Institute of Research and Dialogue for Peace

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DETERMINANTS OF INORGANIC FERTILISERS AND IMPROVED SEEDS USAGE ALONG EXTENSION SERVICES SUPPORT FOR AGRICULTURAL PRODUCTIVITY IN RWANDA

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ABBREVIATIONS AND ACRONYMS

CIP	Crop Intensification Program
EICV	Integrated households living condition Survey
FAO	Food and Agriculture Organization of United Nations
FGDs	Focus Group Discussions
FY	Financial year
DAP	Di -Ammonium phosphate
GoR	Government of Rwanda
IRDP	Institute of Research and Dialogue for Peace
MINAGRI	Ministry of Agriculture and Animal Resources
LUC	Land Use Consolidated (LUC)
KIIs	Key Informant Interviews
MINALOC	Ministry of Local Administration
NST1	National Strategy for Transformation
NAP	National Agricultural Policy
NISR	National Institute of Statistics in Rwanda
PSTA 4	Strategic Plan for Agricultural Transformation 4
RAB	Rwanda Agriculture Board

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EXECUTIVE SUMMARY

This report presents the findings of a study on determinants of inorganic fertilizers and improved seeds usage, along extension services support for agricultural productivity in Rwanda was carried out by Institute of Research and Dialogue for Peace- IRDP researchers. The aim of the study was to establish the major barriers to increasing the availability, access and use of inputs as the basis for proposing policy options to improve input use. To achieve this the following activities were carried out: (1) Analysis of secondary data on fertilizer availability, access and use from different stakeholders, and reports and studies relevant to fertilizer and other inputs in Rwanda, (2) collection and analysis of primary data and collating it with information from secondary data to support identification of constraints to increase input use, and (3) contribution to the development of policy options to support the attainment of the GoR goal of increasing fertilizer use from the current 36Kg/ ha to 75Kg/ha by 2024,which is the target in PSTA4.

IRDP conducted a rapid review of available literature on fertilizer use to understand what the key barriers and constraints to increasing fertilizer use. This included: issues relating to the timely supply of appropriate inputs, the affordability of inputs, issues relating to the distribution of inputs, and lack of knowledge on the part of farmers about how to access and effectively use of inputs. The consulted documents included, but was not limited to, the Strategic Plan for Agricultural Transformation IV, the National Fertilizer Policy, the World Bank 2018 Rwanda Drivers of Growth study, the Seasonal Agriculture Survey, the Agriculture MIS system held at MINAGRI, and other relevant data sources and key policy documents.

The survey employed both quantitative and qualitative methods to understand and analyze the main barriers to increasing fertilizer uptake among farmers, along with related topics including seed use and engagement with extension services. This included structured surveys and focus group discussions with a group of farmers and other concerned individual interviews. The survey was conducted in ten Districts, covering all provinces and included farmers producing priority food crops covered by CIP. Approximately 1,846 farmers were reached through the survey; the study covered the sample of 862 farmers in CIP sites and 984 farmers in non-CIP sites.

In-depth interviews were conducted through FGDs with group of farmers, the representative of central government authorities (Government Ministries, Agencies, etc.), Local Government Officials, local government agronomists, extension services providers, agro dealers, development partners in agriculture sector, CSO representatives operating in the agriculture sector, Academicians in the field of Agriculture. In additional to this KIIs and FGDs participants

proposed key actions or recommendations as area of improvement to address challenges facing the access to inorganic fertilizers and improved seeds.

The analysis of the collected data, provided the following findings

Socio-economic and Demographic characteristics of the surveyed farmers and linked determinants in use of improved seeds and fertilizers

About 98.2 percent of the surveyed farmers practice farming (crops and livestock) as a main economic occupation, and 85.3% own the land where they cultivate. 72.9%) received the extension services. The majority of surveyed farmers (64.9%) have primary level of education and 24.3% did not attend any formal school. With such some poor educational background farmers cannot take the advantage of written materials such as leaflets that are often made available by RAB, instead they mostly depend on the information made available by word of mouth from the farmer promoters, FFS Facilitators and agronomists and NGOs.

55.4% of surveyed farmers belong to Category one and Category two of Ubudehe Clusters. The prices for agriculture inputs under the subsidy program are reasonable but the purchasing power of some farmers who belong in CAT1 and CAT2 of ubudehe category is still low compared to the required fertilizers and improved seeds for their pieces of land. Among the surveyed farmers, only 37.4% belong to agriculture cooperatives50.7% are registered in SMART-Nkunganire program. Although the system was introduced to address challenges that were being experienced in the inputs management and distribution, it caused new challenges in that each farmer must own a smart phone, and also be literate as to calculate the farm size in meter squared to be able to register.

Most farmers cultivate land which is less than one hectare (82.0%), and the predominant crops grown in season B, 2019 are beans (68.1%) followed by maize (67.2%), Irish potatoes and cassava represent 26.9% and 24.6% respectively. Farmers grow a variety of crops on the same piece of land, either as mono-crop or in intercrops. Among the crops predominantly grown by the farmers, it is only maize which is covered by the crop subsidy program. Therefore, farmers are faced with non-availability of improved seeds and inorganic fertilizers for those crops not covered under the subsidy program.

The policy environment and how it determines the fertilizers and seeds usage among the farmers.

CIP Subsidy policy: The farmers outside CIP seem not to have an avenue for procuring certified seeds and even the farmers within CIP access to certified seeds is limited to the three crops covered by the subsidy program. Access to certified seeds outside the subsidy program are not guaranteed.

Importation policy: RAB establishes the required amount through consolidation of the orders as submitted by the farmers through the smart Nkunganire system. However, there are delays in RAB communicating this information to the importers.

Seed marketing: Although the government of Rwanda encourages the private sector to invest in seeds and fertilizers marketing and distribution the government controls the seed regulation and distribution and guides the pricing of the seeds and fertilizers, through the ministerial guidelines released every year. Therefore, seed and fertilizer pricing is not liberalized nor bargained between, distributors and users.

Fertilizer marketing: The government policies do not provide clear guidelines on the companies' roles and responsibilities in the fertilizer market.

Distribution system: Current Government policies mandate the number and location of agro dealers, creating efficient market reach while causing many of them to be unprofitable.

Barriers to achieving increase in inorganic fertilizer and improved seeds Usage

Barriers as identified by Private companies (importers), include Policies not been fully implemented; Inadequate demand forecast system and Inconsistency in subsidy strategy.

Barriers as identified by seed producers- Key challenges, which face the seed producers/multipliers in, include the following; Insufficient post-harvest equipment (driers, storage); limited mechanization; Land availability to meet seed production requirements (isolation for hybrid); insufficient of irrigation facilities leading to the rain fed seed production negatively affecting the quality of seeds; Inadequate knowhow on hybrid seed production ;Inadequate seed processing facilities; Limited market (only sell to RAB) and sometimes there is late of payment of suppliers invoices.

Barriers as identified by Farmers-The reasons hindering use of improved inputs, particularly fertilizer and seed are identified as follows:The price of inputs –The farmers consider fertilizers and seed expensive despite the fact that most receive it at a heavily subsidized price; Availability of inputs at the right time; The inputs suitability to the respective agro ecological zones; Poor seed quality; Sometimes farmers experience delayed planting due to the delay of supplying the improved seeds to the agro-dealers outlets; The subsidies are limited to inorganic fertilizers and improved seeds, not for pest and disease control chemicals, the farmers need subsidies in pesticides for pest and disease control; Sometimes the farmers do not get market for their yield; Low quality of yields, which are not accepted by buyers due to inefficiency of postharvest practices.

In conclusion, the findings of this study revealed the following as important determinants of fertilizers and seeds use;

- High cost of inputs: Farmers acknowledge the benefit of high yields as a result of using improved seeds however they state that the cost of acquiring these seeds is still too high even under the subsidy and hence they are not able to use the hybrid seeds in all seasons.
- Registration with Smart-Nkunganire: -. It is mandatory to register with smart Nkunganire so as to order for the specific amount and type of inputs required. Those who do not register cannot benefit from the subsidy program.
- Types of crops grown: Farmers use improved seeds only for those crops under the seed subsidy program.
- Types of seeds and fertilizers availed at the local agro dealers: Farmers (through their cooperatives) do not have direct linkage with the seeds and fertilizer companies to allow them order directly for what they need. Therefore, the farmers buy what the government avails to the agro dealers and the farmers' preferences may not be locally available.
- Farmers' knowledge and mindset: The provision of proximity extension services has played a major role in improving farmers' knowledge in using agriculture inputs (using fertilizers and improved seeds). The advisory services provided by the extension workers play a key role in the farmers' mindset on whether to use or not use inorganic fertilizers and improved seeds.
- Administrative issues:Regarding to the findings; the farmers in FGDs in Nyanza, Nyabihu and Burera districts, proposed that there is a need of prioritizing to prepare the inputs request list at least two months before requesting inputs, and there is a need to train and to facilitate the farmers how to make their request in smart-Nkunganire using mobile phones because some of farmers do not know how to use telephone to apply for inputs

From the findings and conclusions, the survey arrived at recommendations for policy actions to improve farmers' usage of agriculture inputs and to improve private sector involvement in inputs sector.

Recommended Policy Actions that should be addressed

- Inclusion of more crops under the seeds and fertilizers program
- Establishment of guidelines on good practices that facilitate marketing of seeds and fertilizers outside the CIP subsidy program
- Clear, long term time-bound strategy for the subsidy program to allow companies plan accordingly
- Basing to the findings, the government subsidies should be maintained at a level to match the farmer's capacities. The farmers who belong in Category one and two should be advocated in getting special support, they have land to cultivate but they do not have the capacity to buy inorganic fertilizers for their total cultivated land.
- Clear fertilizer strategy with specified private companies' roles and responsibilities in the fertilizer market thereby eliminating unfair playing ground.

- The establishment and support of cooperatives and community-based fertilizer and seeds purchasing networks at village level.
- Fertilizer procurement based on soil maps for the country such that for each agro ecological region, the nutrient deficiencies are identified and the nutrient requirements are established.
- Introduction of inorganic fertilizers tailored to local crop and soil requirementsin the country

Recommendations to improve farmers' usage of agriculture inputs

- The government should effect reforms in the targeting of input subsidies beneficiaries in terms of withdrawing particular households, i.e. large-scale producers, and therefore allow a channel of scarce public resources to agricultural households in need.
- The poverty reduction programs should be sustained to increase the purchasing power of the farmers and later help the farmers to have the capacity of buying the agriculture inputs without government subsidies.
- Put in place the program to support the farmers who have poor purchasing powers and who belong in CAT1 and CAT 2 of ubudehe to access the inorganic fertilizers.
- *Improving farmers' access to credit*-There is needed to improve access to credit by farmers, through various measures.
- *Changing the farmers' mindset toward inorganic fertilizers use*- There is a need for strong mobilization in using inorganic fertilizers to farmers who have wrong information on the negative effects of inorganic fertilizers.

Recommendation to improve private sector involvement in inputs sector

- Import supply chain: Respecting the phytosanitary tests in the country /port of origin considering they are in COMESA. This will reduce the days the fertilizers remain at the port awaiting permission to import into the country.
- RAB should Provide data on the fertilizer requirements per region based on aggregated demand

CHAPTER 1: INTRODUCTION

1.1 Background

The agricultural sector remains the backbone of the Rwanda's economy, and employs nearly 70% of the Rwandan population, mostly in smallholder farming. Because agriculture employs most of Rwanda's population, the performance of the sector has a significant impact on progress in reducing poverty. According to the findings from the EICV5, the reduction in poverty from 56.7% to 38.2% that pushed a million of Rwandans out of poverty between 2005/6 and 2016/17, was driven primarily by agricultural interventions. The poverty reducing effects of agricultural development are particularly significant for women who constitute two-thirds of the total agricultural workforce.

The Crop Intensification Programme (CIP) was introduced in Rwanda in 2007 by the Ministry of Agriculture and Animal Resources (MINAGRI) to address the problems of land fragmentation, low use of agricultural inputs and low access to extension services. Its primary goal is to increase agricultural productivity by significantly increasing the production of eight priority food crops (maize, rice, wheat, beans, soybean, cassava, Irish potato and banana) across the country. The programme provides support to around 50% of Rwanda's farmers in four areas: i) Access to inputs, ii) Land use consolidation (LUC), iii) Proximity extension services and iv) Post-harvest handling and storage.

Ikiraro supported IRDP to research farmer satisfaction with CIP in 2017. The research found there is moderate levels of satisfaction amongst smallholder farmers with CIP overall. 65% of surveyed CIP farmers were satisfied with services provided through the four components of CIP, and 75% believed the CIP had helped them to attain household food security. However, satisfaction levels varied for the four components, with access to inputs and proximity extension services scoring higher than land use consolidation and post-harvest services and storage handling. The survey also revealed that farmers have significant concerns about the land use consolidation component of CIP, and that there is common perception that the programme is intended to enable government to take control of farmers' lands. Farmers also criticized the promotion of mono cropping in consolidated lands, claiming mono cropping exposes farmers to greater risks of crop failure. Farmers also frequently complained that inputs were not made available in a timely way and that current supply arrangements led to high prices. Farmers, who believe that distributed fertilizers have harmed the quality of their soil, have also questioned the quality of inputs.

IRDP held consultations with MINAGRI and RAB who showed interest in a more limited and focused question: understanding perspectives and barriers to input use under CIP and exploring options to increase application rates that align with farmer preferences. The study was

therefore focus on the use of inorganic fertilizers and improved seeds and the extension services support for improved agricultural productivity.

1.2 Fertilizer use in Rwanda

Fertilizer is regarded as crucial for small-scale farmers in crop production Rwanda. Intensive use of inorganic fertilizer in conjunction with improved seed varieties and expanded extension services have brought about rapid increase in fertilizer rates in Rwanda. According to MINAGRI, CIP has led to a 150% increase in the production of priority crops over the period 2007-2013 on CIP supported plots. These gains have been driven by increased use of chemical fertilizer and improved seeds, consolidation of cropped areas, more active use of agriculture extension services and investments in post-harvest technologies.

Fertilizer use has improved from 4Kg/Ha in 2007 to 35Kg/Ha in 2016/17. Fertilizers are used predominantly for food crops (approximately 78%). CIP subsidizes up to 95% of fertilizers used on priority food crops by up to 35% (down from 50% in 2014); this is coupled with strengthening of extension services to promote farmers' awareness and knowledge of the use of fertilizers. All fertilizer used in Rwanda is imported, with nearly 55,000 tons imported on average annually from 2015-17.

In 2007, the GoR launched the flagship Crop Intensification Programme (CIP) with the goal of increasing agricultural productivity of priority food crops under the Strategic Plan for the Transformation of Agriculture. Recognizing that low soil productivity was a major constraint to crop productivity, CIP prioritized improving the availability and access of fertilizers for farmers. To make the fertilizers affordable subsidies were provided initially for maize, wheat, rice and Irish potato production. Fertilizer use was promoted among farmers through proximity extension services and the use of demonstrations.

From 2007-2013/14, MINAGRI offered crop-based fertilizer subsidies for maize and wheat at 50% of the retail price. These high subsidies proved to be a burden on the budget, and cases of smuggling were reported. From Season 2014 A MINAGRI introduced fertilizer based subsidies, and in July 2014 reduced the subsidies for DAP and urea from 50% to 33%, and 28% respectively. Moreover, the number of eligible crops was increased to include maize, wheat, rice, Irish Potatoes, soybeans, cassava, banana, beans, fruits and vegetables. In FY 2015-16 subsidies were introduced for secondary and micronutrient fertilizers (such as sulfur, zinc, boron, and copper) and lime.

To improve the efficiency of fertilizer trade as well as the efficiency of subsidy management, MINAGRI in FY 2014/15 shifted from the distribution of subsidized fertilizers through vouchers

to distribution to listed farmers. Farmers were originally given vouchers; this has shifted to extension-developed lists, and a digital registration system known as the Smart Nkunganire System

1.3 Rationale of the study

Modern agriculture depends on inorganic fertilizers to replace nutrients removed by plants, thereby enabling sustainably high yields. In low and middle-income developing countries, average fertilizer use was 168 kg/ha of nutrients, while average world use was 141 kg/ha (World Development Indicators, http://wdi.worldbank.org) Rwanda's current low fertilizer use constrains yields far below what farmers achieve in other countries, and which could be achieved in Rwanda. Current fertilizer use in Rwanda is low (35Kg/Ha of net cropped area in 2016/17) vis-à-vis the 50 Kg/Ha in Abuja Declaration on Fertilizers target for an Agricultural Green Revolution. This results in sub-optimal production yields and low returns to farmers.

The limitation has largely been due to a knowledge gap among farmers on how to optimally use fertilizers as well as other inputs in order to have the maximum benefit. To close this gap, preferred options include: Getting improved seeds to small farmers and increasing fertilizer use are critical to raising agricultural productivity in Rwanda. An important prerequisite for creating high quality crops with good growth and high yield is good seeds, and therefore improved seeds have been included in the subsidy programme. The government of Rwanda through innovative private sector partnership is set to increase production of locally produced seed. It is important to add nutrition to these improved seeds in form of inorganic fertilizers so as to achieve high productivity.

In effect, agricultural extension services are what tie improved seed, chemical fertilizers, and credit together for the Rwandan smallholder farmer. At the beginning of the Crop Intensification Programme (CIP), the Government worked hand-in-hand with service providers to advise farmers on the types, quantities and application methods for various fertilizer applications for the different CIP crops. The extension agent to farmer ratio was about 1:500. The model was quite successful in increasing fertilizer use from 4kg/ha pre-CIP to about 8kg/ha in 2010. On the other hand, the model proved to be quite expensive for the Government to manage, limiting the budget available for fertilizer purchase, and thus later dropped. The Government developed TWIGIRE MUHINZI, which utilizes a Farmer Field School approach and farmer-to-farmer extension. Farmers form groups of about 25 individuals on a village level. A farmer promoter (volunteer extension agent) is responsible for training the farmers in these groups based on the extension messages and training that s/he has received from RAB. Farmer Field Schools with demonstration plots are used to practically pass on the extension messages and GAPs to farmers within their respective groups. The study was therefore establishing how the provision of extension services imparts the farmers with skills and knowledge on application and usefulness of fertilizers respectively.

1.4 Research Questions

The study was focus to answer the following research questions.

- How is the enabling environment in terms of policies, strategies and programmes?
- Challenges in using Seeds and fertilizers, and other inputs, including cost and affordability, availability, accessibility, relevance, reliability?
- Which factors make that farmers decide to use or not to use fertilizers and seeds (social demographic characteristics, attitude towards usage, Knowledge on seeds and fertilizers application etc.)?
- Which are the farmers' preferences in Seeds and fertilizer types and usage?
- What is the Knowledge and attitudes toward good agricultural practices with respect to fertilizers and seeds use?
- Which are the practices used by farmers in applying fertilizers?
- What is the farmers' experience with, and quality of advice given by extension workers?
- How are the farmers' relationships with agro dealers, distributors and local government officials?
- Which are the sources of information on input use, changes in guidance and related issues?
- Which are the barriers to achieving the target of an over two-fold increase in fertilizer application?

1.5 Study Objectives

1.5.1 overall objective

To understand and analyze the main barriers to increasing fertilizer uptake among farmers, along with related inputs including seed use and engagement with extension services.

