharan Africa than the rest of the world. This poor crop productivity of crops in Sub Saharan Africa is partially attributed to limited research and prevalence of diverse environmental stresses that substantially affect the yields.

Like in other parts of the world, in 2007, Rwanda introduced the Crop Intensification Program aimed at boosting agricultural production of major staple crops in the country. Major emphasis was put on crops consumed by Rwandans in big quantities and affordable by many. It emphasized use of fertilizers, improved seeds, enhanced extension services, land consolidation, improving post-harvest management of produce and use of irrigation. This also came with the subsidy program to encourage adoption and use of inputs and services for farmers. However, overtime, the CIP targets were not met despite some increase in production and productivity. This study embarked on use of inputs and Extension services during CIP ignoring other variables for they are still at low levels of implementation and thus limited data to this effect.

In Rwanda, there is also a disconnect between the extension agents and researchers in which case, the disseminated materials by the extensionists are not research-based. In this regard, the extension materials used vary between extension agents and institutions and therefore the quality of disseminated materials vary. The example to this is when CIP was introduced in Rwanda, about 12 NGO were contracted to render the extension services in a bid to sensitize farmers on agronomical practices and market linkages in addition to capacity building aspects. RDO was one of them. However, apart from the deliverables and key performance indicators, there was no uniformity in the used models.

During the evaluation of PSTA II preparing for the PSTA III, the following were perceived as challenges to the extension systems in Rwanda. These included; lack of synergy and harmonization of different agricultural approaches and development initiatives, programs and/or plans at different levels; Lack of information sharing among

different actors in agricultural sector; lack of extension training, educational or information material for extension workers, farmers, local authorities and other actors, Lack of means of transport for extension workers (means of transport, GPS, veterinary Kits, Computers.....); Media which are not effectively and sufficiently used in agricultural extension information sharing/dissemination; Research confined in experimental stations and not sufficiently done in farmers' fields.

In Rwanda, to augment increase in productivity of maize, CIP imported improved seeds from neighboring countries in the region. In 2008, about 520MT of maize seeds were imported and the trend kept growing up to 1,417MT in 2010A (CIP, Report 2011). Under CIP, the use of improved seeds by farmers has improved rising from 3%in 2007 to 40% by 2011. Sufficient quantities of quality seed are a critical resource for agricultural development.

In Rwanda, there is strong public sector involvement in all seed sector components and further private sector involvement is needed.

There have already been significant achievements in regard to the legal framework concerning seeds, increased production, and the building up of basic infrastructure for reinforcing production and quality control. Under PSTA II, farmers received both high quality seed varieties and advisory services in seed and crop production (MINAGRI, 2013).

The study focuses on maize as it is the most staple crop consumed by many Rwandans especially in the study area. The aim of this study was to assess the extent the use of improved seeds, fertilizers and extension services influenced maize production in the context of CIP. The outcome of the study is to assess areas that need more efforts and others to be strengthened.

1.1.2. Overview of Crop Intensification in Rwanda

Crop Intensification Program (CIP) is a flagship program implemented by the Ministry of

Agriculture and Animal Resources since 2007 to attain the goal of achieving Agricultural productivity. It targets to attain this goal by significantly increasing production of the targeted food crops in the country. This is done through a multi-pronged approach that includes use of improved inputs fertilizers and seeds, consolidation of land use, rendering of extension services and improving Post Harvest handling and management. Six crops have been targeted here. They include; Maize, Wheat, Beans, Cassava, Irish potatoes and Rice.

The introduction of this policy amongst others saw the sector grow from 2% by 2007 to 7% by 2012 (MINAGRI, 2013). Since, the implementation of the Crop Intensification Program, there has been an increase in the use of inputs, including agrochemicals and improved seeds. With the introduction of CIP inputs were subsidized by 50% in the beginning which overtime has been scaled down to 25% to date. This has been in a bid to encourage the farmers to buy them in bigger volumes.

Nonetheless, some farmers have not been using the improved inputs due to perceived high prices and also preferring their traditional local seeds for their resistance to harsh conditions. Also even those who subscribe to CIP, use low volumes of both improved seeds and fertilizers. The Government also, through RAB hired the services of NGOs who offered the extension services. However, not all farmers have access to regular extension services. Since the inception of CIP, government has been importing both improved seeds and fertilizers from outside the country. Because of this, there has been times when they arrive late and for improved seeds, there has been cases of poor germination of the seeds. CIP has created so many microenterprises and small businesses in input distribution, processing and transport. Maize has emerged out as the most popular crop in terms of input use and extension services. It consumes more than 60% of the fertilizers and seeds distributed through CIP. This is because it is a predominant food crop consumed by almost all households in the country and especially in Nyagatare district which is one of the top producers of maize in the country. Because of CIP there has been increased maize

production in Rwanda.

1.2. Statement of the problem

Since the introduction of the CIP, inputs were subsidized at 50% and currently at 25%. However, ten years from the introduction of CIP, many farmers remain non-adopters of and non-users of fertilizers and improved seeds. Maize productivity has remained below targeted levels of 6MT/Ha, and application rates for fertilizers still remain below the CIP 2015 target. Compared to the developing countries average of 100kg/Ha/annum for application of fertilizers and 270kg/ha/year for industrialized countries, the national average for Rwanda is 38kg/ha/annum (Minagri report 2015) compared to the CIP targets of 50kg/ha/annum and below the target as contained in the Abuja Declaration on Fertilizer for an Agricultural Green Revolution of 50Kg/Ha.

Since 2007, there has been fluctuation in maize production. In 2008, maize production stood at 101,659MT and gradually grew to 667,833MT in 2013 and gradually dropped to 583,096 MT in 2015 and to 388,417 by 2017 *(FAO GIEWS Country brief on Rwanda 2018).* On the other hand fertilizer usage increased from 1.3kg/Ha/annum of arable land to 12.6kg/ha/annum in 2013 and dropped to 10.9kg/ha/annum in 2016.

During this period, there was a steady growth in the import bill for maize seeds from outside. In 2011, this stood at US$ 9,586,091 and steadily grew to US$21,804,807(Newtimes 20/7/2018). Also 34% of the farmers in the study area are none adopters of CIP in which case they use both local and improved varieties and some use fertilizes and others don't. The extension services are offered by several extension agents. Some are Civil Society organizations supported by the government or other development partners while in some instances, there are government extensionists based at sector level to support farmers. The extension materials include the Farmer Field Schools, extension messages and sharing of the agronomical practices with the farmers. In some instances, the extension goes along the value chain including linkages to markets and financial institutions. However, in some cases,

these interventions are disjointed between areas and farmers. Therefore increasing maize production and productivity in Nyagatare district in the context of increased adoption rates for fertilizer and improved seed usage as well as improved and coordinated extension services is very important.

1.3. Objectives of the study

1.3.1. General objective.

The overall objective of the study was to determine the effect of Crop Intensification Program (CIP) on maize production in Nyagatare District, Rwanda.

1.3.2. Specific objectives

1. To analyse the influence of CIP on use of improved maize seeds for enhanced maize production, in Nyagatare District
2. To determine the influence of CIP on fertilizer usage on maize production in Nyagatare District
3. To assess the influence of CIP on accessibility of extension services for increased maize production in Nyagatare District.

1.4. Research hypotheses

Ho_1: CIP does not have influence on use of improved seeds for enhanced maize production

Ho_2: CIP does not have influence on fertilizer usage for enhanced maize production

Ho_3: CIP does not have influence on accessibility of extension services for enhanced maize production

Alternative Hypothesis

H_1: CIP have influence on use of improved seeds for enhanced maize production

H_2: CIP have influence on fertilizer usage for enhanced maize production

H_3: CIP have influence on accessibility of extension services for enhanced maize production

1.5. Justification to the study

Better understanding of the contribution of crop intensification programe, will avail information that will greatly be used by extension workers, researchers, scientists and policy makers to further the promotion of CIP within the study area and beyond the confines of the study area. The identified parameters will assist proponents of CIP to know who to target for CIP adoption.The study will be important as it will help to evaluate the existing gaps in the planned activities and strategies to promote small holder farmers to participate in CIP.

1.6 Scope of the study

Nyagatare district is one of the districts of Eastern province producing Maize in large volumes. There are 24 Maize growing cooperatives composed of 2,799 farmers of whom 1,683 are men and 1,116 are women. However, due to financial hindrance and time limitations, this research did not cover the whole district. It was only limited to 24 cooperatives of farmers growing maize. The study covered a period of eight moths and coasted 2million Rwandan Francs.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter is comprised of theoretical literature review helped establish the already existing theories, conceptual frame work, review of empirical studies and critique of relevant literature

2.1. Theoretical framework

A theoretical framework here is used to limit the scope of the relevant data by focusing on specific variables and defining the specific viewpoint [framework] that the research used in analyzing and interpreting the data that was generated. It also facilitates the understanding of concepts and variables according to given definitions and builds new knowledge by validating or challenging theoretical assumptions. It specifies which key variables influences a phenomenon of interest and highlights how those key variables might differ and under what circumstances.

2.1.1. Theory of production

The study adopted the theory of farm Production and profitability. This part outlined the considerable detail the physical or technical relationships underlying the factor-product model. A production function was developed using tabular, graphical, and mathematical tools, with illustrations from agriculture. The law of diminishing marginal returns was introduced. Marginal and average physical product concepts will be developed. The rules of calculus for determining if a function is at a maximum or minimum was outlined, using a total physical product and marginal physical product concepts to illustrate the application.

Finally, the concept of an elasticity of production was introduced, and the elasticity of production was linked to the marginal and average product function. Consumer surplus is the monetary gain obtained by consumers because they are able to purchase a product for a price that is less than the highest price that they would be willing to pay. Producer surplus is the amount that producers benefit by selling at a market price that is higher than the least that they would be willing to sell for; this is roughly equal to profit demonstrated by (Weyl & Fabinger, 2013). Production theory is the study of production, or the economic process of converting inputs into outputs.

The profitability of production is the share of the real process result the owner has been able to keep to himself in the income distribution process. Profit is normally measured in money terms as gross financial revenue minus total financial cost per period. Production is the processes and methods employed to transform tangible factors/resources or inputs (raw materials; semi-finished goods; or subassemblies) and intangible inputs (ideas, information, knowledge) into goods and services or output defined by (Ntabakirabose, 2017).These resources can be organized into a farm or producing unit whose ultimate objectives may be profit maximization, output maximization, cost minimization or utility maximization or a combination

Certain parameters (Price taker and price maker) have to be known for one to understand how farmers make their decisions that enable them to attain their goals. This will enable a farmer to decide on what price to charge and to overcome the problems related to Food security, Profit maximization and finally Risk reduction. Although profit maximization is an important objective it is by no means the only one that motivates farmers. The basic theory of production is thus simply an application of constrained optimization. The farm-unit attempts either to minimize the cost of producing a given level of output or maximize the output attainable with a given level of costs indicated by (Oluwatayo, Sekumade, & Adesoji, 2008).

Cobb Douglas function has been used to estimate the relationship between inputs and outputs. Factor -Product relationship guides the producer in making the decision how

much to produce. This involves concept of the production function, average and marginal physical product, and various stages of production.

Relationships vary with crop variety, soil types, water quality, technologies; any given input-output relationship specifies the quantities and qualities of resources needed to produce a particular product. The economic model commonly used to determine the relationship between the various factors and the output in agriculture is the Cobb Douglas production function (M. Desai, Watthey, & Zuckerman, 1976). The production function of any farmer is determined by resource availability of the farmer. A production may be defined as a mathematical equation showing the maximum amount if output that can be realized form of the Cobb-Douglas production function is given by:

Where:

Y = total production (the monetary value of all goods produced in a year)

L= labor input

K = capital input

A = total factor productivity where α and β are the output elasticity's of labor and capital, respectively.

These values are constants determined by available technology. Returns to scale refers to a technical property of production that examines changes in output subsequent to a proportional change in all inputs (where all inputs increase by a constant factor).

If output increases by that same proportional change then there are constant returns to scale, sometimes referred to simply as returns to scale. If output increases by less than that proportional change, there are decreasing returns to scale. This relationship is known as input-output relationship by farm management specialists and fertilizer responsive curve by agronomists where the Price ratio is the choice indicator. Based on

the assumptions of a goal of profit maximization and making decisions in the short run, combined with our understanding of diminishing marginal productivity, the question is "what level of input should a farmer use and what level of output should the farmer produce to maximize profit. To evaluate the profitability of producer economists also used the theory of economic surplus. Because of agricultural produce that are usually perishable especially during season.

Many primary markets are subject to extreme fluctuations in price. There are several methods of intervention available to governments and agencies. Buffer stocks should help stabilize prices by taking surplus output and putting it into a store, or, with a bad harvest, stock is released from storage. A target price can be achieved through intervention buying and selling. The buffer stock managers are likely to establish a price ceiling, above which intervention selling will occur, and a price floor, below which intervention buying will take place .Yet, it must be recognized that there is an important ethical problem in relying on the market to equate the supply and demand of food.

Smallholder farmers produce agricultural commodities mainly for two purposes; consumption and marketing. Farm households entirely consume, entirely market or consume and market the output of a particular commodity. Farm households that entirely consume their produce are not market-oriented and their main objective is to meet their food needs. In this study, household decisions on soya bean production and marketing were premised on the utility maximization theory. According to the utility maximization theory, producers maximized utility subject to constraints in production resources. It was assumed that farm households were rational in using production resources and choosing the market that maximized their utility. The main objective of selling an agricultural commodity by farm households or traders is to maximize profit. In this study it will assume that farm households and soya bean traders' decisions to participate in the soya bean market were influenced by perceived utility or net benefit from selling the commodity.

Soya bean marketing is assumed to be influenced by socio economic factors of farm households and market characteristics. It is assumed that maize producing households and traders interacted with perfect competitive markets in determining the output sold, price and demand for maize.

2.1.2. Theory of Costs

From the market survey, the estimated market size and share enables the expected sales to be calculated. The gross profit (or gross loss) is the difference between the expected income and the total operating costs over the first year, including any loan repayments. Income is therefore calculated as follows: Income = Selling price per unit x number of units sold. The income clearly depends on both the price of a product and the amount that is sold.

When selecting a price for a product, two approaches can be taken: first the price can be based on production costs and it is set to ensure that income exceeds the total costs. This however, does not take account of competitors' prices and to be successful, the new product should be priced at or below the price of other similar products. The second approach is therefore to set the price to compare favorably with existing products and calculate the likely profit at the planned scale of production. When the production costs and income are compared using the second approach, the operation of the business should be above the breakeven Point. Above this point is the minimum level of production that can enable the enterprise to make a profit.

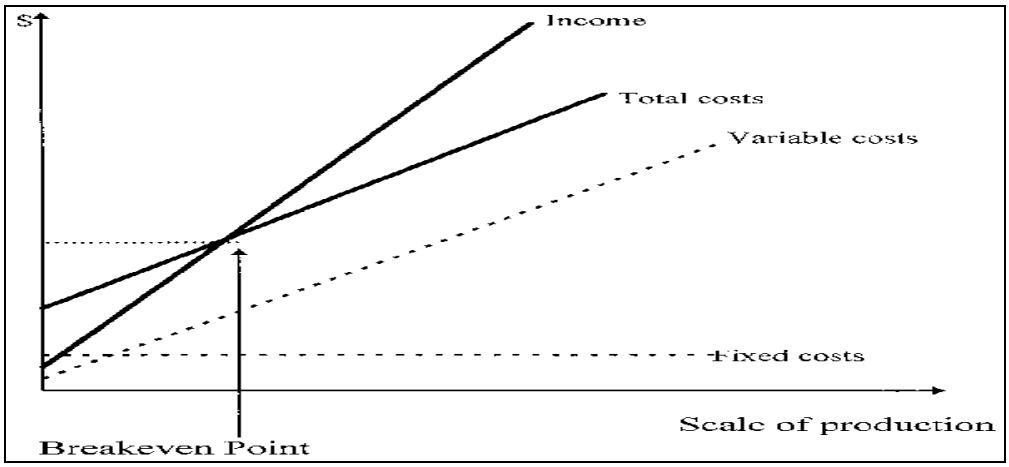

Figure 2.1: Breakeven Point for maize production

2.1.3. Institutional theory

This theory was defined by Thomas B. Lawrence (2008).The institutional theory is a theoretical framework for analyzing social (particularly organizational) phenomena, which views the social world as significantly comprised of institutions enduring rules, practices, and structures that set conditions on action. The institutions are fundamental in explaining the social world because they are built into the social order, and direct the flow of social life. They are the constants that determine the rules of variation. Institutions are not everywhere and for everyone; rather, they are situated within specific social contexts and condition action within those contexts. Consequently, institutional research typically focuses on the institutional context– sets of institutions and their relationships and effects that are relevant in a situation.

Institutional contexts provide cognitive frameworks for social actors, and these frameworks both constrain and enable action. Institutional contexts constrain action by enacting rules that are often invisible. At the same time, these contexts enable action by making the world understandable and meaningful actions. The resurgence of institutional theory in the 1970s began with investigations of the effects of institutional contexts on the structures of organizations (Meyer & Rowan, 1977).Over time;

researchers began to theorize the dynamics of the institutional context itself. For instance, they examined how a social fact can reach the status of an institution, i.e., become institutionalized. They also addressed many fresh questions, e.g., how institutions die, how they change, how they relate to each other, how social actors can affect their institutional context. These efforts have expanded institutional theory to constitute a wide range of social research. This theory was applied to the current study in such way it will show the role of presence of policies and how it benefits farmers. The theory helped to analyse different facilities offered by ministry of agriculture and natural resources.

2.2. Conceptual frame work

INDEPENDENT VARIABLES

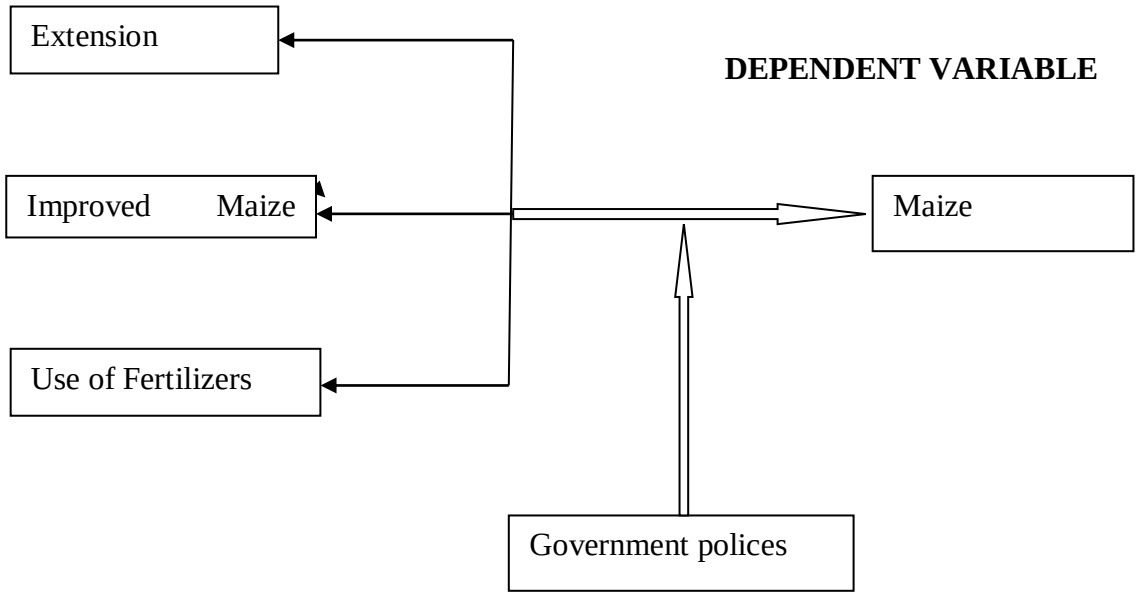

Figure 2.2 Conceptual frame work

2.3. Review of empirical findings

2.3.1. Influence of improved maize seeds on agricultural production.

Among the Agricultural inputs, seed is recognized as having the greatest ability to increasing on-farm productivity since seed determine the upper limit of crop yields and productivity of other agricultural inputs (Bezu, Kassie, Shiferaw, & Ricker-Gilbert, 2014). This means that in order to sustain and increase production volumes, it is critical to find mechanisms that guarantee farmer access to high yielding certified varieties. Moreover, such mechanism is paramount for successful variety improvement for sustainable agriculture development (Hellin, 2007) cited in (Munyua, Orr, & Okwadi, 2013).

According to findings by Bezu et al. (2014), in :*Impact of improved maize adoption on welfare of farm households in Malawi- A panel Data Analysis, (2013)"* it was realized that Small Holder farmers continue to maintain preferences for local(as opposed to improved) maize seeds despite its lower yield potential. This is attributed to the perception that local varieties produce better quality flour, require less external inputs, and establish better pest resistance in storage (Abate et al., 2015; Kapembwa & Chapoto, 2016).

Studies conducted to evaluate the impact on maize production by Cantore (2011) using the Regression model, results showed that inspite of the progress induced by CIP, at National level, it is not statistically supported by the hypothesis that high expenditures on inputs affected agricultural output.

These econometric results showed non-significance of the improved seeds coefficients which can be explained by the fact that the depletion levels of inputs is still low to generate a virtuous process of crop production at aggregated level. More often, farmers always have the option of reusing local seeds from previous harvests; however, they degrade in quality over time, and most local seed that farmers' plant has a low yield

potential. This leaves the option for using the hybrid seeds that generate higher returns in terms of yields and incomes. Maize hybrids have the potential to give yields of between 8-13MT/Ha depending on the fertility of soils and management in the field. But even with this background knowledge, farmers still resist the use of hybrid seeds.

Seed providers attribute the low adoption rates of improved or hybrid maize seed varieties to a number of factors, including: a lack of awareness among both dealers and farmers about the availability and value of existing varieties; the high relative price of hybrid seeds due to poor and uncompetitive grain prices or poorly functioning markets; poor germination of seeds distributed and Limited effective distribution of seeds; Poor sanitary status of seed due to the prevalence of crop pests and diseases ;.farmers slow transition from traditional methods to modern agronomic practices and technology; lack of access to good quality hybrid seeds; and a lack of credit for final crop input purchases.

2.3.2. Influence of fertilizer usage on agricultural production

Some studies have been conducted in East Africa examining the relationship between fertilizer usage and soil fertility as well as yields .In some of these studies, fertilizer use and low intensity has been highlighted as some of the factors hindering productivity growth globally but with more effect in the sub-Saharan Africa (Fuglie & Rada, 2013).

Many reasons have been ascribed to this low fertilizer usage which include lack of access to credit, lack of knowledge on fertilizer use and high prices of fertilizers (Odendo, Obare, & Salasya, 2009) cited in (Ayuya et al., 2015). Furthermore, fertility of soils in many small holder farming systems in Africa differ significantly at the farm and landscape level leading to differences in crop productivity and crop response to additions of fertilizers (Zingore, Murwira, Delve, & Giller, 2007) cited in (Ichami, Shepherd, Sila, Stoorvogel, & Hoffland, 2019).