1.5.2 Specific objectives

- To provide insights into the most important determinants of fertilizers and seeds use;
- To analyze the policy environment and establish how it support the fertilizers and seeds use among the farmers;
- To identify the challenges faced by farmers in using fertilizers and seeds;
- To establish the factors that make the farmers decide to use or not use fertilizers and seeds;
- To establish the farmers' perceptions on how the factors in 3 affect the fertilizer and seeds use;
- To establish the farmers' knowledge on fertilizers and seeds use;

- To establish how the provision of extension services impart the farmers with skills and knowledge on use of fertilizers;
- To make recommendations on how to address the identified challenges so as to improve the fertilizer application rates in the country;

1.6 Scope of the survey

1.6.1 Desk Review

IRDP conducted a rapid review of available literature on fertilizer use to understand what the key barriers and constraints to increasing fertilizer use are, which can then be tested through the survey. This included: issues relating to the timely supply of appropriate inputs, the affordability of inputs, issues relating to the distribution of inputs, and lack of knowledge on the part of farmers about how to access and effectively use of inputs. This included, but was not limited to, the Strategic Plan for Agricultural Transformation IV, the National Fertilizer Policy, the World Bank 2018 Rwanda Drivers of Growth study, the Seasonal Agriculture Survey, the Agriculture MIS system held at MINAGRI, and other relevant data sources and key policy documents.

1.6.2 Data collection

This component undertook both quantitative and qualitative methods to understand and analyze the main barriers to increasing fertilizer uptake among farmers, along with related topics including seed use and engagement with extension services. This included structured surveys and focus group discussions with a group of farmers and other concerned individual interviews. The survey was conducted in ten Districts, covering all provinces and reaching farmers producing food crops covered by CIP. Approximately 1,846 farmers were reached through the survey. Topics to be covered by the research included: a) Challenges in accessing fertilizer and other inputs, including cost and affordability, availability, etc. b) Farmer preferences in fertilizer types and usage, c) Knowledge and attitudes toward good agricultural practices with respect to input use, d) Practices used by farmers in applying fertilizer, e) Experience with and quality of advice given by extension workers, f) Relationships with agro dealers, distributors and local government officials, g)Sources of information on input use, changes in guidance and related issues, h) Barriers to achieving the target of an over twofold increase in fertilizer application.

CHAPTER 2: METHODOLOGY

2.1 Technical Approach

The study investigated the factors determining the level of fertilizer use and the farm and farmer related characteristics as well as farmers' perceptions on fertilizers and improved seeds use as well as how provision of extension services affect the fertilizer usage. The reports from districts (Imihigo documents, 2017/2018FY related Agriculture), Rwanda Agriculture Board (RAB, Agriculture sites reports, 2017) and Other Agriculture National Statistics (SAS 2018, Households agriculture Survey, NISR 2018) indicated that, there are agriculture sites that met the requirements of crop intensification Programs (CIP).The study covered the CIP consolidated sites and non-CIP consolidated land in Rwanda. The survey analysis of the farmers' decisions on fertilizer and seeds use mainly considered the factors lying within the public domain (e.g. prices and marketing, fertilizer provision, distribution and research, etc.), and on agro-climatic conditions and characteristics of the farm or the farmer (e.g. education, age, experience and farm resources). The survey contained a series of questions relating to farmers' subjective assessment of the factors influencing their decisions about fertilizer use. Both farmers within LUC and Non-LUC sites were asked to list the most influential factors when deciding how much fertilizer to use. In addition, farmers were asked to rate the decision variables according to their importance, whereby farmers were asked to rate the level of the importance of a series of decision variables using closed ended-questions and four Likert scales ranging to four choices.

2.2 Methodological Approaches

The survey undertook both quantitative and qualitative methods to understand and analyze the main barriers to increasing fertilizer uptake among farmers, along with related topics including seed use and engagement with extension services. This included structured surveys and focus group discussions with a group of farmers and other concerned individual interviews. Surveys were conducted in ten Districts, covering all provinces and reaching farmers producing eight food crops covered by CIP. In additional to this, the survey provided farmers, central and local agriculture partners, agro dealers, district and sector agronomists, extension services providers responses on their needs, what do they say about the implementation process on agriculture

policies and program and what do they wish to keep and what to exclude in the existing processes. To gather the quality of information, the study included desk review (documentary research which allows gaining an in-depth knowledge of previous studies on similar topics, relevant policy documents and other related reports), face-to-face interviews between interviewer and farmer through structured questionnaires and focus group discussions with a group of farmers who belong in CIP and Non-CIP sites, farmers Cooperatives, agro dealers in district, agronomists, extension services providers and other concerned individual interviews were also conducted and used.

2.2.1 Target group and sampling procedures

According to EICV5 main indicators report (NISR, 2018) and Agriculture Sites reports (RAB, 2018) show that the total number of farmers in 10 selected districts is 1,389,000. 357,605 farmers have their plots in CIP sites and 1,031,395 farmers don't perform their farming activities in CIP. The farmers, who have plots in CIP sites, registered by district agronomists and also by other extension services providers and this assist them to get agriculture services. This survey targeted 10 districts, the ordinary citizens such as small, medium and large scale farmers with at least aged 18 and above, the implementing and interventions institutions in the agriculture sector within districts were targeted as KIIs (local Government Officers, agronomists, extension services providers, agro-dealers, importers of inputs, development partners in agriculture sector, CSO representatives operating in the field of agriculture, Academicians in the field of Agriculture were the part of target population). The Policy level institutions were the part of interviewees (MINAGRI, RAB).

The recent published data by the National Institute of Statistics of Rwanda (NISR) from the integrated households living condition Survey (EICV5/2016/2017) results indicated that the total population who are involved in agriculture sector is 5,825,000.

This total population is disaggregated into young people aged 16-35 years who are equivalent to 2,443,000 and adult persons aged 36-64 years who are counted 3,382,000. The female who participate in agriculture sector count 3,114,000 and male count 2,711,000 (EICV5). The total population who participate in agriculture sector, the independent farmers count 4,534,000 and are distributed to 30 districts and 416 sectors in Rwanda.

Table 1 below illustrates the status of farmers within selected districts as a part of sampling unit.

Table 1:Target famers in 10 districts

Province	**Districts**	**Total farmers in District (NISR, EICV5, Table A.8)**	**Farmers in CIP Sites**	**Farmers in Non-CIP sites 2019**

			(RAB Report 2019)	
East	Gatsibo	207,000	48,255	158,745
	Kirehe	169,000	44,462	124,538
North	Musanze	140,000	61,283	78,717
	Burera	153,000	48,838	104,162
West	Nyamashe ke	168,000	48,483	119,517
	Nyabihu	121,000	35,677	85,323
South	Ruhango	130,000	28,104	101,896
	Nyanza	146,000	28,528	117,472
CoK	Kicukiro	36,000	4,873	31,127
	Gasabo	119,000	9,102	109,898
Total		**1,389,000**	**357,605**	**1,031,395**
Proportion			**25.75 %**	**74.25%**

Source: NISR, EICV5, 2017 and RAB report.

2.2.2 Sampling technique and Sample size determination

To get the accurate information, each category of farmers (CIP sites and non-CIP sites) is independent to provide information related to the key variables to respond the study objectives. In this study purposive and simple random probability sampling were used in selecting sample representatives in term of agriculture program geographical scope where the agriculture inputs are applied within farms. The farmers who are or not benefiting in CIP were sampled. The criteria of choosing the surveyed farmers was guided by the study objectives as follows:

- Selecting independently CIP and Non-CIP sites in districts where the farmers use or do not use agriculture inputs (Fertilizers, Seeds) and get extension services;
- Representation based on the selected priority crops as their land use requirements. The surveyed farmers indicated the kind of crop grown among the eight priority crops;
- Clustering the farmers based on farming scales (large or small), and nature of land used uplands, lowlands and marshlands;
- Clustering respondents by social and demographic characteristics.

The scope of sampling was based on selecting locations and individual; whereby 10 Districts and 20 sectors, 2 sites in each sector (CIP site and Non-CIP site) were selected using stratification sampling, 3 or 4 districts were selected in the province and 2 sectors were selected within a district and 2 sites were selected within a sector. To determine the sample sizes of the farmers surveyed in each site (CIP-Non-CIP Sites); the Raosoft formula and calculator were adopted and used where each sample is independent for getting accurate information (n_1= CIP sites 'farmers and n_2 = Non-CIP sites 'farmers. The farmers in both sites were known (see table 1): The following Raosoft formula and calculator were used to determine sample size: (http://www.raosoft.com/samplesize.html): $X = Z(^{c}/_{100})^{2}r(100-r)$; $n = {}^{N}x/_{((N-1)E^{2}+x)}$; $E = \mathbf{Sqrt}[{}^{(N-n)x}/_{n(N-1)}]$ whereby: the sample size *n* and margin of error *E* are given by:; where *N* is the population size, *r* is the fraction of responses rate that is interested in, and *Z*(*c*/100) is the critical value for the confidence level *c*.). The table below illustrates the sample size for each category of farmers. The table below illustrates the sample sizes.

Table 2: Sample size calculation using Raosoft formula

Farmers in CIP Sites (357,605)	**Farmers in Non CIP sites (1,031,395)**
Standard error = 3%	Standard error = 3%
Confidence level = 97%	Confidence level = 97%
Response rate = 80	Response rate = 75
Sample size = 836 farmers	**Sample size = 981**

The sample size calculations showed that the study covered the sample of 836 farmers in CIP sites and 981 farmers in non-CIP sites. The data collectors exceed the computed number where the CIP farmers exceeded (26 farmers) and (3 farmers in Non CIP). To determine the number of sampled farmers within district, the farmers' proportions within district were used to know the exacted number of farmers to be surveyed at specific district in both targeted

sites. Table 3 indicates the number of farmers surveyed in each district and each category, while table 4 indicates the criteria of selecting respondents and data gathering methods.

Table 3: Distribution of sample size of farmers in respective districts

Province	Districts	District Proportion with total farmers with CIP sites	Sample size of farmers for CIP Sites	District Proportion with total farmers with Non CIP sites	Sample size of farmers for Non-CIP Sites
East	Gatsibo	0.135	**113**	0.154	**151**
	Kirehe	0.124	**104**	0.121	**119**
North	Musanze	0.171	**143**	0.076	**75**
	Burera	0.137	**115**	0.101	**99**
West	Nyamasheke	0.136	**114**	0.116	**114**
	Nyabihu	0.1	**84**	0.083	**81**
South	Ruhango	0.079	**66**	0.099	**97**
	Nyanza	0.08	**67**	0.114	**112**
CoK	Kicukiro	0.014	**12**	0.03	**29**
	Gasabo	0.025	**21**	0.107	**105**
Total			**836**		**981**

Table 4:Criteria of selecting respondents and data gathering methods

Steps	Key target	How to reach the individual target
Step 1	Identify list of farmers in sites (CIP and Non-CIP) in selected district and the farmer aged 18 years to 64 years were allowed to be a part of the research.	With support of district agronomists, consultants identified the farmers who use of fertilizers, seeds and get extension services for both CIP and Non-CIP sites.
Step 2	Select randomly the respondents/farmers in relation to the desired number of informants in each	Using the list of farmers that is provided by District and sector

	site (simple random probability sampling: each farmer has an equal chance of being chosen)	agronomists for the farmers.
Step 3	Arrange the interviews on structured questionnaire and focus group discussions	Enumerators/data collectors were hired and trained for data collection process and tools
Cross-cutting consideration	Each District/ 2sites, one for CIP and Non-CIP, the sample consisted of male and females. The rule thumb is 3/7 or 7/3 male to female ratio to avoid gender imbalance in the sample (Unisex)	

2.3 Data collection technique and research tools

This component undertook both quantitative and qualitative methods to understand and analyse the main barriers to increasing fertilizer uptake among farmers, along with related topics including seed use and engagement with extension services. This included structured surveys and focus group discussions with a group of farmers and other concerned individual interviews. Data collection included the following four methods:

- Desk Review (Reviewing agriculture policies, strategies and other relevant documents);
- Key Informants Interviews (KIIs) guides for agriculture stakeholders and partners;
- Focus Group Discussion (FGDs) with forming group of 7-12 farmers; and another group needed;
- Questionnaire Survey-Csentry data Collection, with individual farmers (Using Smartphone/tablets).

2.3.1 Desk Review

The review of policies and other documents related allowed in gaining an in-depth knowledge about the policies provisions and expectations, and outcomes in helping farmers to access and use of agriculture inputs (fertilizers, seeds) and to get extension services, the researchers got the existing knowledge from previous studies on similar topics, relevant policy documents and other related reports). IRDP commenced the study by conducting a rapid review of available literature on fertilizer use to understand what the key barriers and constraints to increasing fertilizer use are, which was then tested through the survey.

This included: issues relating to the timely supply of appropriate inputs, the affordability of inputs, issues relating to the distribution of inputs, and lack of knowledge on the part of farmers about how to access and effectively use of inputs. This included, but is not limited to, the Strategic Plan for Agricultural Transformation IV, the National Fertilizer Policy, the World Bank 2018 Rwanda Drivers of Growth study, the Seasonal Agriculture Survey, the Agriculture MIS

system held at MINAGRI, and other relevant data sources and key policy documents. IRDP also encouraged to consult with stakeholders conducting complementary work, including the IMSAR project team and FAO. This ensured data collection activities do not duplicate ongoing work or existing data sets and answer the most relevant questions.

2.3.2 Conducting Focus Group Discussions (FGDs) and Key Informant Interviewees (KIIs) -using interview and FGDs guide

FGDs were formed with aligned in-depth interviews with group of farmers, the representative of central government authorities (Government Ministries, Agencies, etc.), Local Government Officials, local government agronomists, extension services providers, agro dealers, development partners in agriculture sector, CSO representatives operating in the field of agriculture, Academicians in the field of Agriculture. The interviewees provided the information on the gaps between policy/ program and reality on field in policy implementation as well as perceptions, views and opinions on the access and use to fertilizers, seeds and on provision of extension services.

The participants were requested to report challenges, gap met in the access, use of agriculture fertilizers and seeds and extension services and to report other external factors affecting agriculture activities in the range of getting fertilizers, seeds and extension services. In additional to this KIIs and FGDs participants proposed key actions or recommendations as area of improvement to address challenges facing the access to fertilizers and seeds.

2.3.3 Survey using questionnaire

The selected farmers were the primary unit of this study, Quantitative data was gathered using Closed- ended questionnaire which contained variables to be measured using statistical parameters, such as the extents, percentage shares, performance, trends and among other things. The key variables and questions in the questionnaire were linked to the study objectives. Data was collected using electronic kit (Csentry version 7.3). This software was installed in Mobile-Tablets and connected to IRDP server. Data was transmitted at daily basis by enumerators for data quality checking and quick feedback. This helped in assuring data to be most reliable, secure and paperless economy. Given the nature of this survey, two data collection tools, namely, farmers' questionnaire, agriculture service providers questionnaire were used. These two questionnaires contained a set of questions with codes, and security error control.

2.4 Data processing

2.4.1 Statistical model to be used in data analysis

Data transmitted to IRDP server was treated using advanced statistical soft wares, which included STATA, SPSS and Excel. Tabulation plan was created to analyze quantitative data. Descriptive analysis was adopted; graphical and tabular expositions of variables were displayed to get indicators. The broad themes of statistical models such as mean indices, standard deviation was used to assert the level of factors that make farmers decide to use or not to use inputs as per guided by the enabling environment, Constraints faced by farmers in accordance to agricultural inputs usage (affordability, availability, accessibility, relevance, availability, reliability), the attitudes towards usage good practices with respect to inputs use; the level of perception on the quality of the extension services received. The statistical test of CHI-SQUARE TEST was used to assess the degree of association and relationships underlying between variables, at this stage, the analyst checked significance effect between variables to research questions and study objectives. Qualitative data was analyzed thematically by understanding the ideas and opinions that emerged and was related to the analyzed quantitative data.

2.4.2 Analysis plan and statistical indicators to be produced

The analysis of survey indicators was split into three main parts: General information on farmer's demographic characteristics, agricultural inputs (chemical fertilizers, seeds and liming) and proximity to extension services. And from these main indicators there were drawn research variables to answer to the study questions thereafter.

CHAPTER 3: POLICY REVIEW

This section highlights the most recent policies and programs in support of fertilizers and seeds sectors development in Rwanda, as well as the key actors and their respective roles and responsibilities and the major elements of the fertilizers, seeds and extension services in Rwanda.

3.1 Key actors in the inputs (fertilizers and seeds) system

The key actors in the inputs (fertilizers and seeds) system include farmers, international suppliers, local importers, distributers and agro-dealers.

- **Farmers:** Farmers are on the demand-side acting as consumers of the inputs (fertilizers and seeds). To address how to maximize their productivity, the government provides quality farm inputs through subsidy and delivering them within walking distance of every farmer; offering extension advisory services on improved agricultural techniques.
- **Agro-dealers:** Agro-dealers are local sales outlets, and there are approximately 1,500 trained and registered agro-dealers, who are active in Rwanda, delivering seed, fertilizer, and other agricultural products to farmers. Around 700 agro dealers are authorized to distribute subsidized fertilizers under the CIP program. Agro-input dealers play a significant role of bringing the inputs close to the farmers
- **Distributer (APTC):** In 2016, The Cabinet approved a new fertilizer distribution model to replace the old one that was beset with fraud and related malpractices, whereby one distributor — Agro-Processing Trust Corporation Ltd (APTC) was mandated to distribute the inputs from the selected eight importers. APTC oversees distribution to agro-dealers and verifies delivery to farmers.
- **Local importers:** In 2013, the government took steps to liberalize the fertilizer market, privatizing importation. The number of importers increased to seven from three companies initially. These private importers import fertilizers and certified seeds.
- **Districts:** The Government is increasingly seeking to transfer responsibility for delivery to district-level authorities. In this regard, While Rwanda Agriculture Board (RAB), has been central in the inputs subsidy process, it is no longer directly involved, leaving the monitoring of the inputs distribution to be handled by sector and district authorities. The management of subsidies has been decentralized, but RAB remains with the responsibility of planning, monitoring and supervision of subsidies.
- **RALICS:** Rwanda Agriculture and Livestock Inspection and Certification Service (RALICS), enforces the Rwanda plant health law and related phytosanitary requirements for seed import and export. The department is responsible for activities that impact seed trade in

several ways, including acting to enhance safe trade by limiting the introduction and spread of new pests; improving the quality of agricultural products for export; and resolving trade issues related to plant health. RALICS oversees plant pest and plant disease monitoring, surveillance, and diagnosis; pest risk analysis; inspections; and issuance of import and export certifications.

- **RAB:** RAB is an autonomous body whose mission is leading agriculture sector development into a knowledge-based; technology-driven, and market-oriented industry, using modern methods in crop, animal, fisheries, forestry, and soil and water management in food, fiber, and fuel wood production and processing.
- **MINAGRI:** MINAGRI's mission is to initiate, develop, and manage programs to transform and modernize agriculture and livestock to ensure food security and to contribute to the national economy. MINAGRI is responsible in setting the policies, rules and regulations governing the inputs sector.