This holds true for Rwanda where fertilizer application and dosage is uniform in all districts irrespective of the differences in soil structure, soil PH, topography and land scape. Fertilizer ratio is an important determinant of fertilizer usage for small scale farmers. The higher the ratio, the higher the application rates among the farmers. The positive and significant relationship of the maize prices on the output markets and fertilizer usage is confirmed by this research where maize prices on the commodity market have positive significant relationship to the fertilizer usage and thus maize production at 1% confidence level. This is also in line with the findings of Silvanus Wanjala (SIMIYU) in (2014) in the study of *"Factors influencing maize production among small scale farmers in Kenya, a case of Bungoma central sub-county"* which showed a positive significant relationship that exists between maize prices and fertilizer usage.

Nitrogen is vital plant nutrient and major yield-determining factor required for maize production (Both the nitrates and the orthophosphates are very mobile and loosely bound in the soil and hence easily leached. This can only be mitigated by the application of organic fertilizers to enhance the soil retention capacity and reduce nutrient leaching. Earlier studies don't show how this has impacted negatively on productivity and soil properties and no recommendations point to alternatives. This study made analysis of how continuous application of mineral fertilizers has had effects on maize production potentials.

Nonetheless, recognizing, that Rwanda is characterized by low soil productivity due to nutrient depletion arising from over-cultivation, leaching and soil erosion, it is imperative that increased and judicious use of fertilizers is adopted to achieve agricultural intensification. Use of synthetic mineral fertilizers alone will exacerbate the environmental impacts and have reverse impacts on agricultural production capacity in the long run (MINAGRI 2008).

Experts have recommended greater emphasis on integrating organic fertilizers in the farming system. This is in a bid to raise carbon levels and make nutrients from fertilizers more available to crops. In Malawi, Sauer and Tchale (2009) cited in (Lunduka, Ricker - Gilbert, & Fisher, 2013) found that controlling for other factors, maize yields response to fertilizers was higher with integrated sols fertility management. However, the CIP policy embarks on inorganic fertilizer applications for short term gains ignoring the long term benefits for soil conservation and sustainable fertility management.

Marenya and Barret (2009) cited in (Kassie, Jaleta, Shiferaw, Mmbando, & Mekuria, 2012) provide evidence which suggests that soil organic matter significantly influences the economic returns of the fertilizer inputs in the production of Maize in western Kenya, therefore providing opportunity to exploit the economic complementarities of the two resources. Tonitto and Ricker-Gilbert (2016) note that there is a growing acknowledgment for the need to combine the application of chemical fertilizers and organic resources to simultaneously tackle short-term crop nutrient demands and long-term increase in soil Organic matter in Sub-Saharan Africa. Furthermore, ENOCK (2018) found out that large areas of soils in Africa are less productive due to acidity-related to parent materials and low retention capacity of chemical fertilizers into the soil as a result of limited application of organic fertilizers.

However, despite these and other studies conducted, the CIP policy in Rwanda is silent on the use and importance of organic fertilizers neither was there any budget allocated to its promotion and use.

2.3.3. Influence of extension services on Agricultural Production

Extension has been a driving force behind the diffusion of improved technology to small holders in all countries that have experienced a wider uptake of improved maize technologies. Different countries use different models. Theoretically, increasing the productivity of maize production would require either increased input use especially acreage expansion, improvement in resource use efficiency and or technological change

derived from use of new technologies. Capacity building in agricultural extension is the process whereby relevant stakeholders and organizations unleash, strengthen, create, adapt and maintain capacity over time, usually with the objective of assuring sustainable agricultural growth and improving the lives of the stakeholders (Greijn, Hauck, Land, & Ubels, 2015). It requires the acquisition of individual skills and institutional capacities as well as development of opportunities to put these skills and networks of productive use in the transformation of the agricultural sector.

The role of education in improving farmers' efficiency is widely known because it enables the farmers to understand the socioeconomic conditions governing their farming activities and learn how to collect, retrieve, analyze, and disseminate information. Moreover, with higher levels of education, farmers are able to organize themselves into farmer groups or associations that can engage in policy issues on matters pertaining to their operational activities and can easily negotiate contracts with other actors in the value-chain.

Education also enhances farmers' understanding of extension recommendations This is in line with this study findings where the majority of farmers (78.4%) attained primary level of education and none of the respondents had attained tertiary level of education (Mulinga, 2013).

In Rwanda, because the frontline extension workers (EWs) are under Ministry of Local Government, yet the agricultural activities lie under the portfolio of the Ministry of agriculture, there is a need to strengthen linkages between the two ministries for some practical opportunities for actualizing the linkages. This study pointed out the lack of extension training material both for extension workers and farmers, limited access of producers to good quality agricultural inputs, especially good quality seeds, lack of means of transport for public extension workers at District and Sector level and the fact that local authorities and extension workers do not demonstrate in their own farms what they are supposed to teach or advice to farmers.

Research results not effectively translated into extension messages, to be disseminated to different beneficiaries and partners. According to the study conducted by (Oyekale & Idjesa, 2009) cited in (Maruod, Breima, Elkhidir, & El Naim, 2013), in "*Adoption of Improved maize seeds and production efficiency in Rivers State, Nigeria"* it was found that adoption of improved maize seeds increased as the years of education increases. This is because educated people display better adoption of technology. However, this study reveals that majority of the farmers in Rwanda have only attained primary education level and so is the trend in the usage of the improved seeds varieties.

2.4. Critique of the existing literature and research gaps.

Some researchers have shown that intercropping increases output in maize-based systems. To this effect, according to Panel Data collected by Tegemeo institute of Ergerton University, Ariga, Jayne, and Njukia (2010) cited in (Chambon, Dao, Tongkaemkaew, & Gay, 2018) found a raising trend in the proportion of maize area planted in more complex intercropped patterns since the mid of 1990s as a result of the returns generated. On the contrary, the CIP in Rwanda emphasizes the Monocroping system in maize growing. Further research should be undertaken to make comparative analysis between the two models and their effect on maize production.

CHAPTER THREE

METHODOLOGY

Introduction

This chapter deals with the methodology that the researcher used to collect data from the respondents. It highlights the research design, the area of the study, study population, sample size, design of the research and the methodology of data collection and the research instruments to be used. The chapter further describes the strategies for quality assurance (control), research procedure followed, data management and analysis and the ethical considerations observed during the field study.

3.1. Study Area

This study was conducted in Nyagatare district located in the Eastern Province of Rwanda. Its objective was to assess the effect of the Crop Intensification program (CIP) on maize production in Nyagatare district. The study was conducted in Nyagatare District because it is one of the Districts in the Country where maize crop is recommended as key priority crop.

3.1 Research design

The research design in this research used both quantitative and qualitative methods. It used quantitative approach because it was to capture data that was analyzed to assess the contribution of the independent variables to the maize production. With it, findings are in form of statements, tables or figures. Quantitative analysis was used to capture social trends and policy implications. Qualitative approach in Research as defined by Ritchie and Lewis (2003: 3) is a 'neutralistic ,interpretive approach concerned with understanding the meaning which people attach to phenomena(actions, beliefs, opinions, decisions) with their social world' . During this research, qualitative methodology was employed to assess the opinion and perceptions of farmers on the CIP vis-à-vis maize

production in Nyagatare district. This was through the interviews with the respondents during the research. However, during the interviews, there was need to ask the respondents what the trends mean to them or how they perceived the CIP policy. The qualitative analysis also helped to understand the patterns in the quantitative analysis.

3.2. Target Population

The study population constituted the maize growers in the district of Nyagatare. In total, they were 278 maize farmers grouped in 7 cooperatives.

3.2.1. Sample size determination.

To get the number of respondents, *n*, and estimated population N, the research used Slovin formula:

$$n = \frac{N}{1+N(r2)}$$ r= sampling error; **(1)**

Where n is the sample size, N is the population, r is the sampling error which in this case is taken as 5% that the researcher is willing to permit. Using the formula, the sample size is

Where **N** is the sample frame, **n** is the sample size and r is the margin of error

$$n = \frac{N}{1+N(r2)} = \frac{278}{1+278(0.05X0.05)} = \frac{278}{1.7} = 164$$ **(2)**

Therefore, the sample size used was 168 respondents randomly selected from 7 cooperatives.

3.2.2. Sampling techniques

This research used Stratified random sampling because the population was not homogeneous among all the members in the 7 cooperatives. In this regard, all members of the cooperative had equal chances of being interviewed. Purposive sampling was also employed to get views of people with relevant information and Data and able to identify challenges. Simple random sampling was used to obtain the sub sample from each cooperative.

Table 3.1: Sampling frame

N0	COOPERATIVE	MEMBERS	RESPONDENTS
1	COOPAMA	37	**22**
2	CODEMATA	33	**19**
3	COBATURU	40	**24**
4	CODEVANYA	45	**26**
5	KOKUINYA	44	**26**
6	CODEMACO	38	**22**
7	CODEGRIFOGA	42	**25**
	TOTAL	**278**	**164**

Source: Cooperative administration

3.3. Pilot test

In order to ensure the quality and the reliability of data generated, Cronbach's alpha coefficient tests were used for reliability to measure internal consistency. This also was intended to get an understanding of how to put questions to the respondents to generate clear response from them.

3.4. Data Collection Instruments and procedures

3.4.1 Primary data

3.4.1.1 Questionnaire

Primary data was collected directly from respondents (farmers) through face-to-face interviews using multi-stage and pre-tested questionnaire. A multi-stage questionnaire was used to collect primary quantitative data from the selected cooperative members and leaders through a cooperative member survey (Questionnaire appended) to assess the extent at which fertilizers, improved seeds, extension services contributed to maize production during CIP. Views from all respondents were captured on the administered questionnaire.

3.4.1.2 Key Informants interviews

Key informants' interviews were also conducted.The main purpose was to complement the main instrument (questionnaire). In total, 9 In-depth Interviews were conducted with the following groups: Nyagatare District Agriculture Officer, NGO representatives at district level (RDO& Duterimbere), Minagri Representatives at district level (RAB & RSSP), the Chairman of the Union of Cooperatives in Nyagatare, Rukomo sector Agricultural officer and the Executive secretary of Mimuri Sector. The selection of these people was based on their role in maize growing in Nyagatare or their access to data required on maize production.

3.4.2 Secondary Data

Secondary data was collected from Rwanda Agriculture Board (RAB), internet, published books and journals, and records of Ministry of Agriculture, Rwanda. Data was also collected on some farm records ,where they existed such as, yields, input access and distribution, agricultural practices used in farming, farmers organizational structure, level of education, access to credit, land size, family size, experience, participation in extension services, membership in cooperative ,and role of the cooperative union in supporting farmer cooperatives .

3.5 Data Processing and analysis

The data collected were summarized, coded, and entered in the computer using SPSS and Microsoft Office Excel and were analyzed using STATA computer program, version 13. Both descriptive and quantitative analyses were carried out. The results were presented through text, tables and figures accompanied by interpretations.

3.6 Probit model

Based on conceptual frame work developed in 2.4, the probit regression model was used to estimate the socio economic and institutional factors affecting profitability among small scale maize producers. The dependent variable in this model is a binary variable which is adopters in maize production in last farming seasons or not. The probit model is a statistical probability model with two categories in the dependent variable. Probit analysis is based on the cumulative normal probability distribution. The binary dependent variable, takes on the values of zero and one.