3.2 Rules and Regulations

3.2.1 - Crop Intensification Programme (CIP) - Input Subsidies

CIP was launched in 2007. The objective of CIP is to increase agricultural productivity of high-potential food crops by stimulating increased farmer adoption of new production technologies - particularly fertilizer, seed and irrigation - primarily through the use of input subsidies. The rules governing the input subsidies are contained in the Ministerial guidelines, issued at the beginning of each agricultural season. The guidelines indicate the companies authorized to import the inputs and the subsidized price at which the farmers should be sold to the inputs. The input subsidy program is centered on farmers using the Twigire Muhinzi [agriculture extension] model, whereby farmers register under the smart Nkunganire for the amount of inputs required.

3.2.1.1 improved seeds subsidies

Under the Crop Intensification Programme (CIP), the use of improved seeds has raised from 3 per cent in 2006 to 12.5 percent in 2018 in small-scale farms and 53.1 per cent for large-scale farmers. Five regional seeds companies are the ones contracted to import seeds into the country (Table 5). RAB is also a marketer of subsidized seeds, however, RAB only markets its own varieties produced by seed multipliers, which is far much less than what private companies market. The seeds, which are subsidized, include maize, wheat and soya. The imported seed is distributed to farmers through agro-dealers, under the supervision of APTC.

Table 5:Contracted subsidized seeds importers (2019/20)

Importer	***Crop and variety***
One Acre Fund	Maize (H629, H628, PAN691, PAN4M21, PAN53, SC 403, SC 637,

	ZM607, Pool 9A, M101, RHM104, RHM1407, RHM1402)
Western seed co Ltd	Maize (WH505, WH507, WH403)
SEEDCO international	Maize (SC403, SC513, SC637, SC719, SC 529), Soybean (SC Sequel, SC Squire, SC Safari)
Kenya seed company	Maize (H629, H628, H513), Wheat (KS Njoro II, KS Chozi)
RAB	Maize (ZM607, Pool 9A, M101, M103, RHM104, RHM1407, RHM1402, RHMH1520, RHMH1601), Wheat (Musama, EN161, EN 48, Nyaruka, Gihundo, Rengerabana, Cyumba, Reberaho, Majyambere, Keza, Mizero, Kibatsi and Nyangufi), Soybean (Peka 6, SB24)

Source: Ministerial Guidelines, and list of importers of agriculture inputs, Rwanda 2019

Seeds subsidy also varies depending on the seed as, for instance, H629 – a hybrid maize grown in high altitude areas, gets 75 per cent subsidy, with a kilogram at Rwf460 instead of Rwf1, 840 Imported soya seed, like SC Safari, is subsidized at 85 per cent, where a kilogram goes for Rwf250 against Rwf1,440 (unsubsidized).

3.2.1.2 Fertilizer subsidies

Before CIP was launched in 2007, fertilizer application averaged about 4.2 kg/ha per year - among the lowest fertilizer utilization rate in the world (Crawford, E.W et al. 2015). Farmer fertilizer utilization increased to 10kg/ha in 2010 and 29kg/ha by 2013 and to 35 kg/ha by 2017. However, the fertilizer application rates remain low compared to scientifically recommended levels to maximize yields. According to a study conducted in 2015, that the use of NPK17-17-17, Urea and DAP in maize, Irish potato, bean, rice, cassava and wheat crops is well below recommended application levels. In addition, most farmers, who are not within CIP still do not access or use any mineral fertilizer. In season 2019/2020, only five private companies have signed contracts with the Rwanda Agriculture Board (RAB) to import and timely supply mineral fertilizers in the country under the Government's subsidy programme.

The majority of imported fertilizer is imported under CIP and applied to priority food crops (maize, wheat, rice, Irish potatoes, beans and cassava). The crops that are covered under the Government subsidy scheme for fertilizers in 2019/20 year are maize, beans, wheat, soya, rice, Irish potatoes, cassava, banana, vegetables and fruits. According to the most recent Ministerial instructions, the subsidy varies depending on the type of fertilizer.

3.2.2 Regional Trade Policy

Rwanda is currently a member of the East African Community (EAC) and Common Market for

Eastern and Southern Africa (COMESA) regional free trade areas. Both regional groupings have initiatives in place to harmonize and facilitate trade in agricultural inputs. For COMESA, once a variety is released in two-member states that variety can be included on the regional variety catalogues and shall be registered in other COMESA countries without further tests. The EAC requires a variety to be released in one-member state only before it can be made available for regional trade in all the countries in the EAC.COMESA has been implementing the COMESA Seed Harmonization Implementation Plan (COMSHIP), established in 2015, through its specialized agency, the Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA). Rwanda has fully domesticated the COMESA seed regulations within national seed laws. COMESA and EAC are currently in the process of developing regional harmonized fertilizer and agro-chemical regulations.

3.2.3 Standards Laws and regulations

Standards Laws and regulations are in place to ensure and control the quality and standards of agricultural inputs. Law no.30 on Governing of Agrochemicals, 2012 provides the legal basis for quality control of fertilizer. The law requires that new fertilizer products be registered in order to be sold locally; fertilizer bags be properly labeled (incl. the product name, net weight or volume, nutrient contents (N, P2O5, K2O, S, etc.), name of manufacturer, contact information of manufacturer, country of origin, name of importer, contact information of importer, manufacturing date and expiration date); and prohibits the sale of mislabeled fertilizer bags. Law Governing Seeds and Plant Varieties in Rwanda, 2016 provides the legal basis for standards around seed. The law ensures the protection of plant breeders' rights; provides legal guidelines on variety registration and seed quality control.

3.3 Policies and strategies

3.3.1 Updated National Agriculture Policy (July2018)

Within pillar one of Productivity and Commercialization for Food Security, Nutrition, and Incomes, and under the Policy Actions to Increase crop, livestock, fisheries and aquaculture productivity, the policy, accessibility and optimal use of good quality seeds enhance crop yields and their subsequent contribution to food security, balanced nutrition, value of the product in the market, and economic growth. This policy encourages policy reforms that shift role of governmental seed regulatory system from direct supervision of seed production toward technical and policy support for cost effective varietal development of wide range of seed provision options that are led by private seed industry. The policy acknowledge that the levels of inorganic fertilizer used by smallholder farmers in Rwanda, are low and, in many cases, insufficient to increase crop yields. Therefore, the agriculture policy supports more albeit judicious use of inorganic fertilizers to increase crop productivity.

3.3.1 Rwanda's Strategic Plan for Agriculture Transformation phase 4 (PSTA 4)

Rwanda's Strategic Plan for Agriculture Transformation phase 4 (PSTA 4) outlines priority investments in agriculture and estimates required resources for the agriculture sector for the period 2018-2024. It is the implementation plan of the National Agricultural Policy (NAP) and represents the agriculture sector's strategic document under Rwanda's National Strategy for Transformation. Within Rwanda's PSTA 4, there are four seeds and fertilizers specific focus areas, these focus areas include: Innovative research on crop improvement and husbandry technologies; Efficient and sustainable use of inputs; Productive alliances and Development of PPP and alternative models.

3.4 Seed systems overview

3.4.1 Types of seeds system in the country

There are four identified dominant seed supply systems in Rwanda, as highlighted in Table 6, which include farmer-saved, public-private, public, and private. The farmer-saved and public seed systems represent most of the seed volume.

Table 6:Types of seeds supply systems in Rwanda

SEED SYSTEMS	***SEED SYSTEMS***	***PUBLIC – PRIVATE***	***PUBLIC***	***PRIVATE***
Type of Crops	Local food crops	Food and cash crops	Major food and cash crops	High-value crops
Crops	• Common bean • Potato • Maize (OPV) • Banana • Sweet potato • Cassava	• Maize (OPV) • Potato • Common bean	• Maize (OPV) • Potato •Soybean • Wheat • Rice •Common bean • Cassava	• Maize (hybrid) • Soybean • Vegetable
Types of Varieties	Local and improved	Improved	Improved	Improved and hybrids
Quality Assurance System	Farmer-selected	Farmer-selected, certified emerging through private seed producers	Certified	Certified
Seed	Farmer-saved,	Local private seed	APTC, Agro-	Regional private seed

Distribution	farmer to farmer exchanges (trading, selling)	companies, APTCagro- dealers, farmer groups, cooperatives	dealers and NGOs	companies, NGOs, agro-dealers

Source: Broek et al. (2014), IMSAR (2016) IRDP field research team interviews (2019).

3.4.2 Seeds system elements

- **Research and Variety Development:** The Government has the mandate to ensure that high yielding varieties adapted to various agro-bio-climatic areas of the country are available on the market, however both Public and Private companies produce new varieties. RAB has as one of its mandates to develop and release new varieties and It partners with CGIAR to access genetic material. Private companies also develop their own varieties and apply to release and market them under the Seed Law. According to RAB between 2000 and 2017, at least 33 maize varieties were released but 55 per cent of them were sold, 43 bean varieties were produced of which 7 per cent were sold, five wheat varieties of which 60 per cent were sold while 12 soya bean varieties of which 33 per cent were sold.
- **Seed Production and Conditioning:** Seeds produced in Rwanda are classified in the following 4 categories: i) Foundation Seeds; ii) basic seeds; iii) certified seeds; iv) Quality declared seeds.
- **The Rwandan Agricultural Board (RAB)** is responsible for the production of early generation seed (breeder and foundation seed) production, and the **seed multiplication** is undertaken by individual farmers and farmer groups, who procure the foundation seed from RAB. These include individual producers, cooperatives and private seed companies. RAB has a team of inspectors who monitor and certify the seeds produced by the multipliers. The seed multipliers sell their seed back to RAB (currently limited to maize, soybean, potato and wheat seeds) who then distribute to farmers, typically through APTC and agro-dealers (same distribution channel as fertilizers) and farmer cooperatives, with a subsidy of up to 75%. In addition to the certified seed produced locally, RAB as well as several private importers import and distribute other subsidized certified seeds (mainly hybrid maize, wheat and soybean). The imported seed is distributed to farmers through agro-dealers, under the supervision of RAB.
- **Seed Marketing:** The Government through the Ministerial instructions which are released every year and guides the amount and types of inputs to be imported into the country by the authorized companies and also the prices at which the inputs shall be retailed.
- **Promotion of Seed use:** To improve the low rate of seed use in the country, the Government shall promote the use of seeds and other agricultural inputs through the national agricultural extension system, better information on seeds and better geographic seed distribution.

3.5 Fertilizer system overview

3.5.1 Overview of the fertilizer sector

There is no primary production of fertilizers in Rwanda. Enterprise Nkubili (ENAS) has a blending plant in Kigali, operating since 2015. Rwanda Fertilizer Company (RFC), jointly owned by OCP, APTC Limited and the Government of Rwanda, is under construction in Bugesera and expected to be complete and operational in 2019. The majority of fertilizer used in Rwanda is procured from international sources. The main fertilizers imported to Rwanda are NPK, DAP and Urea. NPK continue to be the most used fertilizer in Rwanda. DAP is mostly used on soybeans, maize and wheat and it's the second most consumed fertilizer. Currently, 6 companies import all the country's fertilizer needs, covering both open and subsidized markets.

Most of the fertilizer companies compete in tenders and supply to RAB by importing the fertilizers and also have sales operations in Rwanda, such as Yara International. These companies sell to the private market through distributors and agro-retailers. Some companies, such as One Acre Fund are importers and also own retail stores and run an integrated import-distribute-sell operation.

3.5.2 Fertilizer system Elements

- **Import supply chain:** Importers make shipments to Kigali from the port of Dar- es - Salaam. They present samples of the fertilizers for phytosanitary testing to RALIS, after which they are issued with the import permit.
- **Bidding for tender:** annual RAB tender bid applications are distributed toward the beginning of the year, allowing suppliers one month after winning the bid to supply the amount of fertilizer,of their chosen quantities, but not lower than a minimum quantity stated in the bid.
- **Warehousing:** Most companies have the main warehouse at the Economic zone. However, they have also established warehouses upcountry. The main reason for opening stores upcountry was to help farmers access fertilizers from the distributing company (APTC) easily and on time.
- **Distribution channel:** There are four types of fertilizer distributors/wholesalers: 1.) APTC Ltd, a GoR affiliated enterprise, which distributes the imported subsidized fertilizer to farmers; The companies are allowed to trade fertilizers through the Agro Processing Trust Corporation Ltd (APTC Ltd), which, in turn, takes those fertilizers to farmers in all the districts of the country. However, Companies that purchase their fertilizer without any government subsidy do not distribute through APTC.(2.) Tea and coffee wholesalers, who procure from local importers through their apex organizations, then distribute to their member associations, which in turn distribute to growers; (3.) Agro-processors, supplying their out-grower farmers; and (4.) Cooperatives, grain producer associations and private importers-cum-distributors who procure fertilizer from private suppliers and supply it to their members on cash/credit basis.

- **Creating Demand/Market:** Companies importing fertilizers have been mandated to invest in the promotion of fertilizers. The importing companies work with the national extension system-Twigire Muhinzi to provide extension services to farmers and establish model /demonstration farms, which help drive demand for fertilizer. They have developed plans to work through the decentralized extension system (TWIGIRE MUHINZI) to promote fertilizer use.
- **Institutional buyers:** The only institutional buyer is ENAS, who procures fertilizers from the importers for blending purposes.

3.6 Extension system support to inputs use

3.6.1 Policy

Within Rwanda's PSTA 4, there are five seeds extensionservices specific focus areas, these focus areas include:

Proximity extension and advisory serviceswith an*Objective* to capacitate producers to make informed decisions and adopt agricultural innovations which increase, diversify, specialize, and intensify agricultural production, and covers the following thematic areas; Institutional capacity development; Quality proximity extension services to farmers: Tailored and demand-driven services by private sector: services to commercial farmers. Skills development for agriculture value chain actors with an *Objective* to support and empower rural value chain actors to profitably engage in farm and off farm activities in the agri-food sector.

3.6.2 Overview of the extension system

The **public extension system** is the main source of information on input use for farmers. RAB coordinates the extension services under the Twigire Muhinzi national extension system, which is a decentralized farmer-driven extension system launched by the GoR in 2014.This involves the organization of farmers into Twigire farmer groups at the village level; these groups are trained by a network of farmer field school (FFS) facilitators and lead farmers (farm promoters). Currently, there are 14,200 farmer promoters and 2,500 FFS facilitators who train farmers groups through demonstration plots, field days and village meetings. Through the Twigire Muhinzi extension system 59,453 farmer groups composed of 1,013,782 farmers countrywide have been established, with 68% of Rwandan farmers accessing extension and advisory services through the Twigire Muhinzi extension model.

Smart Nkunganire: The CIP subsidy program is known as "NKUNGANIRE". Rwanda Agriculture Board (RAB) in collaboration with stakeholders build a platform to digitize Rwanda's Supply Chain Management of the national farmers' subsidy program dubbed 'Smart Nkunganire System' (SNS). This program provides a digital database of farmers (Individual & Cooperatives) and all stakeholders through self-registration process via a USSD short code.

The farmers who qualify for the subsidy register for the amount of inputs, which they require, thus providing the supply chain players with the ability to anticipate supply/demand and the ability to meet the demand and avoid stock shortage or waste. The system also provides for a systemized real time monitoring process of the subsidy program. The system allows for collecting and registering information from farmers on land, location, and crops grown. The system is thought to provide recommendations on inputs to use to a specific farmer in a specific area.

Agro-dealers: are another source of information to farmers. The technical knowledge of most agro-dealers is limited although they are primarily used as conduits to deliver subsidized fertilizer. Most agro-dealers focus on fertilizers and plant protection products and have little knowledge of seeds as they are largely by passed in the delivery of seed to farmers (with the exception of horticulture/vegetable seed).

3.6.3 Elements of the extension system

RAB has the responsibility of providing agricultural extension services for both crop and livestock and coordinate, disseminate and manage the decentralization of the extension service provision. MINAGRI have the responsibility to provide policy direction, while MINALOC has the responsibility of the implementation of the extension service through managing the agronomists at districts and sector level (Figure 2). According to Draft CAEP, 2018, Twigire Muhinzi is a good extension approach that is founded on local culture and practices such as voluntarism. In particular, the FFS approach empowers farmers through discovery learning techniques and training on special topics. Twigire Muhinzi has an advantage of geographic proximity and use of community-based frontline extension agents enhance accessibility of the service and help to quickly reach all farmers through mobilization and demo plots. Twigire groups also serve as entry points for other development interventions from various partners. The approach promotes group formation, which fosters social cohesion among farmers. Existing FFS groups and Twigire groups provide viable foundation for promoting aggregation, economies of scale and creation of strong business ventures. The current Twigire Muhinzi has been proven to increase awareness, adoption and productivity levels in the areas where it has been implemented (Somers et al. 2017).

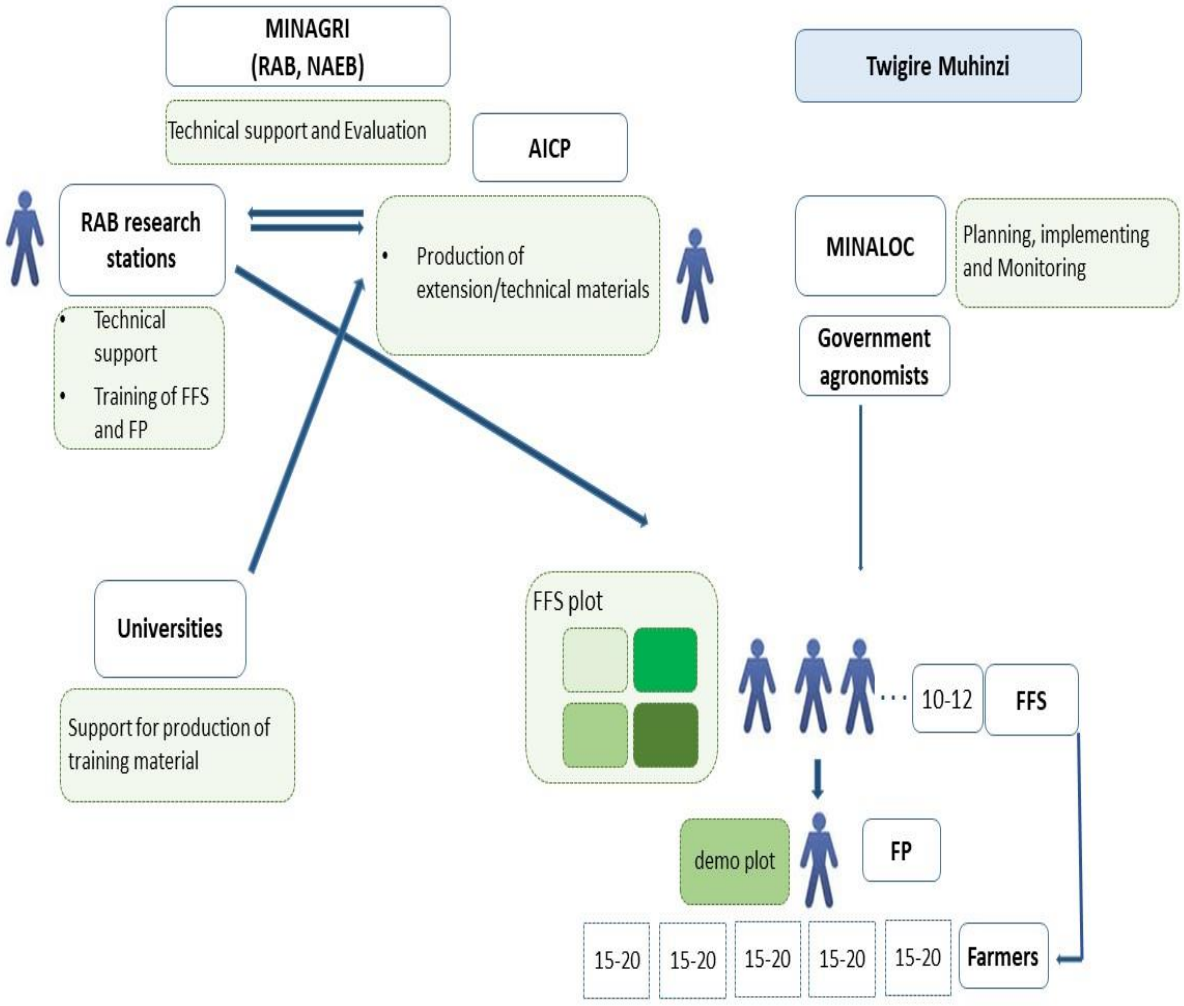

Figure 1:Twigire Muhinzi extension system

(source Draft CAEP,2018)

CHAPTER 4: DATA ANALYSIS AND INTERPRETATION OF FINDINGS

The findings of this study were established using different techniques of data collection, which include qualitative and quantitative techniques. Ten districts and 29 sectors were included in the study and 1,846 farmers were interviewed including 862 farmers within the CIP sites and 984 farmers within non-CIP sites. Focus Group Discussions (FGDs) were conducted in sampled districts; twenty-nine agrodealers were interviewed at district and sector level. (KIIs) were held with the policy makers (MINAGRI) and key stakeholders involved in the fertilizers and improved seeds sector, who included importers, distributers and agro dealers. In additional desk review of relevant agriculture policies and other documents was undertaken. The findings

are presented in line with the study objectives and grouped into 6 Sections; whereby each section is a primary unit of analysis and provides information responding to specific study objectives.