The probit analysis provides statistically significant findings of which Crop intensification Program increase or decrease the probability of using improved seeds, fertilizers or access to extension services and in the binary probit model, maize producer in 2018 was taken as 1, while the counter factual as 0 respectively. According to (Jones, 2009) probit model assumes that *F* represents the cumulative distribution function (F) of

a standard normal variable. The cumulative distribution function (F) is then expressed as follow: probit model assumes that *F* represents the cumulative distribution function (F) of a standard normal variable. The cumulative distribution function (F) is then expressed as follow:

$$Prob(Y_i = 1) = \emptyset(\beta_i X_i) = \int_{-\infty}^{X_i} 2\pi^{-0.5} \exp\left(-\frac{X_i^2}{2}\right) dX_i \quad (1)$$

The inverse of equation above (1) gives the linear form of the probit model also estimated in studies by (Oladejo, Olawuyi, & Anjorin, 2011) and (Sebatta, Mugisha, Katungi, Kashaaru, & Kyomugisha, 2014). It is stated as: $\emptyset^{-1}(p_{ij}) = Y_i^* = \beta_i X_i + \epsilon$ (2).

The parameter estimates of the probit model provide only the direction of the effect of the independent variables on the dependent variable but they do not represent either the actual magnitude of change(Demeke & Haji, 2014).

The magnitudes of the coefficients of the probit model can be obtained by computing partial effects of the explanatory variables that is differentiating equation (2) with respect to each explanatory variable.

3.6.1 Model Variable and Hypothesis Testing.

To get the true results of this study, hypothesis testing was done using the null and alternative hypotheses. The null hypothesis is the statement or the statistical hypothesis that is actually being tested. The alternative hypothesis is the remaining outcomes of interest. The significance level is also sometimes called the size of the test and it determines the region where the null hypothesis under test will be rejected or not rejected. More specifically, a significance level of 1%, 5% and 10% was adopted in this study to explain the significance levels of different variables.

The significance level used in this research is commonly known as the ***p*-value**. It gives the marginal significance level where the researcher would be indifferent between rejecting and not rejecting the null hypothesis (Gujarati, 2005).

The *p*-value has been used in this study during the analysis of the data results to determine the significance of the data generated for interpretation and generalization. The economic model specification of the variables was: Any services from Crop intensification Program in last season of 2018A.

Table 3.2: Definition of Variables in the model

VARIABLE	Description	Expected sign
Gender	1 if male, 0 if female	
Age	Age of respondent at the time of interview in years	-
Marital status	Married, single , divorced or widowed	+
Education background	Level of education attained	+
Family size	Number of people in the family	+
Accesses to financial credit	Whether farmer has access to credit for agricultural activities. 1 If Yes, 0 if No	+
Goods commodity prices	Prices of maize grains on the market after harvest.	+
Farmer Incomes	Farmer incomes from agricultural activities	+
Cost of fertilizers	Cost of fertilizers on the market in Francs	-
Training	Whether farmer received training. 1 if Yes, 0 if No	+
Distribution channels	If they exist.1 if Yes, 0 if No	+
Field trials	Existence of field trials: 1 if Yes, 0 if No	+
Availability of extension services	1 if Yes, 0 if No	+
Amount of rainfall	If rains were enough or not	+
Cost of seeds	Cost of improved seeds on the market	-
Output markets	Existence of output markets	+
Extension to farm and beyond	Whether extension goes beyond farm to other areas in the value chain.1 for Yes ,0 for No	+
Farm size	Size of land used for growing maize measured in Ha	+
Existence of Farmer Field Schools	1 if Yes, 0 if No	+

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter highlights the research findings and assessments done to the effect on the contribution of fertilizers, improved seeds and extension services on maize production during CIP in Nyagatare district. The findings were presented in the manner of specific objectives. The findings revealed the importance of each of these variables and perceptions of farmers to their importance.

4.1 Descriptive statistics analysis

4.1.1 Social economic characteristics of sampled respondents

4.1.1.1 Gender of respondents

Figure 4.1 pertained to gender distribution of surveyed respondents from the study area. The findings revealed that about 80% were male while 20% were female headed households. The findings from this report highlighted that crop intensification program in agriculture sector from Nyagatare district is predominately by male headed households; thus the findings on gender does not conflicts with the Rwanda national report from NISR (2016) where it highlighted that In 2016 Season A, the distribution of agricultural operators in Rwanda by gender was 70.0% male and 31.1% female (NISR, 2016).

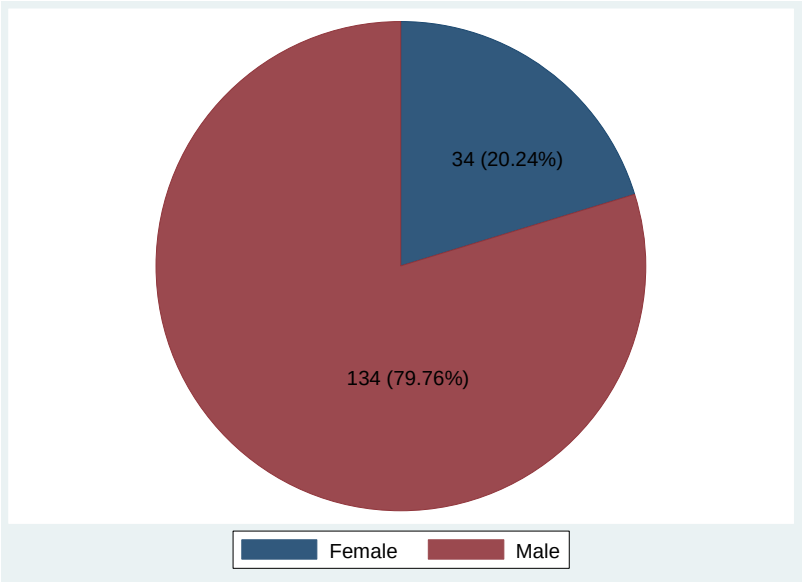

Figure 4.1: Distribution of respondents by gender

4.1.1.2 Education background of respondents

From figure 4.2 majority of farmers' attained primary education representing 69% while among the respondents, 21% of the surveyed farmers from all cooperatives under CIP intervention attained secondary education. Findings also showed that 8% have never been to school while only 2% had attended tertiary education. Based on current statistics report from NISR (2016), the findings are similar where during 2016 SAS Season A, the report figures illustrated that 67% of agricultural operators had attended primary level education, 26% had no education, 6.5% attended secondary level education and only 1.0% had attended tertiary level education, indicating high levels of illiteracy among Rwandan farmers. This is consistent with that of Roser and Cuaresma (2016) where it is stated that as countries develop their education levels, the share of the population working in agriculture is declining. The results pose a big challenge for agricultural development in developing countries as farmers uptake of technology for agricultural

innovations is still very low and thus the heavy labor intensive rather than capital intensive agricultural development.

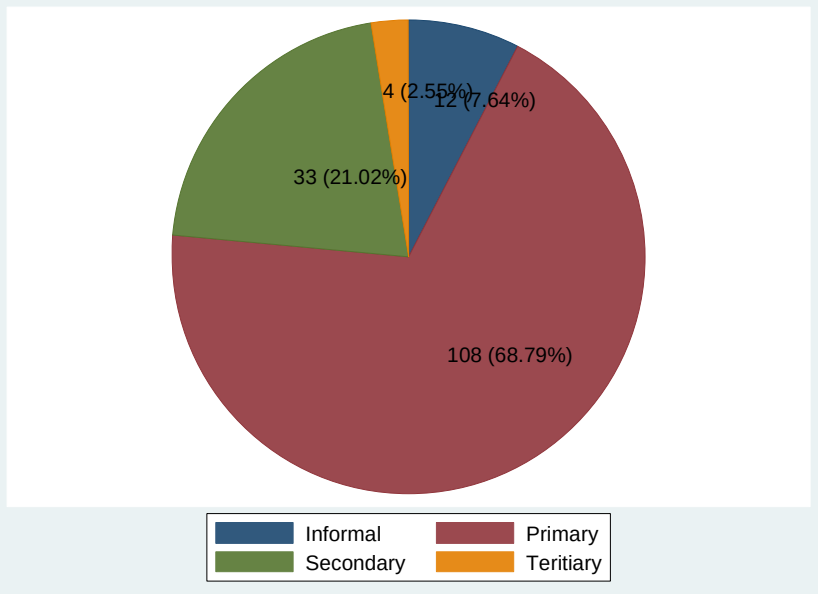

Figure 4.2: Distribution of sampled respondents by education background

4.1.1.3 Marital Status of respondents

Results from the field survey presented in figure 4.3 below indicated that about 72% of the sampled farmers in Nyagatare district were married, 16% were single, 8.5% were widowed and only about 4% were divorced/separated. From the point view of the discussion, the findings highlighted that there is low number of youth engaged in Agriculture.

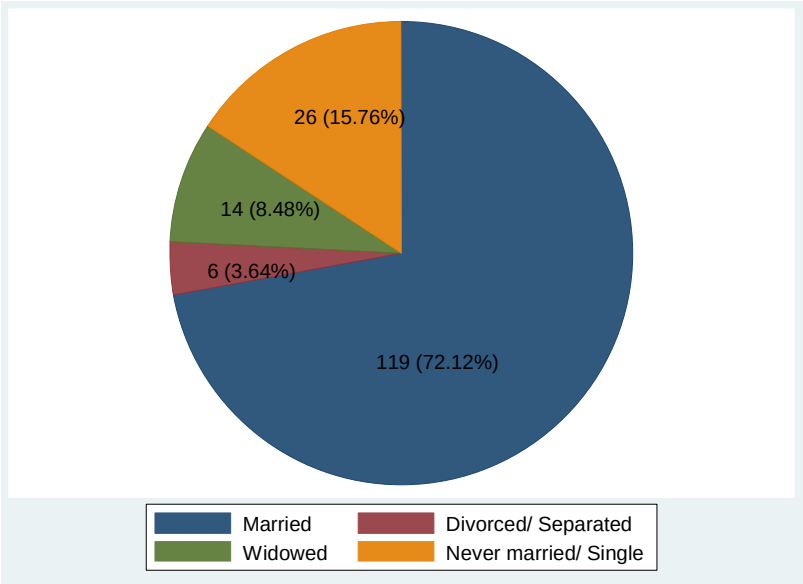

Figure 4.3: Distribution of respondents by marital status

4.1.1.4. Summary of age, family size, farm size, land allocated for maize and experience

The ages of the household heads of the sampled respondents ranged from 19 and 71 years with mean of 40.017 years for adopters of CIP while for their counter factual groups, the age ranged from 18 to 80 years with the average mean age of 39.455 years old respectively. For all sampled cooperative members from Nyagatare district, the findings indicated that mean age was 39.76 years with the standard deviation of 11.37 respectively. This indicate that the population of Nyagatare district are still energetic to perform agricultural tasks; these agree with the report of NISR, 2016 where findings revealed that majority of agricultural operators in Rwanda were in the age group of 25-34 (25.8%) followed by agricultural operators in age-group of 55 years and above (25.6%). The age group distribution of agricultural operators by Stratum varied more in the age group of between 45 and 54 years old.

Family size is useful for formulating various development plans and for monitoring and evaluating their implementation. In the study area, the comparative findings on the household's family composition revealed that the average family size was 4.52 members/ family with a minimum 1 and maximum of 9 members for the treated groups and ranging from 1 to 12 members with the average mean family size of 5.14 members/ family respectively, mean while for all sampled farmers, the average mean of family size composition was 4.702 members per household which shows us the study area is not more populated considered the surrounding areas.

Land is the major productive asset in development countries like Rwanda. Cultivated land appears to be the most important scarce factor of production and the implementation of intensification program like CIP in Rwanda. In the study area, own land, rented and shared lands was used for cultivation. By comparing the treated and control group in terms of their land holding size, the average landholding size of the sample households in the study area is ranged from 0.1ha to 6.15ha and average mean farm size of 1.644ha for adopters of CIP while for non-adopters, the farm size ranged from 0.09ha to 3.13ha with the average mean farm size of 1.339ha of land respectively. In the study area, generally, the average mean land holding capacity was 1.588ha of arable land, which is not comparable to the national land holding capacity of 0.76ha per small scale farmer in Rwanda as reported by (Kathiresan, 2012).

The average mean of area under maize farming was ranged from 0.0ha to 4.7ha with the associated average mean of planted maize of 0.927ha of farmed maize for adopters of CIP while the control group, the land under maize production varied from 0.06ha to 2.5ha with the average mean of 0.789ha of cropped land under maize respectively. In general, the whole sampled farmers owned the on average 0.906ha of land under maize production per households in cooperative to access easily the services of Crop intensification Program. The findings on land under maize production outweigh the Rwandan national holding capacity of 0.76ha/ household as reported by (Kathiresan, 2012).

Summary statistics also from table 4.2 indicated that farming experience varied from 2 years to 16 years with the average mean of 5.76 years for adopters of CIP, while for non adopters of this program, the results indicated that it ranged from 2 years to 17 years with average mean of 5.64 years respectively. When looking on whole sampled farmers, the average mean experience was 5.726 years indicating high experienced farmers in new technological program adoption.

Table 4.1: Summary of age, family size, farm size, land allocated for maize and experience

Variable	Obs	Mean	Std. Dev.	Min	Max
Adopters of CIP					
Age	98	40.017	11.372	19	71
Family size	98	4.521	1.996	1	9
Farm Size	98	1.644	1.192	0.1	6.15
Land allocated for maize	98	0.927	0.774	0	4.7
Experience	98	5.760	3.652	2	16
Non adopters of CIP					
Age	56	39.455	11.740	18	80
Family size	56	5.136	2.237	1	12
Farm Size	56	1.339	0.791	0.09	3.13
Land allocated for maize	56	0.789	0.527	0.06	2.5
Experience	56	5.636	4.298	2	17

4.1.1.5 Access to land tenure system by T- test of equality of means

Table 4.1 pertained to t- test of equality of means by accessibility of land tenure of small scale farmers in Nyagatare district. Findings indicated that about 93% of the adopters have land with title while 86% of non adopters also have no access to land with title head. For whole sampled farmers, 91.3% of the sampled farmers have access to land with title while 8.7% of the sampled farmers have land with no title. These findings are

statistically significant with t-value of -1.43 and p-value of 0.0774 statistically significant at 10% level of significant, with associated degree of freedom of 159 respectively.

Table 4.2: Access to land tenure system by T- test of equality of means

Group	Obs	Mean	Std. Err.	Std. Dev.
Non adopters of CIP	56	0.8605	0.0535	0.3506
Adopters of CIP	98	0.9322	0.0232	0.2525
Combined	164	0.9130	0.0223	0.2827
Difference		-0.0717	0.0502	
T-stat				-1.4295
P-value				0.0774
DF				159

4.1.1.6 Participation in cooperative services

The study was conducted in Nyagatare district solely in cooperatives where Crop Intensification Program services are delivery easily to members. Based on table 4.2 below, findings revealed that 100% of sampled respondents were cooperative members (paid coops share) and among them only 45.9% were from producer cooperative society, 8.18% were from Savings and Credits Cooperatives, 34.6% were from Self- Help group and about 11.32% were from Community Based Organization. Contrary, findings from this study does not resonate with the Rwandan national report from NISR (2016) where it indicates that only 0.5% of agricultural operators in Rwanda operates under cooperatives while about 99.5% are working individually (NISR, 2016). The high level of cooperative membership participation facilitate the implementation of CIP deliverables which are not limited to land use consolidation, but also to proximity of

extension services, improved seeds, fertilizers and increase the area coverage under crop production.

Table 4.3: Participation in cooperative services in Nyagatare district

Cooperative membership	**Freq.**	**Percent**	**Cum.**
Yes	164	100	100
Total	164	100	
Types of cooperatives			
A producer cooperative society	75	45.91	45.91
SACCO	14	8.18	54.09
Self-help group	56	34.59	88.68
Community Based Organization (CBO)	19	11.32	100
Total	164	100	

4.1.1.7 Credits accessibility by T- test of equality of means

Credits accessibility for small scale farmers enhances their ability to afford new farm inputs in the CIP subsidy program and based on results from 4.4 which are pertained to t- test of equality of means by accessibility of credits of small scale farmers in Nyagatare district. Findings indicated that about 33% of the adopters have access to credits while 41% of non adopters also have access to credits. For whole sampled farmers, about 35.2% of the sampled farmers have access to credits from different financial institutions while 64.8% of the sampled farmers have no access to bank credits. These findings are statistically significant with t-value of 0.931 and p-value of 0.3533 which is not statistically significant with associated degree of freedom of 163 respectively.

Table 4.4: Credits accessibility by T- test of equality of means

Credits accessibility	Obs	Mean	Std. Err.
Non adopters of CIP	98	0.4091	0.0750
Adopters of CIP	56	0.3306	0.0429
Combined	164	0.3515	0.0373
Difference		0.0785	0.0843
T-stat			0.9309
P-value			0.3533
DF			163

4.1.1.8 Source of credits in the study area

The CIP entails use of inputs and other services yet at times farmers have no ready cash to buy them (inputs). This study seeks to see which source of financing farmers have access to for them to buy inputs. The summary statistics revealed that 64.5% of the total sampled members accessed credits from Savings and Credits Cooperatives (SACCO), 35.7% have accessed loan from microfinance institutions, 32.7% get their loan from their respective cooperatives, 13% of the members get credits from farmers' group, 12.7% of the sampled farmers get their credits from NGOs while only 12% are getting credits from friends/ family and there is no farmers accessed credits from mobile credits. The study reveals that the closeness of the SACCOs to the farmers has enabled them to get credits more easily than other financial institutions.

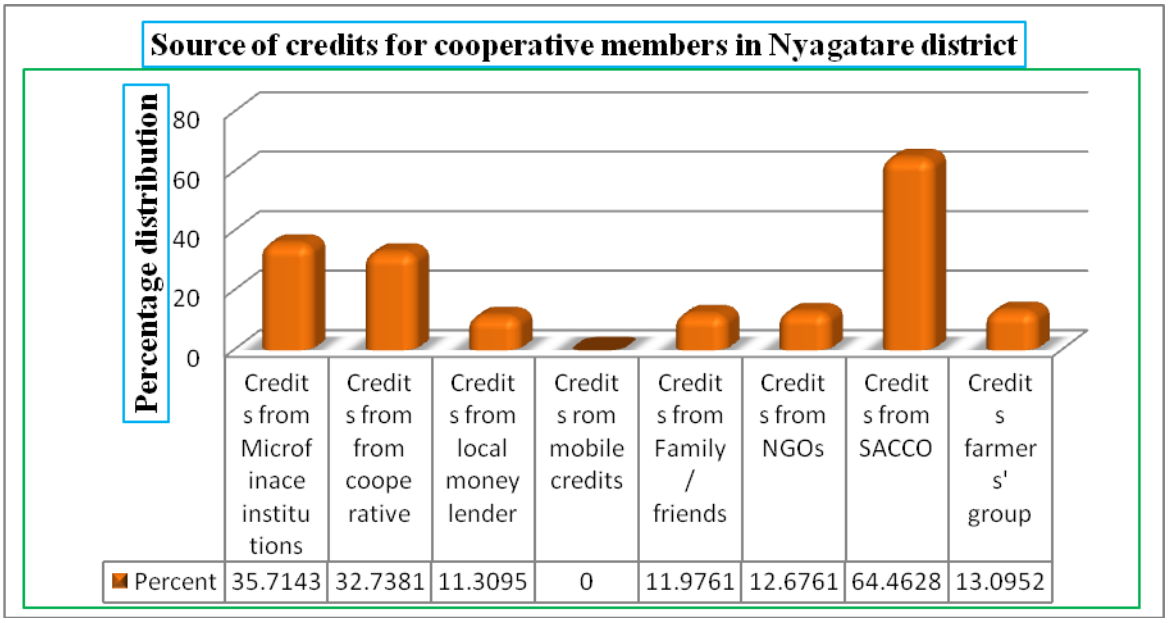

Figure 4.4: Source of credits for cooperative members in Nyagatare district

4.1.1.9 Access to extension from CIP by t-test of equality of means

Based on results presented in table 4.5 from T- test of equality of means, the summary findings indicated that about 37.2% of the adopters of crop intensification program accessed extension services while 29.6% of the non adopters accessed extension services. For the whole sampled farmers, only 35% of the total cooperative members coperating in Nyagatare district have almost accessed extension services. The t- test of -0.906 with p-value of 0.183 and DF of 163 were not statistically significant.

Table 4.5: Access to extension from Crop Intensification Program

Access to extension services	Obs	Mean	Std. Err.	Std. Dev.
Non adopters of CIP	56	0.2955	0.0696	0.4615
Adopters of CIP	98	0.3719	0.0441	0.4853
Combined	164	0.3515	0.0373	0.4789
Difference		-0.0764	0.0844	
T-stat				-0.9063
P-value				0.1831
DF				163

4.1.1.9.1 Extension agent implementing Crop Intensification Program in the study area

Figure 4.5 indicated the percentage distribution of farmers received extension agents for different services last 12 months of 2018. The findings from the field survey showed that at least 13% of the total sample members received the extension agents from government, 11% of the farmers received the extension agent from farmers' groups and only 6% of the total farmers in the study area received the extension agents from NGOs respectively. The findings partially concludes that the extension services is still at low level and this is in line with report from DAM, RWAMAGANA, and DISTRICT (2013) which revealed that Households have little access to agricultural extension services at baseline and only 5.4% of households were visited by a public extension worker in 12 months. Even for the small proportion of households visited by a public extension worker, frequency of interaction is quite low: the visited households reported an average of 4 visits over the past 12 months (DAM et al., 2013).

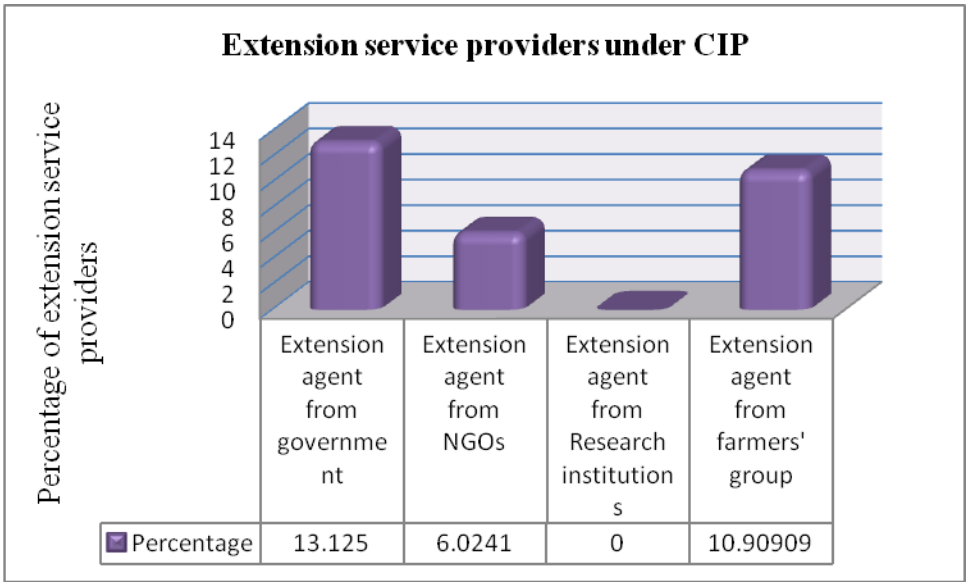

Figure 4.5: Percentage distribution of farmers received extension services last 12 months

4.1.1.10 Accessibility of fertilizers by t-test of equality of means

Fertilizer accessibility either inorganic or organic manure play a vital role to increase crop productivity and production in general for farmers. Based on results from t-test presented in table 4.6 below, findings showed that about 88.4% of the adopters used the fertilizers while 80% of the non adopters never used any type of fertilizer either inorganic or organic fertilizers. Findings on whole sampled farmers also indicated that 86% of the total sampled cooperative members use fertilizers and these are statistically significant at 10% level of significant with t-value of 2.4576 and p-value of 0.0734 and DF of 163 respectively. The results conflicts with the report conducted DAM et al. (2013) under Ministry Agriculture and Animal Resources found that in Rwamagana district, the use of organic fertilizer rated at (90.3%) over the total sampled farmers(DAM et al., 2013).