4.1 Socio-economic and Demographic characteristics of the surveyed farmers and linked determinants in use of improved seeds and fertilizers

The Socio-economic and demographic characteristics of the farmers is a key factor, which informs how behaviour, attitude and capacity influence the using or not us inginorganic fertilizers and improved seeds. Table 7summarizes the variables of this section.

Table 7:socio economic and demographic characteristics of the surveyed farmers

Category		**Male**		**Female**		**Both sexes**	
		Count	**%**	**Count**	**%**	**Count**	**%**
Marital Status	Married	984	94.4	628	78.1	1612	87.3
	Single	38	3.6	28	3.5	66	3.6
	Window	13	1.2	121	15	134	7.3
	Divorced	7	0.7	27	3.4	34	1.8
	Total	**1,042**	**100**	**804**	**100**	**1,846**	**100**
Highest level of education	Primary	725	69.6	473	58.8	1198	64.9
	Secondary	107	10.3	53	6.6	160	8.7
	University	13	1.2	3	0.4	16	0.9
	TVET	17	1.6	7	0.9	24	1.3
	None	180	17.3	268	33.3	448	24.3
	Total	**1042**	**100**	**804**	**100**	**1846**	**100**
Main occupation of the farmer	Cropping and Livestock	1017	97.6	795	98.9	1812	98.2
	Business	16	1.5	6	0.7	22	1.2
	Civil servant	9	0.9	3	0.4	12	0.7
	Total	**1,042**	**100**	**804**	**100**	**1,846**	**100**
Ubudehe category before July 2019	Category 1	88	8.4	153	19	241	13.1
	Category 2	432	41.5	350	43.5	782	42.4
	Category 3	521	50	301	37.4	822	44.5
	Category 4	1	0.1	0	0	1	0.1
	Total	**1,042**	**100**	**804**	**100**	**1,846**	**100**

As illustrated in table 9 most of the interviewed farmers were married 87.3%. Regarding education level of surveyed farmers; the findings indicate that most of farmers had completed primary education level (64.9%) and who were not attended any formal education represent (24.3%); the farmers who have completed secondary, university and TVET education level represent (10.9%).

There is good evidence that farmers' perceptions are influenced by levels of basic education (See Pickney 1994 for Kenya, Nkonya, Schroeder, and Norman 1997 for Tanzania, and Jha and

Hojjati 1993 for Zambia); Thus education level of the household head may be taken as a proxy for being exposed to (or able to access) technical information on fertilizer use, and thus may be positively associated with fertilizer use (Omamo et al. 2002; Omamo and Mose 2001). This study therefore assumed that increased education level of the household head on increased amount of fertilizer used presumably arises from a better understanding of the usefulness of fertilizers, and it may also imply better crop management.

In regard to the main occupation of surveyed farmers the results show that, Crops and Livestock, the main activity (98.2%).These results also indicate that, the fertilizers and cropping are the main interests of surveyed farmers. This finding proves that, to use fertilizers and cropping have the main place in the activities of that farmers. Ubudehe category before July 2019 was the factor that influences the affordability and capacity in using agriculture inputs (fertilizers and improved seeds). Table 8 indicates the picture of the Rwandan Population expenditures by gender and age and quintiles.

4.1.1 Classification of Rwandan population by expenditure, by age, by gender

Table 8:Classification of Rwandan population by expenditure, age and gender

Quintiles	Average expenditure	GIN Coefficients	Total expenditure	Population	Male	Female	Age (Average)
Quintile 1 - Poorest	86,213	0.13	202,032,039,718	2,343,404	1,093,316	1,250,088	20.7
Quintile 2	139,671	0.06	327,322,294,003	2,343,518	1,101,726	1,241,792	21.9
Quintile 3	192,217	0.05	450,451,148,488	2,343,452	1,112,137	1,231,315	23.3
Quintile 4	279,758	0.07	655,654,993,182	2,343,652	1,135,430	1,208,222	24.8
Quintile 5 - Richest	696,825	0.30	1,632,654,536,741	2,342,992	1,184,705	1,158,287	25.9
Total	**278,920**	**0.43**	**3,268,115,012,132**	**11,717,018**	**5,627,314**	**6,089,704**	

Source: EICV 5(2017/2018); NISR

Table 8 indicates the statistics for expenditure approach where the expenditure approach stands with the money spent on goods and services including to buy agriculture inputs for the farmers; This table also shows the GIN coefficients as measure of income inequalities; total expenditure, average expenditure indicates the money spent per year per person in Quintile, the population by age and gender of the population are also dispatched by quintile.

The results in table 10 indicate that, both male and females compose the active Rwandan population, with different purchasing power as indicated by their levels of expenditures as portrayed by their capacity to buy goods and services. The farmers in category one and two of ubudehe clusters (40%) have a limited purchasing power to buy agriculture desired quantity of

agriculture inputs and the farmers in CAT 3, CAT4 and CAT 5 (60%) have a full capacity to by a total desire agriculture inputs. The statistics in table9 indicate that, 55.4% of surveyed farmers belong to Category one and Category two of Ubudehe Clusters. The 5th Integrated Households living Condition Survey (EICV5, 2016/2017) revealed that, the Quintile one and Quintile two represent 40% of the total population, they have almost the same range of average expenditure in affording good and services. Their expenditure ranging of 86,213 and 139,671 Rwf per year and their GIN Coefficients of 0.13 and 0.06 are not indicating high inequalities between their annual incomes.

Table 9:Monthly wages from farm income

Quintile	**Farm - wages (Monthly wages)**	**Population Wage farm**
Quintile 1 - Poorest	21,013	170,506
Quintile 2	24,721	122,580
Quintile 3	25,111	89,426
Quintile 4	24,155	55,238
Quintile 5 - Richest	33,634	21,768
Total	**23,724**	**459,518**

EICV 5 (2016/2017)

Table 9 illustratesthe monthly wage from farming activities. The statistics shows the population that belongs in Quintile one and Quintile two (63.7%) of total population work in farming activities. Their monthly wage is approximately to 21,013 Rwf and 24,721 Rwf respectively (Lower income earners). To respond this challenge of purchasing power with the cost of fertilizers, The Ministry of Agriculture and Animal resources through RAB introduced the subsidies for this fertilizers and improved seeds to address the affordability challenges.

Studies show that House- holds with higher incomes (often from off-farm income) have been shown to obtain larger harvests because they are able to access farm inputs (Crowley et al. 1996). Linking the EICV5 findings and survey findings, the population in Category 1 and Two of Ubudehe Cluster cannot fully afford agriculture inputs due to their low purchasing power, where they reported that, there is difficult to buy the basic needs of the families and also difficult to save some amount for buying fertilizers and seeds for crops; this was observed by the FGDs participants in Gatsibo, Burera, Nyabihu, Kirehe, Nyamasheke and Musanze Districts. In Burera District the farmers stated that the cost of fertilizers is the main challenge hindering them from using inorganic fertilizers and the main reason is that the farmers in category one of Ubudehe have no capacity to buy inorganic fertilizers and improved seeds, even under the subsidy program. One farmer from Gatsibo district observed "some farmers are lack capital and this hinders the procurement of improved seeds and inorganic fertilizers on time, even when they are availed at the agro dealers on timely basis and at times the farmers even fail to use the inputs" This study therefore concluded that thereis a positive relationship is between income and fertilizer use.

4.1.2 Age of the surveyed farmers

Table 10:Age of the surveyed farmers

Age group of farmer	Male		Female		Both sexes	
	Count	%	Count	%	Count	%
19-24 Years	20	1.9	29	3.6	49	2.7
25-29 Years	107	10.3	81	10.1	188	10.2
30-34 Years	130	12.5	92	11.4	222	12.0
35-39 Years	163	15.6	120	14.9	283	15.3
40-44 Years	138	13.2	104	12.9	242	13.1
45-49 Years	123	11.8	103	12.8	226	12.2
50-54 Years	98	9.4	85	10.6	183	9.9
55-59 Years	105	10.1	73	9.1	178	9.6
60-64 Years	68	6.5	63	7.8	131	7.1
65-69 Years	50	4.8	30	3.7	80	4.3
70-74 Years	24	2.3	12	1.5	36	2.0
75-79 Years	12	1.2	5	0.6	17	0.9
80 + Years	4	0.4	7	0.9	11	0.6
Total	**1,042**	**100**	**804**	**100**	**1,846**	**100**

Age of farmer	*n*	*Mean*	*Std. Dev.*	*Min*	*Max*
	1,846	***44.5***	*13.1*	*19*	*90*

Source: Primary data, farmers survey, 2019

Table 10 indicate that, most of the surveyed farmers 62.8% are between 25 to 49 years old, this means that the agriculture activities have potential labor force, especially youth, and there is an equilibrium between Male and female aged 25-45 years; the female represents 62.1% and male (62.4%). This indicates that, the agriculture in Rwanda is inclusive of both genders. As it is shown in the 2nd table, the 1,846 surveyed farmers, the average in age is 44.5 years old, the minimum age is 19 years old and maximum age is 90 years old. The spread of data in age to their mean is 13.1 of standard deviation. Literature review indicate that the age of the farmer affects access to fertilizer since they have the ability to source for fertilizer than their older counterparts, (Otitoju and Ochimana, 2016) especially when fertilizers are sourced at far distances from the farms. Also, young farmers adopt new technology than older farmers because they have a longer planning horizon than older farmers (Alexander and Mellor (2005). Therefore, it is expected that since majority of farmers in Rwanda are between 25 to 49 years old, and are considered young, they should easily adopt and access inorganic fertilizers and improved seeds.

4.1.3 The size of household in surveyed farmers

The size of household among of surveyed farmers is indirect determinant in using the fertilizers and improved seeds; if the family size is large, the more the need to sustain household food security hence the higher the likelihood to intensify crop production by use of agriculture inputs.Table 11 illustrates the size of family' s farmers.

Table 11:Family size.

Size of household	***N***	***Mean***	***Std. Dev.***	***Min***	***Max***
	1,846	*5.3*	*2.1*	*1*	*13*

Source: Primary data, farmers survey, 2019

The average family size is 5 family members, the minimum is one member and the maximum family size is 13 members. Studies show that the higher the family size, the higher the labour available for inorganic fertilizers. The FGDs indicated that application of inorganic fertilizers relies exclusively on family labour and the labour is rarely hired for application of fertilizers. Therefore, most families in Rwanda are expected to have the family labour for application of inorganic fertilizers. However, on the other hand large households spend all income on food and other essential expenditures, leaving little for investment on farms including the purchase of fertilizers. Such households also prefer to grow food crops in place of cash crops to satisfy household food requirements, thus using less fertilizer since farmers prefer not to use fertilizers on food crops such as beans while they use fertilizers on cash crops such as rice.

4.1.4Farming status with regards to agriculture registration programs to collective and agriculture inputs

Membership to cooperatives and Registration with smart Nkunganire

Joining cooperatives and registration with Smart-NKUNGANIRE program are some of the factors, which facilitate the farmer to acquire agriculture inputs (fertilizers and improved seeds). Table 12 the status for surveyed farmers in reference to membership in cooperatives and registration with Smart Nkunganire.

Table 12:Membership to cooperatives and registration to Smart Nkunganire

Modalities		***Count***	**%**
Farmer category	CIP	862	46.7
	Non CIP	984	53.3
	Total	**1,846**	**100.0**
Agricultural cooperative member	Yes	690	37.4

	Non	1,156	62.6
	Total	**1,846**	**100.0**
Registration in the Smart Nkunganire	Yes	935	50.7
	No	857	46.4
	Don't know	54	2.9
	Total	**1,846**	**100.0**
If no, are you in the process of getting registered?	Yes	367	40.3
	No	544	59.7
	Don't know	0	0.0
	Total	**911**	**100.0**

Source: Primary data, farmers survey, 2019

Among thesurveyed farmers, 37.4% belong to agriculture cooperatives while 50.7% are registered in SMART-Nkunganire program.Due to the interests and benefits associated with SMART-Nkunganire registration, 40.3% of surveyed farmers are in process of registration and only a small proportion (2.4%)is not aware to the program. This finding indicatesthat, the registration withsmart Nkunganire is important in aiding farmers to access fertilizersand improved seeds. This is in line with other studies, which indicate that digital platforms have been used to improve fertilizer subsidy distribution to farmers (Madon et al, 2019). The interviewed stakeholders through the KIIs stated that there is a huge improvement in requesting for the amount of fertilizers required through SMART-Nkunganire, in comparison with the previous system where thy used to fill in forms, and submit to the sector agronomists for onward forwarding to districts, and subsequently to RAB.

4.1.5 Land size cultivated by the surveyed farmers

The variable of land size cultivated by surveyed farmers is important in determining the quantity of fertilizers and improved seeds used. Table 13 illustrates the size of land as cultivated by the surveyed farmers.

Table 13:Land size cultivated by surveyed farmers

Size of land cultivated in sqm (interval 10,000 sqm)	Count	Percent
Less than one Ha	1514	82.0
1Ha -1.9Ha	237	12.8
2Ha -2.9Ha	47	2.5
3Ha -3.9Ha	19	1.0
4Ha -4.9Ha	9	0.5
5Ha -5.9Ha	10	0.5
7Ha -7.9Ha	1	0.1
10Ha -10.9Ha	1	0.1

12Ha -12.9Ha	1	0.1
18Ha -18.9Ha	1	0.1
20Ha +	6	0.3
Total	**1846**	**100**

Source: Primary data, farmers survey, 2019

The surveyed farmers observed that, in CIP sites and marshlands, the farmers'own plots divided into 10m*10m (one acre). Indeed, most farmers cultivate land, which is less than one hectare (82.0%) followed by 1ha- 2ha (12.8%) and these are farmers or cooperatives who cultivates land in hillsides.

Our literature review showed that farm size is one of the factors that influence the use intensity of fertilizers in SSA (Olawale et al, 2009).Adesina (1996) found that farm size and land pressure were major factors, which influenced farmers' use of fertilizers in rice fields. Nkonya et al (1997) found that larger farms tended to use fertilizer less than smaller farms. Since most farmers in Rwanda cultivate land, which is less than one hectare, they are therefore expected to have high usage of fertilizers. Indeed, the Rwanda government adopted the crop intensification policy with the principle that even with small farm size, farmers can still improve their productivity optimally by intensifying the use of agricultural inputs, especially inorganic fertilizers and improved seeds. With the knowledge on crop intensification, smallholder farmers can then strategize to acquire and use fertilizer than farmers with large farms. Farmers, through the FGDs stated that the key reason for using inorganic fertilizers and improved seeds is to optimize the production from their small farms so as to meet household food security and to sell the surplus for household income.

4.1.6 The ownership of land cultivated by Districts

The ownership status of the land cultivated, whether owned or rented, is a key factor, which determine the level agriculture inputs use; The District Development Planning and performance contract in Districts has more focus on improving agriculture activities in using fertilizers and improved seeds to a specific hectare, Economic transformation pillar, components of agriculture (MINECOFIN, Planning, District Imihigo 2018/2019 FY). The District Performance Contracts on agriculture the implementers are the citizens. Table 14 indicates the ownership of land by each District and in overall surveyed districts.

Table 14:Ownership status of the cultivated land

Ownership of land Cultivated						
District	**Yes**		**Non**		**Total**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Gasabo	110	86.6	17	13.4	127	100.0
Kicukiro	26	63.4	15	36.6	41	100.0
Nyanza	113	62.1	69	37.9	182	100.0
Ruhango	151	92.6	12	7.4	163	100.0
Nyabihu	150	90.4	16	9.6	166	100.0

Nyamasheke	195	80.9	46	19.1	241	100.0
Musanze	197	86.8	30	13.2	227	100.0
Burera	208	97.2	6	2.8	214	100.0
Gatsibo	227	86.3	36	13.7	263	100.0
Kirehe	197	88.7	25	11.3	222	100.0
Total	**1,574**	**85.3**	**272**	**14.7**	**1,846**	**100.0**

Source: Primary data, farmers survey, 2019

The findings indicate that, 85.3% of surveyed farmers own the landwhere they cultivate and 14.7% have rented land that they cultivate. At district level, the percentage shares of the ownership of land range are 97% to 62.1% within sampled districts. Burera District has a highest proportion of farmers who cultivated their own land and the least percentage share is observed in Nyanza and Kicukiro Districts with 62.1% and 63.4% respectively, the information from District Development Planning (DDP) and performance contracts (Imihigo); and information from the survey indicate that, there is a high demand for fertilizers and improved seeds*(MINECOFIN, Planning, Imihigo, Economic Transformation Pillar, agriculture 2018/2019FY) in these districts.*

The lack of land ownership can discourage agricultural technology adoption, as observed by Abdulai et al. (2011), land ownership tends to facilitate investment in soil-improving and natural resource management practices. According to Adunni and Werner 2007, Ownership of farm induces greater use of fertilizer by the households by 5.14 times. This is expected because farmers tend to invest more in soil fertility management strategies if they own the land than when borrowed or rented. Since majority of the surveyed farmers own the land where they cultivate, they are expected to have a greater use of inorganic fertilizers and improved seeds.

4.1.7 Ownership of land cultivated by category of farmers

Table 15 indicates that 84.8% farmers in CIP sites cultivate their own land and in non-CIP 85.7% cultivate down land. The overall, 85.3% cultivate down land and 14.7% have rented land to cultivate.

Table 15:Land ownership status by CIP and NON CIP farmers

Farmer category	Yes		Non		Total	
	Count	%	Count	%	Count	%
CIP	731	**84.8**	131	15.2	862	100
Non CIP	843	**85.7**	141	14.3	984	100
Total	**1,574**	**85.3**	272	**14.7**	1,846	100

Source: Primary data, farmers survey, 2019

4.1.8 Percentage share of the types of crop grown by District

The type of predominant crops grown in sampleddistrict depends on the climate, topographic characteristics and geographic conditions of the region. In this study, the sampled districts were

located in different regions; Savanah region in eastern province (Kirehe, Gatsibo districts), Volcanoes region (Burera, Nyabihu, Musanze districts); Congo Nil Crest region (Nyamasheke district), and central region (Ruhango, Nyanza, Gasabo and Kicukiro Districts). Table 16shows the crops grown in the respective districts.

Table 16:percentage share of the crops grown within respective districts

	Gasabo	Kicukiro	Nyanza	Ruhango	Nyabihu	Nyamasheke	Musanze	Burera	Gatsibo	Kirehe	Overall %
Maize (%)	64.6	82.9	52.7	60.7	64.5	71.8	61.2	46.3	84.4	85.6	**67.2**
Wheat (%)	0.0	0.0	0.5	0.0	17.5	0.0	47.6	15.4	0.0	0.5	**9.3**
Rice (%)	4.7	0.0	17.6	23.3	0.0	2.1	0.4	0.0	27.0	25.2	**11.3**
Beans (%)	75.6	78.0	77.5	59.5	42.2	96.3	17.6	67.3	80.6	87.4	**68.1**
Soybean (%)	3.9	0.0	4.9	1.2	0.0	5.0	1.3	0.0	3.8	4.1	**2.7**
Irish Potato (%)	18.9	0.0	0.5	0.0	81.9	0.8	89.4	51.9	0.8	8.1	**26.9**
Cassava (%)	22.0	22.0	54.4	49.7	0.0	61.4	0.0	0.9	22.8	12.2	**24.6**
Banana (%)	14.2	7.3	7.7	12.3	0.0	5.0	0.0	0.5	30.8	12.2	**9.5**
Fruits (%)	7.1	0.0	1.1	0.6	0.6	2.1	0.4	0.0	1.5	5.0	**1.8**
Vegetables (%)	19.7	4.9	8.2	3.7	6.0	8.7	6.2	1.4	4.9	1.8	**6.1**

Source: Primary data, farmers survey, 2019

The findings of the study as outlined in table 16 indicate that, the predominant crops grown in season B, 2019 were beans (68.1%) followed by maize (67.2%), irish potatoes and cassava represent 26.9% and 24.6% respectively. The maize was grown in all districts. The highest rank in Maize crop is observed in Kirehe (85.6%), Gatsibo (84.4%) and Kicukiro district (82.9%) while the highest ranks of beans crop are observed in Nyamasheke (96.3%), Kirehe (87.4%), Gatsibo (80.6%); Irish potatoes were grown in Musanze (89.4%), Nyabihu (81.9%), Cassava are grown in Nyamasheke (61.4%), Nyanza (54.4%) and Ruhango (49.7%). Rice, wheat, fruits, vegetables, soybean, banana are grown at small scale in surveyed districts. The type of crops grown guides the types of improved seeds and fertizers used in respective districts. According to the predominant crops grown in specific district, these findings have

The type of crops grown determines the usage of inorganic fertilizers. According to Adesina and Zinnah, 1993, In Africa roots and tubers are an important part of the diet. These crops generally respond well to medium fertilizer application, and in the absence of fertilization they can exhaust the nutrient content of the soils rapidly. Therefore, a substantial amount of fertilizers is used on roots and tubers such as Irish potatoes, as compared to cereals. The study therefore expected that the in the districts where Irish potatoes is dominant such as Musanze (89.4%), and Nyabihu (81.9%), had high levels of fertilizers usage.

4.1.9 Type of crop cultivated by site (CIP and Non-CIP)

The CIP and Non CIP sites are key factors which influences the type of crop grown, table 17 indicates that maize and beans were the predominant grown crops in CIP sites as compared to Non-CIP sites. Other crops grown did not have much difference in percentage shares in both CIP and non-CIP sites.

Table 17:Types of crops cultivated in CIP and Non CIP sites

Type of crops	CIP		Non CIP	
	Count	%	Count	%
Maize	563	29.2	676	29.8
Wheat	108	5.6	63	2.8
Rice	179	9.3	30	1.3
Beans	492	25.5	765	33.7
Soybean	23	1.2	27	1.2
Irish Potato	319	16.5	177	7.8
Cassava	131	6.8	323	14.2
Banana	65	3.4	110	4.9
Fruits	11	0.6	23	1.0
Vegetables	39	2.0	74	3.3

Source: Primary data, farmers survey, 2019

Studies show It was expected that farmers have preference to use fertilizers on cash crops production over food production (Adesina AA, Baidu-Forson J, 1995). It is expected that more fertilizers were used in CIP sites than in non-CIP sites since the study findings indicate that rice and Irish potatoes, which are mainly grown for income, were the predominant grown crops in CIP sites as compared to Non-CIP sites.

4.1.10 The ownership of livestock in surveyed farmers

The survey aimed to establish if the surveyed farmers owned livestock. Table 18 shows the distribution of livestock in farmer's household by type.

Table 18:Livestock ownership status in surveyed farmers

District	Livestock type									
	Frequency					%				
	Cattle	Goats	Sheep	Pig	Poultry	Cattle	Goats	Sheep	Pig	Poultry
Gasabo	61	31	0	10	7	48.0	24.4	0.0	7.9	5.5
Kicukiro	11	17	5	4	7	26.8	41.5	12.2	9.8	17.1
Nyanza	79	35	0	6	20	43.4	19.2	0.0	3.3	11.0
Ruhango	85	75	0	13	19	52.1	46.0	0.0	8.0	11.7
Nyabihu	67	12	47	2	18	40.4	7.2	28.3	1.2	10.8
Nyamasheke	106	23	1	70	12	44.0	9.5	0.4	29.0	5.0
Musanze	76	3	51	3	24	33.5	1.3	22.5	1.3	10.6
Burera	98	26	61	8	6	45.8	12.1	28.5	3.7	2.8
Gatsibo	111	66	1	27	31	42.2	25.1	0.4	10.3	11.8
Kirehe	107	90	3	10	15	48.2	40.5	1.4	4.5	6.8
Total	**801**	**378**	**169**	**153**	**159**	**43.4**	**20.5**	**9.2**	**8.3**	**8.6**

Source: Primary data, farmers survey, 2019

The survey results show that 90% of surveyed farmers own livestock, with cattle and goats been the predominant livestock types at 43.4% and 20.5% respectively. These results indicate that farmers use organic fertilizers at moderate levels. Livestock ownership is important in agriculture activities since livestock provides organic fertilizers and boost productivity of agriculture products. Studies show that farmers who keep livestock may be better able to take advantage of animal manure for soil fertility management in their farms (William etal.1993). However, farmers using livestock manure are less likely to buy chemical fertilizers (Nkamleu, 2008). The study findings, through FGDs observed that one solution to address the high fertilizer cost constraints as practiced by farmers, is to use livestock manures and compost manure without combining with inorganic fertilizers especially for food crops. The farmers in the FGDs observed "We normally mix manure and NPKor DAP while planting the crops".

The farmer's category by ownership of livestock

The survey sought to establish the distribution of livestock ownership in both CIP and Non-CIP farmers as indicated in table19.

Table 19:Ownership of livestock in CIP and non-CIP sites

Livestock	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Cattle	411	47.7	388	39.4	799	43.3
Goats	167	19.4	211	21.4	378	20.5
Sheep	101	11.7	67	6.8	168	9.1
Pig	66	7.7	87	8.8	153	8.3
Poultry	94	10.9	65	6.6	159	8.6

Source: Primary data, farmers survey, 2019

The findings show that, the farmers within the CIP site have more cattle (47.7%; 39.45), more sheep (11.7%; 6.8%), more poultry (10.9%; 6.6%) than thenon–CIP farmers. This scenario applies for goats, and pigs. In general; the surveyed farmers have livestock to provide organic fertilizers; Farmers in both CIP and non-CIP have the knowledge on the importance of combining both organic and inorganic fertilizers for improved crops yields. Hence the explanations why the farmers are not only practice farming but also keep livestock as source of organic fertilizers. This was stated in FGDs of Nyamasheke, Burera, Ruhango and Kirehe districts, the inorganic fertilizers are not sufficient to boost agriculture productivity; there is a need of using both organic and inorganic fertilizers. The FGDs in Ruhango stated that "We use manure while planting along with DAP. This practice boost production, for example, one is field of rice yield 70kg when you mix manure and fertilizers, whereas the same field without fertilizer yield only 30kg."

4.2 Types of seeds sown in 2019 season B

This section informs the types of seeds sown in 2019 season B; the area land cultivated, types of crops grown, source and availability of the seeds and perceptions of the farmers in terms of benefits, satisfaction, accessibility, affordability, and distribution of that seeds.

4.2.1 Main CIP crops and area cultivated by crops

The study covered a total of 1846 farmers including those within CIP and non-CIP sites; these two sampled sites covered a total of 9,813,580 square meters equivalent to 981.4 hectares. The findings in table 22 show that, the predominant cultivated crops in 2019 Season B was Beans (294.3 ha) followed by Cassava (221.2ha), Maize (206.9 ha) and Irish potatoes (123.8ha). Table 20 indicates the distribution of main crops cultivated and areas covered by specific crops.

Table 20:Main CIP crops and area cultivated per crop

Main CIP crops	**Land size**	
	Square meters	**Ha**
Maize	2,068,946	206.9
Wheat	189,789	19.0
Rice	438,733	43.9
beans	2,942,798	294.3
Soybean	86,172	8.6
Irish Potato	1,238,352	123.8
Cassava	2,211,579	221.2
Banana	405,200	40.5

Fruits	45,250	4.5
Vegetables	186,761	18.7

Source: Primary data, farmers survey, 2019

These findings are in line with the national findings on the main crops cultivated and areas covered in season 2019 B, beans covered the largest area, at 282,099 ha, followed by Cassava at 187,511, then maize at 73,139 ha and Irish potato at 49,244 ha. Vegetables and fruits cultivated area was estimated at 14,976 and 7,454 ha respectively (NISR, Season 2019B). This is also explained by farmers during the FGDs where they observed that most farmers prefer to grow beans in the shorter Season B, and Maize is mainly grown in Season A.

4.2.2 Type of seed sown by crop in 2019 season B

This variable is a key indicator, which shows the predominant type of seeds used by surveyed farmers. The traditional and improved seeds were the seeds types used by the farmers and the percentage share of usage by type of crop are presented in the table 21.

Table 21:Type of seed sown by crop in season 2019B

Grown crop in season 2019 B	Types of seed sown					
	Tradition Seeds		Improved Seeds		Total	
	Count	Percent	Count	Percent	Count	Percent
Maize	212	33.4	422	66.6	634	100.0
Wheat	21	24.1	66	75.9	87	100.0
Rice	21	10.4	180	89.6	201	100.0
Beans	863	88.2	115	11.8	978	100.0
Soybean	18	75.0	6	25.0	24	100.0
Irish Potato	308	82.6	65	17.4	373	100.0
Cassava	161	67.9	76	32.1	237	100.0
Banana	52	70.3	22	29.7	74	100.0
fruits	15	65.2	8	34.8	23	100.0
Vegetables	42	56.8	32	43.2	74	100.0

Source: Primary data, farmers survey, 2019

The findings show that, the traditional seeds have the highest percentage shares in usage than improved seeds in such cropsasbeans (88.2%), Irish potatoes (82.6%), Soybean (75.0%), cassava (67.9%), bananas (70.3%) and fruits (65.2%). The predominant usage of improved seeds was observed in Maize (66.6%), Wheat (75.9%), Rice (89.6 %).The findings are in line with the

seasonal agricultural survey by NISR 2019 Season B; the overall use of improved seeds was used at 6 % of all cultivated plots, 11.8% of the agriculture operators and 6.1% of the total cultivated area (NISR, 2019).This was observed by the farmers during the FGDs in Musanze by stating that the improved seeds are so expensive and therefore affordable only by few farmers, while the rest choose to use local varieties."

4.2.3 The main sources of seeds used in season 2019 B by District

The main sources from where farmers obtained seeds include the following; Certified seed multipliers (15.5%), Agro dealers under the subsidy program (38.5%), NGOs (5.4%), Market (5.2%), Cooperative (22.6%), and Other (neighboring farmers, friends 12.7%). The main sources of seed in Nyamasheke District were certified seed multipliers (64.0%), the Agro dealers with subsidy was the main source in Nyabihu (75.6%), as well as in Musanze (69.9%), Burera (62.5%), and Gasabo (50.0%). The NGOs (TUBURA One Acre Fund) is the predominant seeds supplier in southern province in Nyanza district (46.0%); and cooperatives are the predominant suppliers of seeds in eastern province Kirehe (63.7%) and Gatsibo (49.7%). Table 22illustrates the sources of seeds by District.

Table 22:Main sources of seeds per district in season 2019B

District	Certified seed multipliers		Agro dealers with subsidy		NGOs		Market		Cooperative		Other		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Gasabo	14	14.9	47	**50.0**	0	0.0	2	2.1	9	9.6	22	23.4	94	100
Kicukiro	7	21.2	10	30.3	0	0.0	5	15.2	1	3.0	10	30.3	33	100
Nyanza	5	5.0	10	10.0	46	**46.0**	3	3.0	25	25.0	11	11.0	100	100
Ruhango	41	25.5	45	28.0	3	1.9	3	1.9	40	24.8	29	18.0	161	100
Nyabihu	8	10.3	59	**75.6**	2	2.6	2	2.6	0	0.0	7	9.0	78	100
Nyamasheke	48	**64.0**	17	22.7	1	1.3	1	1.3	0	0.0	8	10.7	75	100
Musanze	24	16.4	102	**69.9**	1	0.7	8	5.5	9	6.2	2	1.4	146	100
Burera	1	1.8	35	**62.5**	0	0.0	14	25.0	2	3.6	4	7.1	56	100
Gatsibo	5	3.4	36	24.5	1	0.7	8	5.4	73	**49.7**	24	16.3	147	100
Kirehe	1	1.0	21	20.6	0	0.0	6	5.9	65	**63.7**	9	8.8	102	100
Total	154	**15.5**	**382**	**38.5**	**54**	**5.4**	**52**	**5.2**	**224**	**22.6**	**126**	**12.7**	992	100

Source: Primary data, farmers survey, 2019

The findings are in line with NISR, 2019, which state that most farmers rely primarily on three main sources for their improved seed: government agencies (referred to as RAB/SECTOR), suppliers/NGOs provide, and dealer/shops. In regards to the source of improved seeds in season 2019B, 34.6% was sourced from Agro-dealers; 21.3% from Government, 15% from NGOs, 14.7% from Recognized seed multipliers, 10.3% from markets while 3.7% sourced their seed from cooperatives, (NISR, 2019).

4.2.4 The importers of improved Seeds, recommended improved seeds varieties and pricing

Reference to the research findings, in Season B of 2019 Maize, Wheat and rice were the main crops grown using improved seeds. The ministry of agriculture and animal resources (MINAGRI) released the price of improved seeds in its ministerial guidelines, which are released once a year in July to cover season A&B(table 23). The list of importers and distributers of improved seeds that have the contracts with Rwanda Agriculture Board (RAB) are: Kenya Seeds Company Ltd, Export Trading Group (ETG), Murphy Chemical Rwanda Ltd, Western Seed Co. Ltd, TUBURA one Acre Fund, RAB, and Certified Seeds multipliers. This companies and institutions have the mandate to import and distribute improved Seeds to Agro dealers across the country. Table 23 indicates the variety of seeds with subsidies including Maize, Soybean and Wheat. Other Seeds to surveyed crops were provided locally through seed multipliers, cooperatives andRAB.

4.2.5 Maize Improved Seeds and Prices

Table 23:Recommended Maize seeds prices

Maize Hybrid cultivated in Hill			
Variety of seeds	**Total retail price/Kg (RWF)**	**Subsidy value (RWF)**	**Farmers' price (RWF)**
H629/H628	2,350	1,810	540
PAN691	2,404	1,442	962
SC637	2,400	1,440	960
WH605	2,390	1,793	597
Maize Hybrid cultivated in Valley			
Variety of seeds	**Total retail price/Kg (RWF)**	**Subsidy value (RWF)**	**Farmers' price (Rwf)**
RAB Hybrid RHM104, RHM 1407, RHM 1402,RHM1520,RHMH 1601	1,810	1,357	453
PAN53	2,499	1,499	1,000
SC403	2,400	1,440	960
HW505/507/403/509/101	2,390	1,864	526
H513	2,350	1,810	540

Maize OPV			
Variety of seeds	**Total retail price/Kg (RWF)**	**Subsidy value (RWF)**	**Farmers' price (RWF)**
Pool 9A	860	565	295
ZM 607	860	565	295
M101	860	565	295

Source: Agrodealers survey and Ministerial guideline 2019

Soybean Improved Seed and Pricing

Table 24:Soya beans seeds prices

Soybean (Certified Seeds)			
Variety of seeds	**Total retail price/Kg(RWF)**	**Subsidy value (RWF)**	**Farmers' price (RWF)**
Peka 6	1250	825	425
SB 24	1250	825	425
RSO102/RWSO103	1250	825	425
Soybean (Quality declared Seeds)			
Variety of seeds	**Total retail price/Kg**	**Subsidy value**	**Farmers' price**
Peka 6	900	504	396
SB 24	900	504	396
RSO102/RWSO103	900	504	396

Source: Agrodealers survey and Ministerial guideline 2019

Table 25:wheat seeds prices

Wheat Improved Seeds			
Variety of seeds	**Total retail price/Kg (RWF)**	**Subsidy value (RWF)**	**Farmers' price (RWF)**
Nyaruka, Gihundo, Rengerabana, Cyumba, Reberaho, Majyambere, Keza, Mizero, Kibatsi, Nyangufi	900	554	346
KS Njoro II/ KS Chozi	1,217	791	426

Source: Agro dealers survey and Ministerial guideline 2019

Interviews with RAB indicated that the ministerial guidelines are developed in a participatory process through consultative sessions. The process is a National inter-ministerial committee function comprising of MINICOM, MINAGRI RAB Farmers cooperatives representatives, Sector agronomists, District department of business services, executives, security agencies. However, the farmers, through the FGDs complained that they do not have much authority/ownership in setting of the seeds and fertilizer prices.

The study established through the FGDs and further confirmation from secondary data (records from suppliers) that the prices as provided by the ministerial guidelines isclearly

adhered to by the agro dealers. During the field data collection, it was observed that most of the agro dealers have actually displayed the price list at their premises.

4.2.6 Farmers' perceptions on usage of improved seeds

Farmers stated that the ministerial guidelines are very well clear to them especially on pricing and levels of the subsidies, Through the FGDs it was established that the farmers are aware that there is government support in obtaining the improved seeds known as Nkunganire. To avoid the fraud and corruption the local government Agronomists are responsible for the supervision of the agro-dealers and also share to them the list of farmers who have requested the improved seeds. The means of communication is very clear where the agriculture community facilitators, agronomists and other government officials use radios, community dialogues, local community platforms and text messages to inform farmers the new types of seeds varieties, preparations of the season, time for planting and when there are some diseases outbreaks.