Table 4.6: Accessibility of fertilizers by t-test of equality of means

Access to fertilizers	Obs	Mean	Std. Err.
Non adopters of CIP	56	0.7955	0.0615
Adopters of CIP	98	0.8843	0.0292
Combined	164	0.8606	0.0270
Difference		-0.0888	0.0610
T-stat			2.4576
P-value			0.0734*
DF			163

4.1.1.11 Accessibility of improved seeds by t-test of equality of means

Use of improved seeds for small scale maize producers could play a vital role in the contribution of increased productivity and production in general. As depicted in table 4.7 below, the results showed that about 66% of the adopters have used improved seeds while only 50% of the non adopters of crop intensification program did used improved seeds. Findings revealed that at least 62% of the total sampled famers from 7 maize farming cooperatives used improved seeds indicating t-test of 2.8933with p-value of 0.03**< 5% level of significance and the degree of freedom of 163 respectively. These results conflicts with the report of DAM et al. (2013) found that in Rwamagana district, the use of improved seeds was rated at (92.2%) of the sampled farmers.

Table 4.7: Accessibility of improved seeds by t-test of equality of means

Access to improved seeds	Obs	Mean	Std. Err.	Std. Dev.
Non adopters of CIP	56	0.5	0.0762	0.5058
Adopters of CIP	98	0.6612	0.0432	0.4753
Combined	164	0.6182	0.0379	0.4873
Difference		-0.1612	0.0851	
T-stat				2.8933
P-value				0.03**
DF				163

4.1.1.12 Extent to use fertilizers and improved seeds under crop intensification program

Surveyed respondents from all sampled cooperatives under CIP in Nyagatare district were asked to express the extent levels at which crop intensification program are delivering its objectives in terms of fertilizers and improved seeds. The findings were analysed via the mean scores as depicted in table 4.8. For fertilizers usage, the mean score for CIP to increase crop productivity (mean=4.44, std=0.59) and coincided that all sampled members agreed satisfactory that crop intensification program increased productivity as reported by 45.2% of the all sample farmers from 7 farming cooperatives. For the role of CIP to increase the cost of agricultural production, the computation of mean score pointed out (mean=1.42, STD=0.57) indicating that all farmers strongly disagreed that Crop intensification program does not increase the cost of agricultural production as reported by 61.9% of the all sampled members from 7 cooperatives.

On case of extent of improved seeds, results from the mean score indicated that for improved seeds increased productivity (mean=3.3; STD =1.1) means that they were neutral that implying that improved seeds either could increase productivity or not due several farming conditions (climate conditions, agronomic practices…) and they were rated at 14.3% of the total sampled farmers from the study area. The issues on the increased of cost of agricultural production, the mean score was (mean=2.65; STD =0.9) implies that farmers were neutral either improved seeds could increase the cost of agricultural production or not and it reported by 56.6% of the total sampled farmers in the study area. For the extension services, level of satisfaction indicated (mean=2.23, STD=0.88) and they total disagreed that the extension services delivered to small scale farmers is not satisfied as indicated by 64.9% of the total sampled respondents.

Table 4.8: Extent to use fertilizers and improved seeds under crop intensification program

Extent to which CIP assist members	***1***		***2***		***3***		***4***		***5***			
	SD		D		N		A		SA		M	Sdt
	f	%	f	%	f	%	f	%	f	%		
Fertilizers												
Increase productivity					9	5.4	76	45.2	83	49	4.44	0.59
Increases cost of agricultural production	104	61.9	57	33.9	7	4.2					1.42	0.57
Improved seeds												
Increase productivity	14	8.3	31	18.5	24	14.3	88	52.4	11	6.6	3.3	1.1
Increases cost of agricultural production	27	16.1	25	14.9	95	56.6	21	12.5			2.65	0.9
Extent of extension services	22	13.1	109	64.9	19	11.3	13	7.7	5	2.9	2.23	0.88

Note: SD= strongly disagree, D= Disagree, N= Neutral, A= Agree and SA= strongly agree, M= Mean and Sdt= Standard Deviation

4.1.1.13 Locational characteristics to nearest physical infrastructures

Agricultural development centres are increasing to help small holder maize producers in Rwanda to disseminate information available for maize growers and help them in improving their livelihood. From table 4.9 below, the summary findings indicated the distance to reach any nearest road ranged from 1km to 50 km while the average mean was 20.7km for adopters of CIP. When farm need to participate any nearest markets, the distance travelled ranged from 2km to 40 with the average mean distance of 11.76 km for the adopters of CIP in the study area respectively. For the control group, the markets participants mostly travelled distance ranging from 2km to 30km with the average mean distance of 10.79km to reach any nearest markets outlets for maize production.

Table 4.9: Locational characteristics to nearest physical infrastructures

		Distance to road	Distance to markets
Adopters of CIP	Mean	20.71074	11.76033
	Std. Deviation	32.38761	8.601381
	Minimum	2	1
	Maximum	40	50
	N	120	120
Non adopters of CIP	Mean	22.86364	10.79545
	Std. Deviation	26.93713	8.045162
	Minimum	2	2
	Maximum	20	30
	N	120	120
Total (All)	Mean	21.06548	11.3869
	Std. Deviation	30.72929	8.414363
	Minimum	2	1
	Maximum	40	50
	N	120	120

4.1.1.14. Cost of inputs (fertilizers and improved seeds @ 50% subsidy)

Crop Intensification Program in Rwanda has envisaged the increased the use of improved seeds and fertilizer usage for staple crops under CIP including maize, soybeans, wheat, banana, rice and Irish potato. As indicated in table 4.10, there is a summary of cost accrued in fertilizer use at 50% of subsidy program. The findings revealed that cost of improved seeds ranged from 57,786 Frws to 49652Frws for the adopters of Crop intensification Program (CIP) in Nyagatare district; mean while the average cost of improved seeds at subsidy was 56316 Frws for all sampled members from 7 sampled cooperatives in the study area. On average, the cost accrued in fertilizer use ranged from 24861Frws to 21703Frws of DAP @ 50% reduction from subsidy program for adopters under CIP with the average mean of total cost of 24335 Frws for whole sampled farmers in the study area. The results also indicated that cost of UREA varied from 10396Frws to 9076Frws for the adopters of the crop intensification program while the total average mean for whole sampled farmers was 10176Frws per households under CIP but at subsidy program. On average, the cost of organic manure ranged from 9040Frws for adopters to 24643Frws for non-adopters of the program while the overall average mean cost accrued on organic manure was 8,849Frws respectively. Maize farming requires the application of pesticides to destroy pest and diseases. In this case average mean cost accrued in buying pesticides ranged from 28741Frws for adopters of the program to 24643Frws of the non-adopters of CIP while the corresponding overall mean cost of pesticides was 27967Frws respectively for small scale maize producers.

Table 4.10: Cost of inputs (fertilizers and improved seeds @ 50% subsidy) from CIP

Variable	Obs	Mean	Std. Dev.	Min	Max
		Adopters			
Cost of seeds	98	57785.85	49785.44	0	293750
Cost of DAP	98	24860.86	21396.89	0	129250
Cost of UREA	98	10396.36	8947.791	0	54050
Cost of organic manure	98	9040.314	7780.687	0	47000
Cost of pesticides	98	28740.64	24874.45	0	150400
		Non adopters			
Cost of seeds	56	49651.99	33084.06	3750	156250
Cost of DAP	56	21703.13	14505.15	1650	68750
Cost of UREA	56	9075.852	6065.788	690	28750
Cost of organic manure	56	7892.045	5274.598	600	25000
Cost of pesticides	56	24643.41	16223.91	1920	75000
		All sample			
Cost of seeds		56316.37	48278.48	0	293750
Cost of DAP	164	24334.68	20850.89	0	129250
Cost of UREA	164	10176.32	8719.462	0	54050
Cost of organic manure	164	8848.976	7582.141	0	47000
Cost of pesticides	164	27966.83	23954.05	0	150400

4.1.1.15. Marketing characteristics of sampled farmers based on 50% of subsidy from CIP

For marketing characteristics, the researcher focused only on maize productivity, quantity consumed at home level, quantity supplied to markets, price variation, farmers' revenues and total production cost accrued in maize production stage.

As depicted in table 4.11 below, area allocated for maize both adopters and non-adopters of CIP ranged from 0.927ha to 0.789ha while the overall mean land allocated from maize farming was 0.906ha of maize respectively. The maize yield, due to crop

intensification program action lines, ranged from 3724.79Kg/ha (3.7tons/ha) for the adopters of CIP to 2239.39Kg/ha (2.2tons/ha) for non-adopters of the program while the overall mean average of maize yield in Nyagatare district is 2634.06 Kg/ ha. For maize quantity consumed at home, results ranged from 157.41Kg to 131.95Kg for both adopters and non-adopters of Crop intensification program while the average mean quantity consumed at home level in all sampled respondents was 151.94Kg per each member in Nyagatare district. For maize markets participation, quantity of maize sold ranged from 3575.795Kg (3.575tons) for the adopters of crop intensification program while the counter factual group sold 3109.811Kg (3.109tons) of maize in season of 2018A respectively while on average the quantity supplied to maize market per farmer was 3488.698Kg (3.488tons).

Findings indicated that due to CIP program there is a difference of 0.5tons of maize supplied to markets greater than non-adopters of the program. On average, the maize price varied from 215Frws/kg for the adopters to 209Frws/kg for the non-adopters of the program while the overall mean price of maize produce was 213Frws/Kg and the maximum price paid for maize was 260Frws/Kg respectively. Good commodity market price for the adopters could be attributed to their having access to the Government strategic grain reserves market which non, adopters don't enjoy as they have no contracts with any agro-dealer. Results from the comparative study indicated that, on average, total revenues ranged from 760,888Frws for the adopters of Crop Intensification Program to 633,628Frws for the non-adopters of the program while the associated average mean revenues of maize grower in cooperative is 737,585Frws and the maximum earned revenues is 4,737,600Frws respectively. The above parameters were evaluated under 50% reduction from subsidy program. Thus, on average the mean total cost accrued in maize production varied from 469,836Frws for the adopters to 408,918Frws for the non-adopters of CIP while the overall total production cost was 459480Frws respectively. To indicate the viability of maize farming business venture, the cost benefit ratio (CBR) was partially performed and it shows that CBR=1.605>1, concluding that maize farming under subsidy program is more profitable business.