Even through the implementation process of distribution of improved seeds are very clear, farmers still experience some challenges; the farmers do not know the specific types of seeds which they plant, they only use the name of crop (i.e. Maize); other challenge is that due to the set farmer'sprice, which include low denominations especially coins, of 5 and 10 Rwf, the agro-dealers do not give the right change the farmers, and sometimes the type of improved seeds distributed doesn't match the climate and seasonal condition of the region as observed in Kirehe; Gatsibo, Gasabo and Nyanza districts. Interviews with seed producers, local agro dealers and FGDs with various farmers and other stakeholders indicated the following concerns with regards to challenges in usage of improved seeds;

- The price of improved seeds is still very high especially for the farmers in ubudehe category 1 &2.
- The price of improved seeds is not reflected in the prices of the produce obtained on using the seeds due to the low selling price of the produce,
- On using improved seeds, the quantity and quality of farmers produce, even when provided with the right seeds is often low, because the farmers may not afford the required type and quantity of fertilizers for optimal production,
- Although the distribution system has improved, there are still incidences where seeds are delivered late
- That there are incidences when the RAB seeds varieties are of low quality. Interviews with seed producers indicated that this is caused by the land availability constraints where by cross-pollination from other surrounding maize fields affects the seeds quality.

4.2.7The main reasons for not using improved seeds by surveyed farmers

Some surveyed farmers did not use improved seeds due to different reasons; some crops cultivated such as beans, rice, Irish potatoes, cassava, banana, fruits and vegetables were not subsided by the government in 2019 Season B, other reasons and extents of not using improved seeds were summarized in table26:

Table 26:Farmers' reasons for not using improved seeds

Most important reasons of not using improved seeds	***Count***	***Percent***
No agro-dealer's shops in the neighborhood	164	9.58
Poor quality of the previous received seeds	40	2.34
Improved seeds are very expensiveas compared to the purchasing power of farmers who are belonging in Category1 and Two of Ubudehe Cluster (Poor)	500	29.21
Delay of Improved seeds	84	4.91
The crop grown haven't subsided and certified improved seeds/ Prefer to use own selection seeds from previous yields	924	53.97
Total	**1,712**	**100**

Source: Primary data, farmers survey, 2019

Except forthe farmers who grew the Maize, Wheat and Soybean, other farmers did not use subsided and certified improved seeds. The seeds for the crops not covered under the subsidy program were obtained from own selection seeds from previous yields and farmers cooperatives among others; the main reasons of not using improved seeds, is that the crops grown are not covered under the subsidy program (53.97%).KII with RAB indicated that improved seeds adoption has increase since 2007 when the subsidies were introduced, under the crop intensification program. It was observed that indeed seed subsidies encourage farmers to use improved seeds.However, the subsidized seeds are for only three crops of Maize, Wheat and Soybean. Therefore, for the crops in which the seeds are not subsidized, farmers prefer to use own saved seeds. Literature review showed that the farmer-saved seed systems represent the majority of seed volume in Rwanda. The findings indicated that 29.21% of the surveyed farmers felt that improved seeds are very expensive as compared to the purchasing power of farmers who are belonging in Category1 and Two of Ubudehe Cluster (Poor). This observation was also made by Frahan et al, 2018,who stated that a large share of the input subsidy transfers in Rwanda is absorbed by the large-scale producers who purchase much of the intermediate inputs – an inefficient outcome based on literature since large-scale producers generally have the liquidity to purchase unsubsidized inputs. Less than a half of the policy transfers accrue to the small- and medium-scale holders whose purchase of intermediate inputs are relatively small and practically cash constrained.

4.2.8 Perceptions of farmers on the relation to using improved seed sand the change of household's income

The perceptions of an average proportion of the farmers who used improved seeds in 2019 Season B is that, after using the improved seeds their yield and household income has changed a little better (46.03%) and much better (39.44%) than before using improved seeds. Others (14.53%) felt that they didn't get any change and their income was worse than before using improved seeds. Table 27 illustrates the findings.

4.2.8 Use of improved seeds in relation of the change of household income

Table 27:Use of improved seeds in relation to change in household income

Using improved seeds in relation of the change of household income	Count	Percent
After using improved seeds farmer's income is a little better than before using it	377	46.03
After using improved seeds farmer's income is much better than before using it	323	39.44
After using improved seeds farmer's income is the same as with before using it	53	6.47
After using improved seeds farmer'sincome is a little worse than before using it	39	4.76
After using improved Seeds farmer's income is much worse than before using it.	27	3.3
Total	**819**	**100**

Source: Primary data, farmers survey, 2019

The study findings indicated that for 46.03% of the respondents, their yield and household income has changed a little better after using the improved seeds. This was also observed in other studies. According to a study of Rwanda, where the study used an empirical modeling approach to assess the income and welfare effects of subsidies for intermediate inputs (i.e. fertilizers and improved seeds) across a heterogeneous set of agricultural households, the input subsidy simulation results show positive nominal income and welfare effects. This is explained by the fact that use of improved seeds most often leads to increased yields, especially if the seeds are of high quality, the climatic conditions are conducive and the seeds are used together with the appropriate inorganic fertilizers. However, if these conditions are not adhered to, then the yields may not improve even after using improved seeds, and hence the explanation why a small percentage of farmers felt that their income was the same or worse as compared with before using improved seeds.

4.2.9Farmers' Satisfaction levels on improved seeds usage

The survey sought to establish the farmers' perceptions on the usage of improved seeds and their determinants in reference to their satisfaction in the usage of improved seeds, the availability of improved seeds supplied in the area, accessibility of improved seeds, affordability of improved seeds, reliability of distribution of improved seeds and timeliness of getting improved seeds. Their responses scores were measured using descriptive statistics of mean index, standard deviations and ranks. Table 28 indicates the measurement scales in ranges.

Table 28:Farmersranges perception on improved seeds usage

Mean range	Description	Interpretation
4.26 - 5.00	Strongly Agree	Very High level
3.51 - 4.25	Agree	High level
2.76 - 3.50	Disagree/ Neutral	Moderate level
1.00 - 2.75	Strongly disagree	Low level

https://www.researchgate.net/publication/276394797_Likert_Scale_Explored_and_Explained

Table29 indicates the satisfaction levels for the farmers' perceptions on improved seeds usage as following:

Table 29:Farmers' Satisfaction levels on improved seeds usage

Statements of perceptions and satisfaction level of farmers	***Farmers (n=819)***	***Mean***	***Std. Dev.***	***Min***	***Max***	***Interpretation***	***Rank***
1.The farmers are satisfied with the yield as a result of using the improved seeds supplied (Satisfaction)	819	3.77	0.94	1	5	High level	1
2.Improved seeds are easily available in my area (availability)	819	2.78	0.82	1	4	Moderate level	5
3.Improved seeds are easily accessible (Accessibility)	819	2.83	0.79	1	4	Moderate level	4
4.The cost of improved seeds is affordable (Affordability)	819	2.55	0.84	1	4	Moderate level	6
5.The improved seeds distribution services have increased my use of improved seeds (reliability)	819	2.87	0.65	1	4	Moderate level	3
6. I receive improved seeds on due time at planting stage (timeliness)	819	2.93	0.68	1	4	Moderate level	2

Source: Primary data, farmers survey, 2019

The results in the table29 show that, the farmers who used the improved seeds were highly satisfied with the yield resulted in using improved seeds, while the availability, accessibility, affordability, reliability of distribution and supplying on time of improved seeds are at moderate level; The findings show that the surveyed farmers disagreed and were not satisfied with availability, accessibility and reliability. The farmers strongly disagreed that seeds were affordable.

Regarding significance levels of farmers' satisfaction in the usage of improved seeds, the Chi-square test of statistics was used to test significance level of the following variables; availability of improved seeds supplied in the area, easy access of improved seeds, the affordable cost for improved seeds, reliability of distribution of improved seeds and timeliness of getting improved seeds.

The findings show that there is a significance level between farmer's perceptions and researcher hypotheses as it is indicated in table 32 among six variables tested,the farmers are satisfied with yield as results of using improved seeds, the cost for improved seeds is affordable to the farmers, and there is a reliable distribution for improved seeds by suppliers; the results provide enough evidence to conclude that there is a significance where the ***p-value is less than 0.05***. This means that the farmers who used improved seeds such as maize, soybean and wheat were satisfied with the good harvest and yield, due to the government subsidies in that crops, the cost was affordable to them, and reliability of distribution was good due to well organized distribution channel of that improved seeds from importers, seeds multipliers, agro dealers to farmers.

The statistical tests for other three variables indicate that, the improved seeds are moderately available in the areas, there is a moderate easy access of improved seeds for farmers, and the improved seeds are moderately supplied on time to farmers, In statistical language, there is no significance (p-value > 0.05) in term of availability because there are few seed multipliers and MINAGRI/RAB only provide seed subsidies for only three crops (Wheat, Maize and Soybean) and therefore there is no availability of affordable seeds for various other crops; this is compounded with other issues such as availability of only limited varieties and delayed delivery to farmers.The limited number of crops for which improved seeds are supplied by the subsidies, which include only maize, soybean and wheat, explains these findings. This is despite the fact that the surveyed farmers grow multivariate of crops in addition to maize, wheat and soybeans. Here there is a need of extending improved seeds for various crops and introducing them in subsidy program; this will increase the level of the availability, accessibility, affordability of cost, reliability of distribution and supplying on time for improved seeds.

Secondary data showed that the issue of low access to improved seeds is not only unique for Rwanda; rather it is a challenge in the region. According to statistics, only 23% of the 80 million smallholder farmers in the COMESA region have access to improved seeds, leading to low productivity especially on cereals like maize. Rwanda government has endeavored to curb this problem, in the country and the KII with RAB established that in cognizance to the fact that food security is tied to the use of good quality and improved seeds, RAB has already developed hybrid maize seeds, with high quality, well adopted to the local climatic conditions and costs lower than the imported seeds.

Table 30:Significance level of farmers' perception on seeds use.

Item	Farmers (n=819)	Confidence Level (Score 1.96)	Margin Error (α =0.05)	Chi-Square Value	P-value	Interpretation of the Statistics and conclusion (If P-value < 0.05: Significance, If p-value > 0.05: No significance
1. Farmers Satisfied with yield as results of using improved seeds	819	0.95	0.05	1116.545	0.000	(p-value < 0.05) There is a Significance
2. The improved Seeds are available in the area	819	0.95	0.05	675.798	0.065	(p-value > 0.05) There is no significance
3. There is easy access of improved seeds for farmers	819	0.95	0.05	798.973	0.087	(p-value >0.05)There is no significance
4. The Cost for improved seeds is affordable to the farmers	819	0.95	0.05	424.492	0.003	(p-value <0.05) There is significance
5. There is a reliable distribution for improved seeds by suppliers	819	0.95	0.05	1284.78	0.000	(p-value <0.05) There is significance
6. The improved seeds are supplied on time to farmers	819	0.95	0.05	1288.126	0.067	(p-value >0.05)There is no significance

Although farmers are satisfied with yield as results of using improved seeds,they felt that the cost of the improved seeds is not affordable for most farmers. In the FGDs with farmers, praised the good yields from the improved seeds but decried the high cost of obtaining them. The participants in the FGDs in Kirehe, Gatsibo and Burera Districts observed that, some of the maize improved seeds, which they bought in season 2019 B didn't adapt to the local agriculture seasons; the mix of different varieties which cannot growing in the same conditions, and sometimes delay in planting due to the delay in supplying the improved seeds to agro-dealers and waiting for the final list from agronomists often causes the delay in supply of improved seeds.

4.3 Types ofInorganic fertilizers and the determinants for usage

In this section, the use of inorganic fertilizers was surveyed to establish the determinants of its use, as well as the different aspects linked to these determinants. Various variables were examined using different approaches such as the agriculture policy desk review, farmers' survey, field visits, FGDs and KIIs with different stakeholders. The findings are presented in this section.

4.3.1 The preference of farmers in using fertilizer

This variable stands to show the preference in using different types of fertilizers.Table 31 indicates the percentage share for preference.

Table 31:Farmers' preference in using inorganic fertilizers

District	Inorganic fertilizer only		Organic fertilizer only		I prefer inorganic but I add organic when needed		I prefer organic but I add inorganic when needed,		I do not have a preference		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Gasabo	1	0.8	9	7.1	43	33.9	72	56.7	2	1.6	127	100
Kicukiro	3	7.3	3	7.3	14	34.1	19	46.3	2	4.9	41	100
Nyanza	8	4.4	56	30.8	52	28.6	55	30.2	11	6.0	182	100
Ruhango	16	9.8	85	52.1	56	34.4	5	3.1	1	0.6	163	100
Nyabihu	1	0.6	3	1.8	58	34.9	104	62.7	0	0.0	166	100
Nyamasheke	2	0.8	36	14.9	35	14.5	156	64.7	12	5.0	241	100
Musanze	2	0.9	45	19.8	54	23.8	125	55.1	1	0.4	227	100
Burera	9	4.2	54	25.2	16	7.5	135	63.1	0	0.0	214	100
Gatsibo	8	3.0	67	25.5	41	15.6	142	54.0	5	1.9	263	100
Kirehe	7	3.2	59	26.6	113	50.9	42	18.9	1	0.5	222	100
Total	57	3.1	417	22.6	482	26.1	855	46.3	35	1.9	1,846	100

Source: Primary data, farmers survey, 2019

Table 31 indicates that the most preferable manner in using fertilizers were to use organic and adding inorganic when needed (46.3%) and followed by to use inorganic but adding organic when needed (26.1%), the preference of using Inorganic fertilizer only is at (3.1%) while to use Organic fertilizer only (22.6%). Organic and inorganic fertilizers are essential for plant growth since both fertilizers supply plants with the nutrients needed for optimum performance. Commercial and subsistence farming has been and is still relying on the use of inorganic fertilizers for growing crops (Masarirambi et al., 2010).

However, the study findings show that most farmers prefer to use organic fertilizers. Farmers through the FGDs stated that this preference is mainly due to the high cost of inorganic fertilizers. This was also observed by other studies, which indicated that fertilizer being costly and sometimes scarce can make farmers not apply enough for good growth (Alonge et al., 2007), resulting to farmers depending largely on locally sourced organic fertilizers (Makinde et al., 2010) and Organic wastes, which are rich plant nutrients (Mahmoud et al., 2009).

Farmers' perceptions of fertilizer use are largely influenced by their experience, and may differ from what is provided by researchers (World bank, 2006). This is observed through the FGDs reports of Musanze, Nyamasheke, Gasabo districts, whereby the participants stated that, the use of inorganic fertilizers has many negative effects on land, crops and human health. Some farmers were of the opinion that crops grown in inorganic fertilizers are the sources of cancer while other farmers stated that when they change to lower quantities of inorganic fertilizers used between seasons A and B, they experience poor yields and sometimes the crops do not perform at all; others said that the inorganic fertizers have destroyed their previously fertile land. This observation is also indicated in other studies, and according to Kukiat, 1999, the massive and misuse of inorganic fertilizers in most upland soils is a major form of unsustainable fertilization practice, which is a major factor in inducing soil infertility.

4.3.2 Coverage of using inorganic fertilizers within district

The districts planning and their achievements of district economic transformation on agriculture pillar about land use consolidation and quantity of fertilizers used was drawn in district reports for assessing the levels of fertilizers use. Table 32 indicates the findings.

Table 32:Levels of fertilizer usage within respective districts

District	Cultivated Crops (Type of Crops)	Size of land consolidated (ha)	Input used (Fertilizers) in Season 2019 B	Productivity (2018/2019, Season 2019B (Average Yield per ha)
1. NYABIHU	Maize: 9,863ha Beans: 15,443ha Irish potatoes: 18,343ha Wheat: 2,098ha	45,747ha	NPK: 3,105.1T DAP: 646.7T Urea: 285.1T KCl: 38.4T	Irish potatoes: 30.4T/ha Maize: 4.2T/ha Beans: 2.75T/ha
2. NYAMASHEKE	Cassava: 13,609.2 ha Maize: 12,828.6 ha Soybean: 2,463 ha Rice: 769 ha Beans: 25,272.8 ha	54,942.6 ha	DAP: 815.136 T UREA: 323.515 T NPK: 545.476 T	Maize: 5 T/ha Beans: 3.1 T/ha Rice: 6.2 T/ha Soybean: 1.9 T/ha Cassava: 23.1 T/ha
3. BURERA	Maize:14 502ha Beans: 9 474ha Irish potatoes: 7, 013 ha Wheat: 2 724.5 ha	24,713.5 ha	NPK: 485.539 T Urea: 29.114 T DAP 264. 957 T KCL+BLENDS: 16,819 T	Maize: 6T/Ha Beans: 3.5T/Ha Wheat: 3.5T/Ha Irish potatoes: 32T/Ha
4. NYANZA	Maize: 4352,72 ha, Beans: 25257,5ha Cassava: 7324ha Rice: 1500 ha Soybeans 556,7 ha	38,990.92 ha	DAP: 87.566 T UREA: 79.022 T NPK: 106.891T KCL: 0.5 T	Maize: 3.54T/ha, Beans: 1.48T/ha Cassava: 26,6T/ha Rice: 6,05T/ha, Soybeans: 1.21T/ha

5. RUHANGO	RICE: 1,387 ha CASSAVA: 7,937 ha MAIZE: 3,368 ha BEANS: 16,018 ha SOYBEANS: 650 ha	29,360 ha	DAP: 44.155 T UREA: 34.386 T NPK: 72.002 T KCL and Blends: 568 Kgs	RICE: 6 T/ha CASSAVA: 25T/ha MAIZE: 3.5 T/ha BEANS: 1.8T/ha SOYBEANS: 1.5 T/ha
6. GATSIBO	-	-	DAP: 44.593 T UREA: 245.280 T NPK: 252.667 T	Maize: 4.7T/ha Rice: 5.8T/ ha Beans: 1.6T/ha Soybeans:1.5T/Ha Banana:24T/ha
6. KIREHE	Maize: 26,310 ha Beans: 35,459 ha Rice: 1,632 ha Soybeans: 1,020 ha Cassava: 1,041 ha	65,462 ha	-	Maize: 3.4 MT/ha Beans: 1.2 MT/ha Rice: 5.8 MT/ha Soybeans: 0.86 MT/ha Banana: 17 MT/ha
8. KICUKIRO	-	-	DAP: 15.85 T UREA: 15.0 T NPK: 5.071 T	
9. GASABO	MAIZE: 5,891 ha BEANS: 8,394 ha RICE: 400 ha VEGETABLES: 1,388 ha	16,073 ha	DAP: 222.03 T UREA: 112.924 T. NPK: 35.155 T KCL +Blends: 4.625 T	-
10. MUSANZE	Maize: 10,213ha Wheat 1,488ha Irish potatoes: 10,088Ha Beans: 11,926ha	33,717 ha	---	Maize: 4.2 t/ha Wheat: 2.5 t/ha Irish potatoes: 22 t/ha Climbing Beans: 2.8 t/ha

Source: Districts Development Imihigo planning and MINECOFIN, Imihigo Districts achievement 2018/2019Q3

Table 32 indicates that the predominant crops cultivated in 10 districts were Maize, Beans, Soybean and rice; the predominant fertilizers used are DAP, UREA, NPK and few KCL+ Blends. This is in line with other studies, which indicate that in Rwanda, the main crops fertilized include tea, potato, rice, wheat, and maize (MINAGRI, 2014). The main types of fertilizers used are NPK 17-17-17 on potato, maize, fruits, and vegetables; NPK 25-5-5 on tea; NPK 20-10-10 on coffee; urea on maize, rice, and wheat; and DAP on maize, rice, and wheat (NISR, 2019).