Table 4.11: Marketing characteristics of sampled farmers based on 50% of subsidy

Variable	Obs	Mean	Std. Dev.	Min	Max
		Adopters of CIP			
Area allocated for maize	98	0.927015	0.774226	0	4.7
Yield (Kg)	98	3724.786	3239.491	0	19740
Quantity consumed (Kg)	98	157.4124	128.8044	0	789.6
Quantity sold	98	3575.795	3109.911	0	18950.4
Price	98	214.661	48.69111	100	260
Total Revenues (Frws)	98	760888.4	714786.3	0	4737600
Total Cost	98	469835.8	404302.4	0	2436950
Total farm Income	98	291052.6	363557	-318570	2300650
		Non adopters of CIP			
Area allocated for maize	56	0.789205	0.52746	0.06	2.5
Yield (Kg)	56	2239.386	2109.459	252	9500
Quantity consumed (Kg)	56	131.947	83.8801	10.08	380
Quantity sold	56	3109.811	2025.081	241.92	9120
Price	56	209.2045	44.44677	120	250
Total Revenues (Frws)	56	633628.1	409124.2	54432	1915200
Total Cost	56	408918.1	272867	31110	1291250
Total farm Income	56	224710	192978.7	-51990	830550
		All sample			

4.2.Objectives of the study

The section was presented based on Influence of CIP on use of improved maize seeds for enhanced maize production in the study area, Influence of CIP on fertilizer usage on maize production in the study area and Influence of CIP on accessibility of extension services for increased maize production in the study area. The summary of findings by objectives are presented and discussed in the sub headings.

4.2.1 Objective 1- Influence of CIP on use of improved maize seeds

Table 4.12 indicate the econometric findings from probit model to analyse the Influence of CIP on use of improved maize seeds for enhanced maize production in the study area. Summary of findings indicated that only access to subsidy program for improved seeds, use of improved seeds to increase productivity, quantity of seeds used and attributes of CIP for services delivered are statistically significant at 5% and 10% level of significance respectively and influenced improved seed use during CIP for maize production.

Results from the probit model also showed that **access to subsidy program for improved seeds** affected positively the adoption of crop intensification program and was statistically significant at 5% level of significance (p-value of 0.01<0.05). The positive correlation coefficient implies that one unit increased the accessibility of subsidy program for improved seeds, the adopters of Crop intensification program increased by 6.84 percent of the total adopters of the program. The findings agree with the research conducted by (Nahayo et al., 2017).

Findings also from the run of probit model showed that **use of improved seeds to increase production** affected positively the adoption of crop intensification program for maize producers in the study area and was statistically significant at 5% level of significance (p-value of 0.027<0.05).

Also, this study revealed that **attributes of CIP for services delivered** have positive relationship with the increased maize production during CIP. As the goals of CIP was to increase agricultural productivity of high-potential food crops and to provide Rwanda with greater food security and self-sufficiency through the adoption Land Use Consolidation (LUC) as the main pillar, the proximity advisory services comprising seeds and fertilisers distribution and post-harvest technologies (e.g. driers and storage facilities), the benefits of this program attracted more farmers to increase their food

security as well as economic status; the findings are supported by the research conducted by Dusengemungu, 2016 cited in (Cantore, 2011).

Results presented in table 4.12 indicated that there is positive relationship between **quantity of seeds used** and adoption of CIP for maize production and was statistically significant at 5% level of significance (p-value of 0.015<0.05). Economically, this means that application of 1Kg of improved seeds increases productivity by a level of 0.15% for adopters. The findings are in line with the research conducted by (A. R. Bizoza & Havugimana, 2013)

Table 4.12: Influence of CIP on use of improved maize seeds for maize production

Adoption of Crop Intensification Program	***Coef.***	***Std. Err.***	***z***	***P>/z/***
Influence of CIP on accessibility of improved seeds				
Distributors/ Source of improved seeds	0.0551	0.0831	-0.66	0.507
Access to subsidy program for improved seeds	0.6836	0.2664	2.57	0.01**
Use of improved seeds to increase productivity	2.3487	0.1581	2.21	0.027**
Extent of seeds to increase cost of agriculture production	0.1807	0.1553	1.16	0.244
Quantity of seeds used	0.4154	0.1212	4.13	0.015**
Cost of improved seeds @ 50% of subsidy	-0.0003	0.0004	-0.07	0.946
Attributes of CIP for services delivered	0.5051	0.2639	1.91	0.0056*
_cons	-1.9304	1.3509	-1.43	0.153
Probit regression				
Number of Obs = 164				
Prob > F= 0.0000,				
R-squared = 0.887				
Significant at 1% (*), 5% (**), 10 % (***),				

4.2.2 Influence of CIP on fertilizer usage on maize production in the study area

Table 4.12 indicated the econometric findings from probit model to analyse the influence of CIP on fertilizer usage on maize production in the study area. Summary of findings from probit model indicated that fertilizer usage influences maize production significantly at 69% significance level (R-Squared=0.69).

Findings reveal that only Trainings conducted, need to increase crop productivity positively influenced use of fertilizers during CIP. On the other hand, cost of inputs, negatively influenced the use of fertilizers during CIP.

The Study findings indicate that **trainings** had positive relationship with the adoption of fertilizer usage for enhanced maize production**.** The one reasonable explanation for this is that extension equips the farmer with improved technologies and innovations that improve the farmer's efficiency leading to high yields thus increased production. Extension workers play a central role in informing, motivating and educating farmers about the available technology and also disseminate information about crop practices, optimal input use, and consult directly with farmers on specific production problems, thus facilitating a shift to more efficient methods of production. The results of the study are supported by findings of (Assa et al., 2012).

Results also from the probit model indicated positive correlation between **extent of fertilizer to increase the crop productivity** and adoption of crop intensification program and was statistically significant at 5% level of significance to influence the adoption of CIP program (p-value of 0.05< or= 0.05). Normally due to depletion of soil fertility, farmers' willingly need to adopt the use of fertilizers for two main objectives: additives for providing nutrients, and fertilizers for enhancing soil's effectiveness by modifying aeration and water retention. When farmers accessed fertilizers for increased crop productivity up 0.53percent level of probability, the adopters of crop intensification program increased by 6.45 percent of the total adopters existing in the study area and these findings are coherent with the research conducted by

Results also from the probit model indicated negative correlation between **cost of farm inputs** and adoption of crop intensification program and was statistically significant at 1% and 5% level of significance to influence the adoption of CIP program (p-value of 0.001< 0.05). Crop intensification program through the agro dealers' network markets influenced farmers to afford farm inputs like DAP and UREA at cooperative and household levels. The negative relationship is an indication that there is a gap in fertilizer markets outlets (agro dealers), and when prices of inputs are increased by a unit, adopters of CIP decrease by 22.2percent of the total beneficiaries of the program. The findings are supported by the research conducted by (MAKAU, 2016) and (Musabanganji, Karangwa, & Lebailly, 2016).

Table 4.13: Influence of CIP on fertilizer usage on maize production

Adoption of Crop Intensification Program	***Coef.***	***Std. Err.***	***z***	***P>/z/***
Influence of CIP on accessibility of fertilizers				
Access to fertilizers	-0.0232	0.5525	-0.04	0.067
Awareness on fertilizer subsidy	-0.2624	0.4079	-0.64	0.52
Source of information on fertilizer use				
Neighbors source	1.3137	0.6958	1.89	0.059
Trainings	1.1030	0.5328	2.07	0.038**
Extent of fertilizers				
Increase crop productivity	0.6449	0.3337	3.93	0.053**
Increases cost of agricultural production	-0.5046	0.4095	-1.23	0.218
Attribute Fertilizer use CIP	-0.9708	0.4930	-1.97	0.049
Purchase of farm inputs	-2.2214	0.6960	-3.19	0.001
Cost of DAP @ subsidized program	-0.0003	0.0002	-2.02	0.043**
Cost of Pesticides/herbicides	-0.0003	0.0001	2.12	0.034**
_cons	1.8350	2.8204	0.65	0.515
Probit regression				
Number of Obs = 164				
Prob > F= 0.0000,				
R-squared = 0.697				
Significant at 1% (*), 5% (**), 10 % (***),				

Note: Significant at 10%, 5% and 1% level of significance respectively

4.2.3 Influence of CIP on accessibility of extension services for increased maize production

Table 4.16 indicated the econometric findings from probit model to analyse the Influence of CIP on accessibility of extension services for increased maize production in the study area shows that Extension services influenced maize production during CIP significantly.(R-Squared=77%). Summary of findings from probit model indicated that only access to extension services from NGOs, quantity of maize harvested and level of Satisfaction for extension services influenced the adoption of crop intensification program for maize production and were statistically significant at 5% and 10% level of significance respectively in Nyagatare district.

Results from the probit model presented in table 4.16 showed that there is positive correlation between access to extension services and the adoption of Crop Intensification Program and was statistically significant at 5% level of significance (p-value of 0.023<0.05) to Influence of CIP on accessibility of extension services for increased maize production in the study area. This refers to the number of contacts per year that the respondent met with extension agents. Frequent visit of agricultural extension agents' increases awareness among farmers about new technologies through demonstrations and discussions.

Results also indicated that source of extension agents to promote crop intensification program played a greater role where results indicated that there is a positive correlation between extension agents from NGOs and adoption of crop intensification program at 10% level of significance (p-value of 0.06<0.1 level of significance). The positive relationship implies that Nongovernmental organization are normally involved in funding economic activities for rural awareness, motivation and village Self-Help Group (SHG) formation. This has been in response to the perceived needs at several levels in the study area; these results relay on the research conducted by (Ferris et al., 2014; Ngalemwa, 2013; Randell, 2014). The preference for NGO as agents for extension services explains the absence of public extensionists who are supposed to offer such

services but are not readily available. This is because they are few in numbers and have other attributes beyond agriculture development

Findings from the probit model showed that there is positive correlation between quantity of maize harvested and the adoption of crop intensification program and was statistically significant at 10% level of significance (p-value of 0.097<0.1 level of significance) to influence the adoption of crop intensification program on maize crop production. The positive sign indicates that CIP program was focused on the increased crop production and productivity through adoption of land use consolidation, proximity to inputs usage like fertilizers, pesticides and improved seeds. The implication directly suggests that one 1Kg of maize increased to the harvested crop up to 0.97percent level of probability, adopters of CIP increased by 0.001percent of the farmers under CIP; these findings agree with research conducted by (Pei et al., 2015).

Table 4.14: Influence of extension services for increased maize production

Adoption of Crop Intensification Program	*Coef.*	*Std. Err.*	*Z*	*P>/z/*
Influence of CIP on accessibility of extension services				
Access to extension services	0.8059	0.3533	2.28	0.023**
Extension service provider/ source of extension agents				
Extension agents from government	-0.3519	0.4959	-0.71	0.478
Extension agent from NGOs	1.1542	0.7218	-1.6	0.06*
Extension agents from farmers group	0.6431	0.4611	1.39	0.163
Distance to road	-0.0011	0.0037	-0.3	0.764
Distance to markets	-0.0081	0.0155	-0.52	0.601
Quantity of maize harvested	0.0001	0.0000	1.66	0.097*
Level of Satisfaction for extension services	0.4692	0.1949	2.41	0.016**
_cons	-0.7346	0.5135	-1.43	0.153
Probit regression				
Number of Obs = 164				
Prob > F= 0.0000,				
R-squared = 0.77				
Significant at 1% (*), 5% (**), 10 % (***),				

Note: Significant at 10%, 5% and 1% level of significance respectively.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Introduction

The overall study of this thesis is to analyze effect of crop intensification program on maize production in Rwanda; evidence from Nyagatare District. Indicating summary, conclusion, and recommendation reached for each specific objective is a crucial task. Here summary, conclusion, and recommendation are a brief and main body of this chapter as indicated in the subheadings.

5.1. Summary of findings

Objective 1: Based on the results, the study found that Fertilizer uptake and usage when used in appropriate proportions influences maize production significantly (R-squared=0.697) but only when farmers receive trainings on Good Agronomical Practices and the perception of farmers to use fertilizers to increase productivity is high and when costs of inputs are considered affordable as they negatively affect volumes purchased.

Objective 2: Based on the results, the study found that Improved seeds influence significantly maize production more than other independent variables in the study (R-squared= 0.887) as long as farmers have access to subsidy and are able to use and access improved seeds and they are able to enjoy the attributes of CIP services like extension, marketing and access to finance).