4.3.3The distributed and subsidized inorganic fertilizers and prices (Rwf)

According to the ministerial guidelines in distribution of inorganic fertilizers in Rwanda, the contracted companies by RABfor the distribution and importation of inorganic fertilizers are

YARA Ltd, E.T.G Ltd, Rwanda Fertilizers company ltd, One-Acre fund and A.P.I Ltd. These guidelines indicate the prices of inorganic fertilisers by type, price without subsidy, subsidy price and price to end-user farmer. Table 33 indicates the types of inorganic fertilizers and prices.

Table 33:Prices of various types of inorganic fertilizers

Type of fertilizers Macro fertilizers	**Price without subsidy (Frw)**	**Subsidy price (Frw)**	**Price to end -user farmer with subsidies (Frw)**
UREA	660	198	462
DAP	787	276	511
NPK 17:17:17	724	109	615
TSP	688	117	571
KCL/MOP	664	153	511
Micro nutrients	**Price without subsidy (Frw)**	**Subsidy price (Frw)**	**Price to end -user farmer with subsidies (Frw)**
Ammonium sulfate	491	172	319
Borax penta-Hydrate	1311	656	655
Zink sulfate monohydrate	1066	533	533
Copper sulfate	2242	1121	1121
Compounds/Blends	**Price without subsidy (Frw)**	**Subsidy price (Frw)**	**Price to end -user farmer with subsidies (Frw)**
Urea + Sulfur (40N+5.5S)	698	131	567
NPK23-10-5+5+S, Z, Mg	707	136	571
NPK15-9-20 + S, B, Zn, Mg, Mn	773	138	635
15N+25.6% CaO+ B	686	40	646
NPK5-7-5-5-B, Zn,Cu,Mg,Fe,Mn,Mo	6776	341	6435

Source: Agrodealers survey and Ministerial guideline 2019

Table33 indicates the distribution prices of inorganic fertilizers in forms of prices without and with subsidies to end-user's farmers with subsidies; local agro dealers use these tariffs as they sell fertilizers to the farmers. The fertilizer subsidies are provided for Macro FertilizersMicronutrientsand Compounds/Blends, through direct subsidies that reduce fertilizer prices paid by farmers under the "Smart Nkunganire system". The findings from the KIIs and FGDs showed that farmers accessed inorganic fertilizers at subsidy, which varied between different types of fertilizers.

4.3.4 Distribution of percentage share for the farmers who use inorganic fertilizers

The study aimed to establish the proportion of the farmers who used inorganic fertilizers in season 2019 B among 1846 surveyed farmers.Table34 indicates the proportion by district.

Table 34:Distribution of farmers using inorganic fertilizers

Distribution of farmers in using inorganic fertilizers						
District	**Yes**		**No**		**Total**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Gasabo	84	66.1	43	33.9	127	100.0
Kicukiro	28	68.3	13	31.7	41	100.0
Nyanza	79	43.4	103	56.6	182	100.0
Ruhango	104	63.8	59	36.2	163	100.0
Nyabihu	132	79.5	34	20.5	166	100.0
Nyamasheke	175	72.6	66	27.4	241	100.0
Musanze	162	71.4	65	28.6	227	100.0
Burera	120	56.1	94	43.9	214	100.0
Gatsibo	128	48.7	135	51.3	263	100.0
Kirehe	90	40.5	132	59.5	222	100.0
Total	**1,102**	**59.7**	**744**	**40.3**	1,846	100.0

Source: Primary data, farmers survey, 2019

The results in the table 34show that, the high proportions in using inorganic fertilizers are observed in Nyabihu district (79.5%), Nyamasheke district (72.6%) and Musanze district (71.6%); the least usage of inorganic fertilizers is observed in Kirehe, Gatsibo and Nyanza districts with 48.7%, 40.5% and 43.4 % respectively. This is in line with the study findings in previous sections, which show that, the farmer in Musanze and Nyabihu districts use inorganic fertilizers in Irish potatoes asthe predominant crop of these districts. The study findings also indicate that the farmers in Nyamasheke, Kicukiro, Gasabo, and Ruhango districts use inorganic fertilizers in maize crop, which is predominant crop in these districts. The districts with low usage of inorganic fertilizers grow beans and cassava as the predominant crops of the area, and inorganic fertilizers are seldom used on these crops.

4.3.5 Types of inorganic fertilizers used by surveyed farmers by district

Table 35:Types of inorganic fertilizers used by the surveyed farmers

District	NPK		DAP		UREA		KCL/MOP		Amidas		Cereal		Total
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count
Gasabo	30	5.6	57	8.6	62	12.0	0	0.0	0	0.0	0	0.0	**149**
Kicukiro	9	1.7	18	2.7	17	3.3	0	0.0	0	0.0	0	0.0	**44**
Nyanza	34	6.4	46	6.9	74	14.3	0	0.0	0	0.0	0	0.0	**154**
Ruhango	46	8.7	65	9.8	72	13.9	0	0.0	1	100.0	4	26.7	**188**
Nyabihu	98	18.5	45	6.8	28	5.4	0	0.0	0	0.0	0	0.0	**174**
Nyamasheke	21	4.0	161	24.2	58	11.2	0	0.0	0	0.0	0	0.0	**240**
Musanze	124	23.4	72	10.8	15	2.9	0	0.0	0	0.0	0	0.0	**216**
Burera	87	16.4	75	11.3	6	1.2	0	0.0	0	0.0	0	0.0	**168**
Gatsibo	67	12.6	49	7.4	120	23.2	10	100.0	0	0.0	0	0.0	**246**
Kirehe	15	2.8	77	11.6	66	12.7	0	0.0	0	0.0	11	73.3	**170**
Total	**531**	100.0	**665**	100.0	**518**	100.0	**10**	100.0	**1**	100.0	**15**	100.0	**1,749**
Rate by type	**30.36**		**38.02**		**29.62**		**0.57**		**0.057**		**0.858**		

Source: Primary data, farmers survey, 2019

The results in the table 35 indicate that, the predominant inorganic fertilizers used in season 2019 B were DAP (38.2%), NPK (30.36% and 29.62% for UREA, this statistic indicates that the predominant type of inorganic fertilizers depends on the types of crops grown, and subsidized inorganic fertilizers by the ministry of agriculture and animal resources. The reports from KIIs agro dealers and FGDs provided additional information that farmers were able to differentiate types of fertilizer, and understood rates of application and the roles of respective fertilizers in nutrient supply. However, the farmers indicated that are not able to remember the scientific names of fertilizers, instead they use the color to differentiate the inorganic fertilizers; when the color of inorganic fertilizer changes, it can make the farmers to reject the new color of inorganic fertilizers. The results from the focus group discussions also showed that farmers still based their decisions on common fertilizer distinctions such as: the "whitish one" for top dressing, or the "grey one" for planting.

4.3.5.1 Fertilizer distributed Kgs /hectare in the surveyed districts.

Table 36:Fertilizer distributed kgs /hectare in the surveyed districts.

Districts	Total weights (Kgs) of Inorganic fertilizers used	Hectares cultivated 2018/2019FY Q3/ Season 2019B	Application Rate/kgs per Hectares per district
1. Nyabihu	4,075,300	45,747	89.0 KGs/ha
2. Nyamasheke	1,684,127	54,942.6	30.6 KGs/ha
3. Burera	796,429	24,713.5	32.2 KGs/ha
4. Nyanza	273,979	8,824.0	31.0 KGs/ha
5. Ruhango	718,543	29,360	24.4 KGs/ha
6. Gatsibo	542,540	19,142.1	28.34 KGs/ha
7. Gasabo	374,734	16,073	23.31 KGs/ha
8. Kicukiro	35,921	1,740	20.64 KGs/ha
9. Musanze	3,978,370	33,715	118.0 KGs/ha
10. Kirehe	1,897,541	64,421	29.4 KGs/ha

Source: Adopted figures from District Reports, 2019/2019 Q3 Season 2019B,

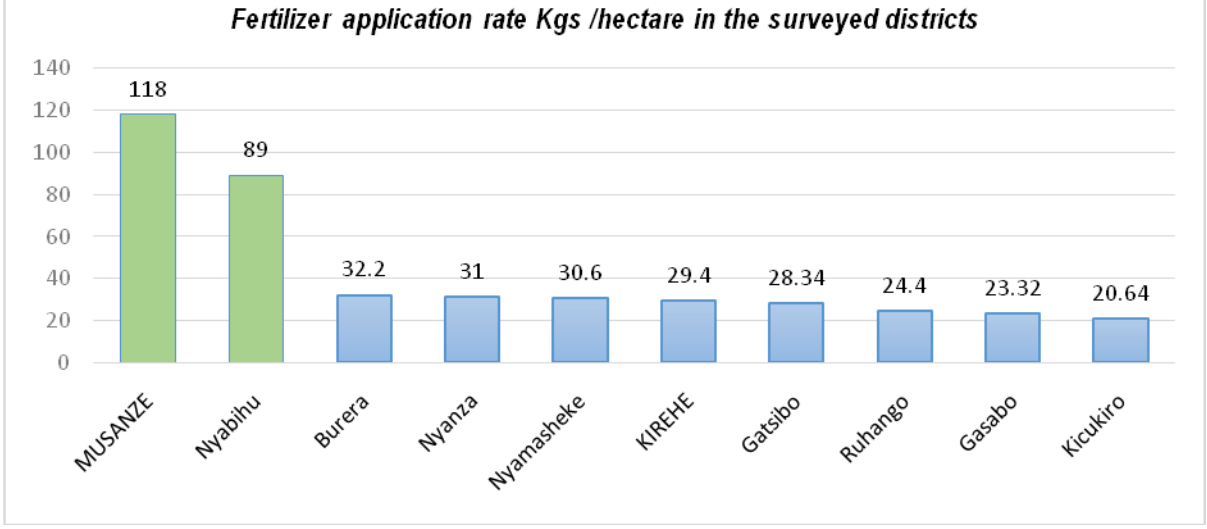

Figure 2:Fertilizer application rates Kgs/Ha in the surveyed districts

Source: Adopted figures from District Reports, 2019/2019 Q3 Season 2019B,

The sampled locations were 10 Districts and 28 sectors; the survey findings as reported in table 36 of this report, indicate the extent of inorganic fertilizers used within the 2 or 3 sectors within 10 Districts covered in the survey. However, the results in the above table cover entire district, and all sectors within 10 districts not only 2 or 3 sectors that were covered in the survey. The results obtained in the surveyed districts provided the same findings as the above findings from the entire district where the farmers in Musanze and Nyabihu were the highest users of inorganic fertilizers. The discussion with farmers in the FGDs in Musanze and Nyabihu districts indicated that they largely use DAP on maize crop and potatoes. These findings were explained by findings from other studies, which indicated that Irish potatoes require large quantity of inorganic fertilizers and this crop is cultivated in large hectare within northern province especially in Nyabihu, Musanze and Burera Districts.

4.3.6 The inorganic fertilizers use per unit area by farmers

The farmers surveyed reported the area of cultivated land in Season B 2019 and also the quantities of fertilizers used in the respective land.The estimated amount in kgs used per hectare was computed to attain the application rate of inorganic fertilizers in the 10districts. Table 37 indicatesthe fertilizer use per unit area in each district.

Table 37: Reported Quantity of fertilizers used within sampled districts.

District	Square Meters cultivated in 2019 Season B	Equivalent of Cultivated Land in Hectares	Quantity of inorganic Fertilizers used in Seasons 2019B in Kgs
Gasabo	1,073,362	107.3	2,154
Kicukiro	339,199	33.9	852
Nyanza	718,330	71.8	2,282
Ruhango	2,891,465	289.1	3,939
Nyabihu	739,208	73.9	14,328
Nyamasheke	587,244	58.7	2,972
Musanze	770,537	77.1	15,897
Burera	382,890	38.3	3,990
Gatsibo	1,071,987	107.2	6,315
Kirehe	1,239,358	123.9	3,456

Source: Primary data, farmers survey, 2019

The of inorganicFertilizer use, which is the quantity of fertilizers used per unit area in 10 surveyed districts was 57kgs per hectare, the highest fertilizer usage were observed in the CIP Sites in Musanze, Burera and Nyabihu Districts where they used the big quantity of fertilizers in Irish potatoes, the least application rate was observed in Ruhango district where the farmers mainly grow cassava and beans. The amount of fertilizer used mainly depends on factors such as the type of fertilizer and crops, the agro- ecological zone where the crop is grown, and farmers' knowledge in fertilizer use.

4.3.7 The reasons for deciding to use,inorganic fertilizers and the main sources of advisoryservices oninorganic fertilizers

The results in table 38 indicate that the majority of the farmers (93.5%) decided to use inorganic fertilizers due to the belief that inorganic fertilizers are most effective to boost the agriculture production.Most of the farmers were advised by agriculture extension services providers (64.2%) and local authorities (35.4%) in using inorganic fertilizers.The main sources of suppliers of inorganic fertilizers are agro dealersthrough the Smart Nkunganire Scheme (36.5%). The discussions with KIIs indicated that every farmer who joins a farmer field school, and learn how beneficial fertilizer use is, makes a decision to introduce fertilizer use in his/her field. The farmers through the FGD discussions stated "extension services do help us in mindset change as we acquire knowledge and skills on using fertilizers and improved seeds". The FGDs discussions also observed that the provision of the extension services by agriculture community facilitators imparts farmers with skills on application of inorganic fertilizers.

Table 38:Reasons for deciding to use inorganic fertilizer and main sources of advisory services

The reasons of deciding to use fertilizers by farmers surveyed	**Percent**
I believe inorganic fertilizers are most effective at boosting my production	93.5
The price of inorganic fertilizers is acceptable to me	3.6
Other (specify)	7.6
Advisors of farmers in using fertilizers to farmers surveyed	**Percent**
I was recommended these fertilizers by local authorities	35.4
I was recommended these fertilizers by a local agro dealers	11.9
I was recommended these fertilizers by an extension worker	64.2
No one recommended inorganic fertilizers to me	10.3
Other (specify)	21.8
The main sources of getting fertilizers by farmers surveyed	**Percent**
Local agro dealers	5.5
Agro dealers on Nkunganire scheme	36.5
NGOs	3.1
Market	1.4
Cooperativefarmers'	10.5
Other	2.6

Source: Primary data, farmers survey, 2019

Based on these results it is observed that, the availability of extension service providers, district and sector agronomists and local suppliers is a key determinant which push the farmers to use inorganic fertilizers in surveyed farmers in 10 districts.This is in line with other studies, which show that perception on use of inorganic fertilizer is mainly influenced by exposure to extension (Jha and Hojjati (1993); Thompson (1987), and Heisey and Mwangi (1997). Thisstudy observes that there is a positive relationship betweenincreased access to extension services of the household head on increased amount of fertilizer used, which presumably arises from a better understanding of the usefulness of fertilizers, and it may also imply better crop management. Because there are many types of fertilizers, appreciation of the appropriate types for specific crops, soil types and their specific requirements, application regimes, rates and timing by the household heads is likely to increase with exposure through extension services. This observation is in line with the study by Kellyand Murekezi (2000), who state that the knowledge on recommended fertilizer' application rate for different crops and zones is a critical in implementing the entire program related to fertilizer use and application.

4.3.8 The most reasons that push the farmers to not using inorganic fertilizers and their association variables

Some of the surveyed farmers did notuse inorganic fertilizers in 2019 season B, and theyprovided the reasonsbehind not using inorganic fertilizers, which are linked to other determinants such as cost, benefits from using it, and distance to reach local agro dealers, table39 indicates the findings.

Table 39:Farmers reasons for not using inorganic fertilizers

Reasons behind not using inorganic fertilizers among surveyed farmers	**Percent**
There are no agro-dealers shops in the neighborhood	1.9
Fertilizers did not impacton yieldin the previous seasons	0.9
Inorganic fertilizers are very expensive	48.4
Delay of fertilizers delivery	1.2
The prepayment model of total invoice for ordered fertilizers doesn't allow to purchase required quantities of fertilizer	1.3
Did not have knowledge on why to use fertilizer and howto be registered in smart Nkunganire program	16.8
Other reasons of not using fertilizers	29.4
The extent to which the farmers agree, if at all, that the cost of inorganic fertilizer is affordable	**Percent**
Strongly disagree	23.9
Disagree	24.0
Agree	32.1
Strongly agree	19.1
Don't know	0.9
To what extent do you agree, if at all, that the price of inorganic fertilizers increased recently	**Percent**
Strongly disagree	2.9
Disagree	3.6
Agree	27.4
Strongly agree	64.2
Don't know	1.9
To what extent do you agree, if at all, the price of inorganic fertilizer is worth the benefit it provides	**Percent**
Strongly disagree	7.7
Disagree	16.4
Agree	47.1
Strongly agree	27.3
Don't know	1.5
Estimation on how close is the nearest Source of inorganic fertilizers	**Percent**
Within 1km	50.7
1km to 3km	27.0
3km to 10km	18.5
10km to 30km	3.5

30km to 100km	0.1
Don't know	0.1

Source: Primary data, farmers survey, 2019

The results in the above table indicate that the reasons of not using inorganic fertilizers are linked to other factors, the most reasons, the farmers stated that, the inorganic fertilizers are very expensive (48.4%), this is linked to the farmers who are belong in category one and two of ubudehe categoryand who are not able to purchase sufficient inorganic fertilizers for their total land.Other studies have also highlighted costas a key constraint to fertilizer use by farmers.The fertilizer supply is limited and the cost is prohibitive for SSA farmers because fertilizer may cost as much as five times the global market price (Erisman, van Grinsven, Leip, Mosier, & Bleeker, 2010). All fertilizer used in Rwanda is imported through neighboring countries, through the regional ports of Mombasa or Dar es Salaam and the retail price in rural Rwanda is a function of various costs including procurement, port handling and clearing, transport and transaction, financing, border clearing, and other local distribution charges (IFDC (2014). To mitigate these costs and make fertilizer affordable to the farmers, the Rwanda government introduced fertilizer subsidies.However, even under the subsidies,the FGD discussions indicated that the farmers in UBUDEHE category 1 and 2 expressed that they cannot afford to procure the fertilizers required for all their land parcels.This is in line with other studies that show that in-spite of government efforts to educate farmers and make fertilizers more available and affordable, poor farmers working with degraded soils have failed to respond to such programs or to increase fertilizer use (Krishna 2009). Other studies show that although fertilizer subsidy programs are motivated by governments to reduce poverty and food insecurity especially for the poor, "Fertilizer promotion policy doesn't help the poorest farmers very much," (Barrett et al 2014).