Objective 3: Also the study found that Extension services influenced maize production significantly during CIP (R-Squared = 0.77) as long as sufficient extension services are secured from NGOs and quantity of maize harvested are big enough to encourage them to produce more as a motivation and at the same time the level of satisfaction for the extension services received is high.

5.2. Conclusions

Objective 1: Based on the results, the study concludes that Fertilizer uptake and usage when used in appropriate proportions influences maize production significantly (R-squared=0.697) but only when farmers receive trainings on Good Agronomical Practices and the perception of farmers to use fertilizers to increase productivity is high and when costs of inputs are considered affordable as they negatively affect volumes purchased.

Objective 2: Based on the results ,the study concludes that Improved seeds influence significantly maize production more than other independent variables in the study (R-squared= 0.887) as long as farmers have access to subsidy and and are able to use and access improved seeds and they are able to enjoy the attributes of CIP services like extension ,marketing and access to finance).

Objective 3: Also the study concludes that Extension services influenced maize production significantly during CIP (R-Squared = 0.77) as long as sufficient extension services are secured from NGOs and quantity of maize harvested are big enough to encourage them to produce more as a motivation and at the same time the level of satisfaction for the extension services received is high.

5.3. Recommendations

Objective 1: The study concluded that fertilizer application is very important in the CIP program. It therefore recommends Government and related stake holders to put in place mechanisms to ensure that farmers receive sufficient training so that they are able to adopt good agronomical practices as they apply fertilizers to enhance production and productivity. This is to ensure that farmers have high perceptions for using fertilizers for increased productivity. The results of the study further recommends to strengthen current fertilizer subsidy program, distribution mechanisms and rural infrastructure to help small holder farmers to access fertilizers at low cost. The study further concluded that cost of fertilizers negatively affected profitability maize production. The study

recommends that the government and other relevant stakeholders should design institutional arrangements that aim at reducing transaction costs of maize production.

Objective 2: The study also concluded that improved seeds influence significantly maize production as long as they are subsidized and accessible. The results of the study recommends that in order to increase maize production in CIP programe, policy makers, implementers and related stake holders need to sensitize and mobilize small holder farmers on the use improved varieties by organizing awareness campaigns on the improved varieties.

Objective 3: From the results of the study, the current extension services do influence maize production significantly.

This study recommends that the public and private extensionists should ensure there are Farmer Field Schools established close to maize gardens and accessible to many farmers and to conduct their extension services beyond farms and across to the whole maize value chain

Study revealed low participation of public extensionists. They should be given ample time to fulfill their obligations in terms of improving agricultural production.

5.4. Recommendation for further research

Some research, have shown that intercropping increases output in maize-based systems. To this effect, according to Panel Data collected by Tegemeo institute of Ergerton University, Ariga and Jayne(2010) found a raising trend in the proportion of maize area planted in more complex intercropped patterns since the mid of 1990s as a result of the returns generated. On the contrary, the CIP in Rwanda emphasizes the Monocroping system in maize growing. Further research should be undertaken to make comparative analysis between the two models and their effect on maize production.

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APPENDICES

Appendix 1: Development of surveying questionnaire

QUESTIONNAIRE ON EFFECT OF CROP INTENSIFICATION PROGRAM (CIP): AN ANALYSIS OF ITS CONTRIBUTION TO INPUT USE AND EXTENSION SERVICES IN NYAGATARE DISTRICT. RWANDA

Section A: Identification

Item	Response	Item	Response
A1) Name of respondent		A7) Name of the enumerator	
A2) Sector		A8) Date of the interview	
A3) CELL		A9) Interview start time (hh:mm)	
A4) Village		A10) Interview stop time (hh:mm)	
A5) Cooperative name		A11) Respondent's consent	1= if yes, 0= if no
A6) GPRS Coordinates: Latitude:Longitude:			

Questionnaire No.

Section B: Demographic and socio-economic characteristics

B1) Gender	B2) Age	B3) Highest level of education	B4) Marital status	B5) Household size
1=Male 0=Female		1=informal 2=primary 3=secondary 4=tertiary	1=Married 2=Divorced/ Separated 3=Widowed 4= Never married	

Section C: Socioeconomic characteristics and Institutional arrangements

Questions	Indicator	Response
C1) What is the size of your farm?	(In hectares)	
C2) What is the size of your farm under maize farming?		
C3) What is the nature of tenure?	1-With title 0=Without title	
C4) How many years have you been practicing agricultural production?	(Open ended)	
C5) What are the three most important agricultural enterprises (crop) undertaken by your household by rank?	(List a maximum of three)	i) ii) iii)

C6) Are you or any member of your household a member of a registeredfarmers' group or association?	1= yes 0= No	
C7) If Yes to C6, what is the type of the group?	1= A producer cooperative society 2=SACCO 3= Self-help group 4=Community Based Organization (CBO) 5= Other(Specify)	
C8) Did you or any member of your household obtain credit facilities or loan in the last 12 months?	1= yes 0= No	
C9) If yes to C8, who provided the loan/ credit facilities?	1=Microfinance institution 2= Cooperatives 3=local money lender /shylock 4=Mobile credit 5=Family/Friends 6=NGOs 7= SACCOs 8= Farmers group 9=Other(specify)	

C10) Was any part of the credit used for agricultural production?	1= Yes 0=No	
C11) If Yes to C10, what was the loan used for?	1= Payment of labour services 2=Purchase of farm Inputs 3=Harvesting and aggregation of produce 4= for marketing and value addition activities 5= buy land 6= purchase of agricultural machinery 7= other (please specify)	
C12) Did you or any member of your household obtain extension services in the last 12 months?	1= Yes 0= No	
C13) If yes to C12, where did you obtain the extension service from?	1= government 2= NGOs 3= Research institutions 4= Farmers group 5= Other(Specify)	
C14) If no to C12, why not?	1= Lack of extension officers 2=distance from extension officers 3= No	

	need for extension officers 4= Other(Specify)	
C15) What is the distance from your homestead to the nearest all weather road?	In Kilometers	
C16) What is the distance from your homestead to the nearest town or market?	In Kilometers	

Section D: Fertilizer usage

D1) Did you use fertilizer in maize production in 2018A?	1=yes 0=no	
D2) If yes to D1, where did you purchase your fertilizer from?	Kindly indicate the options	
D3) Which type of fertilizer did you purchase?	Kindly indicate the options	
D4) If no to D1, what did you use?	1=manure =did not use either manure or fertilizer 3=others(specify)	
D5) Are you aware of any fertilizer subsidy program?	1=yes 0=no	
D6) If YES to D5, what was your source of information?	1=Neighbors 2= Farmer' Field Day 3= Seminars	

	4= Extension services 5= Farmers' group 6= Others(specify)	
D7) In 2018A did you have access to subsidized fertilizer?	1=yes 0=no	
D8) What mainly influence the amount of fertilizer used on your farm?	1= Subsidy program 2=Maize prices on the Market 3= Access to financial credit 4= Land size 5=Tested soils 6=Other specify	
D9) To what extent do you agree with the following statements		
D9i) Fertilizer use increases productivity	1=Strongly agree 2=Agree 3=Neutral 4=Disagree 5=Strongly disagree	
D9ii) Fertilizer use increases cost of agricultural production	1=Strongly disagree 2=Disagree	

	3=Neutral 4=Agree 5=Strongly Agree	
D10) How much would you attribute Fertilizer usage to CIP	1=<50% 2=50- 65% 3=65-85% 4=85-100%	

Section E: Improved seed

E1) In 2018A, which type of maize seeds did you use?	1= Purchased/ New hybrid 2= Retained hybrid 3= OPV from agro-dealers 4= Local varieties	
E2) How did you obtain the seeds?	1=Cash purchase 2=Credit 3= Exchange 4= Free 5= Retained seed 6= Voucher 7= Other (please specify)	
E3) What was the source of the seeds?	1= Government program 2= Small trader 3=Stockist/agent 4=Large company 5= NGO/CBO 6= RAB	

	7= Cooperative 8= Own seed 9=Farmer/neighbor 10=General market 11=Farmer group 12= Church 13=Employer 14= Other (Please specify)	
E4) What quantity did you purchase?	Specify	
E5) What was the cost per kg	Specify	
E6) Did you have access to improved seed from the subsidy program?	1=Yes, 0=No	
E7) If yes to E6 ,what is the Amount of improved hybrid seeds used	Kg	
E8) To what extent do you agree with the following statements		
E8i) Use of improved seeds increases productivity	1=Strongly agree 2=Agree 3=Neutral 4=Disagree 5=Strongly disagree	
E8ii) Use of improved seeds increases cost of agricultural production	1=Strongly disagree	

	2=Disagree 3=Neutral 4=Agree 5=Strongly Agree	
E9) How much would you attribute improved seed usage to CIP	1=<50% 2=50- 65% 3=65-85% 4=85-100%	

Section F: Access to Extension Services

F1) In 2018A, did you or any member of your household receive extension service on maize production?	1=Yes 0=No	
F2) If yes to F1, who provided the extension services?	1=Government 2=private extension 3= cooperative/farmer association 4=NGO'S 5=Others(please specify)	

F3) Who in the household received the extension service?	1= Household Head 2= spouse 3=child 4= farm manger 5=other (specify)	
F4)How often do you receive the extension services?	1=More than once a week 2=Once a Week 3= once in 2 weeks 4=Once a month 5= Other (specify)	
F5) In which areas do extension officers support you?	1=Good Agricultural Practices(GAP)2=Market linkages 3= Securing Financial credits 4= Post Harvest Handling 5=Access to farming Inputs 6=Name other	
F6) In 2018A, did you or any member of your household attend any field day?	1=Yes, 0=No	

F7) What was your level of satisfaction with the extension service	1= very dissatisfied 2=dissatisfied 3=neutral 4=satisfied 5=very satisfied	

Section G: Expenditure

Serial number	Items	Unit	Amount (Frw)	Cost/year (Frw)
1.	Land preparation :			
	Machinery cost			
	Labour cost			
2.	Seeds			
3.	Non-subsidized Fertilizer:			
	DAP			
	CAN			
	NPK			
	Others(specify)			
4.	Subsidized Fertilizer:			
	DAP			
	CAN			
	NPK			
	Others (specify)			
4.	Pesticides/herbicides			
5.	Harvesting cost:			

	Machinery cost			
	Hired labour			
6.	Permanent labour			
7.	Transportation cost			
8.	Rent cost (rented land)			
9.	Other			

Section H: Output

What quantities of maize did you harvest in the previous season?	Was any output marketed?	If yes, where did you market your produce?	What quantities were sold per season/harvest?	Price per unit	Terms of payment	Total income
	1=yes 0=no	1= local open air market 2= supermarket 3= farm gate 4= contracted			1= Cash 2= Credit 3= Other (specify)	

		buyer 5= other (specify)				

Section I: Household Incomes (12 months recall)

Income Source	Did anyone in your household earn income from this source last year)? 1=yes, 0=no skip	If Yes, what is the total income in the year? (KES)
Informal Employment /casual labour		
formal employment		
Agricultural /agribusiness		
Business		
Remittances		
Petty trade (sale of wares or other products in the market apart from the listed items)		
Pension		
Rented out properties		
Others (Specify)_____		

Focus group Discussions

1. In your opinion do you see any contribution of CIP on Inorganic fertilizers usage. How has this contributed to maize production in your area?
2. How has CIP influenced use of improved seeds, Has this contributed to maize production in your opinion
3. To what extent has CIP led to the increased Extension services. Has it influenced maize production .
4. What were challenges encountered in the implementation of CIP in your area

3. What would you recommend to the government and stakeholders with regard to the improved performance of CIP?