The farmers through the FGDs felt that, the price of fertilizers under the subsidy program are not affordable to some farmers and they observed that, when MINAGRI reduced the rate of subsidies from 50% to 30%, the quantity of inorganic fertilizers purchased by farmers also reduced and this led to change in quantity used in the farms thus leading to soil infertility due to inconsistency in the amount of inorganic fertilizer used. This observation is associated to the increasing of prices from previous years. Other studies indicated there have been changes in reduction of fertilizer subsidies over the years. For instance, according to IFDC, 2014, MINAGRI took a further step toward fertilizers competitive markets in mid-2014, setting maximum retail prices for three subsidized fertilizers (NPK, DAP and urea) and cutting subsidies by about a third compared with the previous year. The farmers through FGDs indicated that they are not pre warned as the subsidies are adjusted, and are often caught unawares and therefore not in a position to procure the required quantities in the subsequent seasons.However, the farmers also stated that the price of inorganic fertilizer is worth the benefit it provides in relation to the yields obtained as a result of using fertilizers.

The second reason is that, the farmers do not have sufficient knowledge to use fertilizer, limited knowledge in using inorganic fertilizers.Kelly et al. (2001a and 2001b) found that the most common reason of not using inorganic Fertilizer in Rwanda is the lack of knowledge. The interpretation provided for this reason is that farmers' knowledge of the benefits and of how to use the fertilizers is not strong enough to stimulate use.Kelly et al. (2001b), further state that if farmers do not know about the economic incentives associated with fertilizer, there is a human capital constraint that needs to be lifted by improving knowledge.

Other farmers (16.8%) are not aware and arealso not able carry out registration in smart Nkunganire program using mobile telephone; Some farmers reported that the reasons of not using inorganic fertilizers are that the crops they grew did not need inorganic fertilizers such as beans and banana, and that is the reason why they used much of the fertilizers on maize.slightly less than half (49.3%) of world fertilizer use is estimated to have been applied to cereals, and of the top-three cereals, maize was the greatest contributor to world fertilizer consumption (16.2%), followed by wheat (15.3%) and rice (13.7%). Fertilizer use on the other cereals represented 4.0% of the world total. This scenario is replicated in Rwanda with very little fertilizer used on beans and bananas.Regarding the location of the main suppliers of agriculture inputs the farmers (77.7%) stated that the agricultureinputs are very near to them between within 1 to 3 km from farm to suppliers.

These findings provide evidence that, the cost of fertilizers for farmers in category one and two, the bad experience whereby fertilizers did not impact on yield in the previous seasons due to insufficient knowledge of farmers in using fertilizers, the change in reducing government subsidies that lead to increase of prices, introduction of new technology (Smart Nkunganire registration and request fertilizers) vis a vis to the limited knowledge to use electronic devices; are the main determinants of not using inorganic fertilizers.

4.3.9 The perceptions of farmers in appreciation for the quality of fertilizers with regard to the crop grown, the price and time the inorganic fertilizers are supplied

This section aimed to establishhow the farmers are confident with the quality of inorganic fertilizers used and how the fertilizers are appropriate to the crops grown. The farmers also provided their perceptions about why they preferred to use inorganic fertilizers. The results from surveyed farmers show that, the farmers who used inorganic fertilizers are very confident to the quality of supplied fertilizers(74.4%) and others (23.9%) have little confident on the quality of inorganic fertilizers used. The farmers were also very confident that, the inorganic fertilizers used were appropriate to the crops grown (74.4%) and they preferred to use inorganic fertilizers because, the use of inorganic fertilizers stimulates the best crop yields (92.5%). This was also observed in the discussions in the FGDs where the farmers indicated that using fertilizer and improved seeds increase the harvest, and in Nyamasheke district the farmers indicated that "the use of inorganic fertilizer boosted our production by two to three times therefore, we are committed to using agriculture inputs". These findings revealed that; if

the farmers have good knowledge in using inorganic fertilizers and goodquality inputsare used, the yield increases and farmers gain confidence inusing inorganic fertilizers. Table 40 illustrates the findings.

Table 40:Farmers' perception on fertilizers quality

The farmers are confident in the Quality of fertilizer	**Count**	**Percent**
Very confident	820	74.4
A little confident	263	23.9
Don't know	8	0.7
A little unconfident	7	0.6
Very unconfident	4	0.4
The farmers are confident that the fertilizers allocated are the most appropriate for the crops grown	**Count**	**Percent**
Very confident	820	74.4
A little confident	257	23.3
Very unconfident	10	0.9
Don't know	9	0.8
A little unconfident	6	0.5
The reasons why the farmers preferred the brands of inorganic fertilizers	**Count**	**Percent**
Due to the use of inorganic fertilizers, they produce the best yields	908	92.5
The extensions services providers are credible to the farmers, they are recommended to them to use inorganic fertilizers	62	6.3
They are recommended by local officials	51	5.2
They are the only brand I am aware of	42	4.3
A friend or family member recommends them	32	3.3
They sell at good prices	22	2.2

Source: Primary data, farmers survey, 2019

Farmers' perception of fertilizer quality can be influenced by both the expectation about its true nutrient content and the expectation about the efficiency of fertilizer in general. However, farmers do not have the equipment to perform tests and it is difficult to determine the quality of fertilizer from crop output alone as there are many other factors that could affect output, therefore the only quality indicator with a statistically significant effect on fertilizer intensity is perceived quality, and not the true quality (Khor, 2015). The farmers through FGDs indicated that they share the importance of fertilizers in improving production during the community dialogues conducted in the cells, villages and at Sector levels known as Inteko z'abaturage.

The study therefore observes that that word of mouth rather than the true fertilizer quality, which cannot be easily observed, plays an important role in shaping farmers' perception of fertilizer quality.Therefore, the need to capacitate agro dealers as fertilizer sellers, and frontline line extension workers to provide recommendations to farmers since for the households' perception on fertilizer quality and choice depends on what others tell them.

4.3.10 Status of thetimeliness ofthe inorganic fertilizers distribution to the surveyed farmers

This part of research aimed at establishing if the farmers received the inorganic fertilizers on timely in reference tothe timewhen they made the request, as well as to the planting time. This helps to tell if the inorganic fertilizers were distributed on time or late. Season B 2019 is from 1st March to 31st July 2019, this means that the planting of crops was carried out in March 2019, the request and receiving inputs to use began in January to February 2019.The results in table41indicate that, most farmers (73.7%) requested the inorganic fertilizers on 1st to 28th February 2019, while most farmers (77.1 %) received organic fertilizers between 1st February and 15th March 2019. This show that 90.6 % of the requests were addressed and inorganic fertilizers were provided on time. The few farmers (104 among 1012 farmers) claimed that, the inorganic fertilizers were supplied with some delays (9.4%) of one week to one month.

The findings reveal that, the farmers surveyed received the inorganic fertilizers on time (90.6%) and few delay of 9.4% which is tolerant and caused by some exogenous variables related issue of administrative (compilation of lists), contracts between agro dealers and suppliers, etc. Table 41 illustrates the findings.

Table 41:Timeliness in supply of fertilizers

The time of request of inorganic fertilizers (Date, Month)	**Count**	**Percent**
01-28/02	813	73.7
01-15/03	120	10.8
16 -31/03	19	1.7
After 31/03	59	5.3
Don't know/can't remember	91	8.2
The time of receiving inorganic fertilizers ((Date, Month)	**Count**	**Percent**
01-28/02	658	59.7
01- 15/03	192	17.4
16 -31/03	69	6.3
After 31/03	90	8.2
Don't know/can't remember	93	8.4
Farmers have received the fertilizers at right time	**count**	**Percent**
Yes	998	90.6
No	104	9.4
The length of time delay after the right time was there in receiving fertilizer	**Count**	**Percent**
One week	14	13.5
Two weeks	27	26.0
Three weeks	18	17.3
One month	32	30.8
More than a month	12	11.5
Don't know	1	1.0

Source: Primary data, farmers survey, 2019

Previously, timeliness in supply of fertilizers was a major constraint (IRDP, 2017). KIIs with MINAGRI indicated that the government of Rwanda has reviewed the fertilizer distribution model, thus addressing the constraint of late delivery. Interviews with RAB indicated that several improvements have been effected so as to improve the timeliness in supply of fertilizers. This study finding therefore prove that the new strategies adopted by the government have largely addressed the constraint on timeliness in accessibility of fertilizers by farmers.

4.3.11 How accessibility to inorganic fertilizers affecttimely planting of crops

The study sought to establish how was important toestablish how accessibility to inorganic fertilizers affected timelyplanting of crops. The results in table 42 indicate that, the accessibility of inorganic fertilizers is rated to somewhat easy access (62.0%) and very easy (19.2%). This is due to the process of identifying the farmers' needs for inorganic fertilizers such as the compilation of the listof subsidy beneficiaries by the agronomists to using smart Nkunganire application and other factors such as insufficient information to farmers. The farmers, through FGD discussions alsohighlighted that, the delay of inorganic fertilizers is also caused by the farmers themselves who for instance did not pay advance of first installments or make mistakes in filling the list of farmers who benefited from subsidies, as well as failure and limited knowledge in making the requests using smart Nkunganire application. Due to the delay in obtaining inorganic fertilizers, most farmers (76.9%) said that, the yields were negatively affected due to late planting (85.6%) and sometimes the crops experienced bad climatic conditions such as drought or heavy rainfall as a result of late planting.

Table 42:Accessibility to inorganic fertilizers and how it affects timely planting.

The extent to which it is easy to get inorganic fertilizers	**Count**	**Percent**
Very difficult	35	3.2
Somewhat difficult	172	15.6
Somewhat easy	683	62.0
Very easy	212	19.2
The main reasons for the delay of inorganic fertilizers	**Count**	**Percent**
I was not registered on the list of subsidy	7	6.7
Poor planning during the requesting of fertilizers Amongst local officials/agro dealers (e.g. underestimating number of farmers)	31	29.8
No communication from agro dealers notifying the delivery	22	21.2
Other (delay of approving list, farmers did not pay advance installment on time, etc,	43	41.3
Don't know	21	20.2
The effects of the delay of inorganic fertilizers	**Count**	**Percent**
I could not apply some of the fertilizer	4	3.8
I could not apply all of the fertilizer	4	3.8
My yields were negatively affected	80	76.9
My soil was negatively affected	5	4.8
Other (specify)	18	17.3
The most critical stages of the planting seasons	**Count**	**Percent**

Where the delay of inorganic fertilizers		
Planting stage	89	85.6
Weeding stage	14	13.5
Other stage	1	1.0

Source: Primary data, farmers survey, 2019

Planting date is one of the many factors that affect crops yield potential, however, in most times, farmers have little control over when they are able to get access the fertilizers into their farms for planting. Indeed, the surveyed farmers indicated planting time as the most critical stages of the planting seasons where the delay of inorganic fertilizers can affect the crops production. The primary reason to plant early is to avoid environmental stresses at certain growth stages.For example, maize requires the greatest amount of water during silking, while high temperatures can cause death of pollen and also kernel abortion.Hence timely planting is very crucial to avoid such stresses. This was also observed during the FGDs, whereby farmers observed that when fertilizers are delayed,the planting date is also delayed and the farmers stated that due to the delay in obtaining inorganic fertilizers the yields were negatively affected.

4.3.12 Farmers' perceptions on the Quantity of fertilizers ordered and the quantity allocated

This section aimed to know if the farmers received the total quantity of inorganic fertilizers requested, the extent to which the farmer are satisfiedwith the quantity received, and to know if the quantity received was fully used in thefarms or saved,and to rate the quality of fertilizers purchased. The findings in table43show that, most respondents (95.4%) received all the quantity of inorganic fertilizers they ordered.

Table 43:Farmers' perception on quantity of fertilizer purchases versus the amount ordered

Did you purchase all the inorganic fertilizer allocated to you (n=1,102)	Percent
Yes	95.4
No	4.6
The farmers were satisfied to the purchased fertilizers (n=1,102)	**Percent**
Strongly disagree	0.5
Disagree	2.3
Agree	45.6
Strongly agree	50.8
Don't know	0.8
All fertilizers purchased were all used in the 2019 season B (n=1,102)	**Percent**
I did not use any of the fertilizer I received	1.1
I used some of the fertilizer I received	0.4
I used most of the fertilizer I received	4.0
I used all of the fertilizer I received	94.6
The rating the quality of fertilizers received (n=1,102)	**Percent**
Very poor	0.7
Poor	3.7
Good	77.9

Excellent	17.7

Source: Primary data, farmers survey, 2019

The study through KIIs with RAB and other stakeholders established that has benefits which include increased efficiency, better stock management, and traceability of both subsidies and payments at all levels across the supply chain in real time, increased transparency and reduction of fraud and human errors; the system will also bridge the communication gap. Therefore, the study findings whereby most respondents (95.4%) received all the quantity of inorganic fertilizers they ordered can be attributed to the benefits of smart Nkunganire coupled with the improved distribution system as implemented by RAB.

4.3.13 Gains by farmers as a result ofusing inorganic fertilizers

The results of using inorganic fertilizers were clear based on the change in yield obtained, satisfaction of farmers who use inorganic fertilizers and getting returns on the money spent in buying inorganic fertilizers.Results in the table 44 indicate the farmers'views on comparisonon the yields between using and not using inorganic fertilizers.They confirmed that; yield results from the use of inorganic fertilizers were better than not using inorganic fertilizers (54.2%), and also the yield increasedwhen farmers used inorganic fertilizers (36.9%), and that they are very satisfied with the yield (69.4%) and their income was increased as results of using inorganic fertilizers (34.1%), regarding farmers' perceptions about the money spent in buying inorganic fertilizers and have its returns in yield results, the farmers (80.6%) were in agreement.
Discussions in the FGDs also emphasized on the farmers gains on using inorganic fertilizers.One participant in Gatsibo district stated that "Before using inorganic fertilizers and improved seeds, I harvested 300 Kgs or 400 Kgs of maize in my farm and it is the same farm where lam now harvesting 1000 Kgs and more so this proves that inorganic fertilizers are so useful in increasing production".

Even if the good results in using inorganic fertilizers, some farmers (56.5%) claimed that the price of inorganic fertilizers are still unaffordable due to the reduction of government subsidies from 50% to 30% and the citizens who belong in CAT1 and CAT2 of ubudehe categories,and whodo not have enough purchasing power to buy inorganic fertilizers. Table 44illustrates the findings.

Table 44.Farmers' gains as a result of using fertilizers

Yield results of the use of inorganic fertilizers	**Count**	**Percent**
The yields are much worse than when not using inorganic fertilizer	37	3.4
The yields are a little worse than when not using inorganic fertilizer	42	3.8
The yields are about the same as when not using inorganic fertilizer	13	1.2
The yields are a little better than when not using inorganic fertilizer	407	36.9

The yields are much better than when not using inorganic fertilizer	597	54.2
Don't know	6	0.5
Total	**1102**	**100.0**
The extent of the satisfaction of farmers as results of the use of inorganic fertilizers	**Count**	**Percent**
Very unsatisfied	9	0.8
Somewhat unsatisfied	16	1.5
Somewhat satisfied	312	28.3
Very satisfied	765	69.4
Total	**1102**	**100.0**
The change of income as the results of obtaining good yield from the use of inorganic fertilizers	**Count**	**Percent**
The income is much worse than when not using inorganic fertilizer	29	2.6
The income is a little worse than when not using inorganic fertilizer	47	4.3
The income is about the same as when not using inorganic fertilizer	53	4.8
The income is a little better than when not using inorganic fertilizer	595	54.0
The income is much better than when not using inorganic fertilizer	376	34.1
Don't know	2	0.2
Total	**1102**	**100.0**
Farmers' perceptions about the money spent in buying inorganic fertilizers have its count parts in yield results	**Count**	**Percent**
Strongly disagree	38	3.4
Disagree	167	15.2
Agree	576	52.3
Strongly agree	312	28.3
Don't know	9	0.8
Total	**1102**	**100.0**
The affordable prices in an issue for the quality of inorganic fertilizers	**Count**	**Percent**
Yes, and price would not be an issue	438	43.5
Yes, but price would be an issue for me	569	56.5
Total	**1007**	**100.0**

Source: Primary data, farmers survey, 2019

4.3.14 Farmers perceptions on the effect on affordability of inorganic fertilizers if the government subsidies can be stopped

The results in table 45indicate that, the farmers are aware that the government subsidiesfor fertilizers make them more affordable (87.1%), others 12.9% are not aware of the government subsidies. Most farmers believe that they could afford inorganic fertilizers if government subsidy was stopped (60.2%), some farmers (33.3%) do not believe that that they could afford inorganic fertilizers if government subsidy was stopped, while others (6.5 %) were not sure whether they could afford. The actions that might be taken by farmers in case the price of inorganic fertilizers increases,(44.1%) said that they would try to buy and use less inorganic fertilizer thanthe current quantity, (23.0%) said that they would switch to use organic fertilizer and others

(15.3%) said that would reduce the spending on other household items to buy inorganic fertilizers.

Table 45:farmers' perception on affordability of inorganic fertilizers under the subsidies

The farmers are aware that the government Subsidies for the cost of fertilizers makes them more affordable	**Count**	**Percent**
Yes	960	87.1
No	142	12.9
Total	**1102**	**100.0**
The farmers believe that they could afford inorganic fertilizers if government subsidy was stopped	**Count**	**Percent**
Yes	663	60.2
No	367	33.3
Not sure	72	6.5
Total	**1102**	**100.0**
The actions that might be taken by farmers when the price of inorganic fertilizers increases	**Count**	**Percent**
The farmer would try to buy and use less inorganic fertilizer than I do now	486	44.1
The farmer would switch to organic fertilizer	253	23.0
The farmer would borrow money to buy inputs	56	5.1
The farmer would reduce my spending on other household items to buy inputs	169	15.3
The farmer would search for other means of support	29	2.6
The farmer doesn't know	109	9.9
Total	**1102**	**100.0**

Source: Primary data, farmers survey, 2019

These results provided evidence that, the government subsidies in agriculture activities are very important in helping farmers to get inputs. According to their perceptions, if the government subsidies stopped, some farmers will not be able to continue using inorganic fertilizers and can make a reduction in agriculture productivity and make negative impact on food security. This is in line with other studies such as (Diao, 2017) where it is observed that there is need for diverse incentives and support to enhance productivity as well as production of targeted staple food crops. The study through FGDs observed thatthe existing poverty reduction programs should be sustained to increase the purchasing power of the farmers and later help the farmers to have the capacity of buying the agriculture inputs without government subsidies.

4.3.15 Factors assisting farmers in choosing the type of fertilizers and encouraging them to increase uptake of inorganic fertilizers and usage of lime

Due to the education level and limited knowledge among the farmers on in using agriculture inputs, the government introduced thenational extension system-TWIGIRE MUHINZI, through which the extension services providersequip farmerswith basic knowledge and also helpthe farmers inidentifying the relevant fertilizers.The agro-dealers and local government agronomists also assistthe farmers in various aspects. The results in table 46 indicate that, the agriculture

extension services providers (67.9%), local agrodealers (27.5%) and local agronomist/ official local leaders (33.1%) provide support to the farmers in choosing the relevant type of fertilizers. The most important factor that push the farmers to use inorganic fertilizers is the price of inorganic fertilizers with government subsidy (76.9%), Promoting agents who push the farmers to increase uptake for their area of land were the price with government subsidy (76.9%), Seeing a demonstration of the benefits of inorganic fertilizer on yields (18.7%) and Smaller packages of inorganic fertilizers that are more affordable (30.4%).From the results it is observed that, the contributions of the agriculture extensions services providers, local government authorities, local agronomists in helping of farmers in terms of using inorganic fertilizers and price of inorganic fertilizers with government subsidies are key determinants of the use of inorganic fertilizers in surveyed farmers in 10 districts.

Table 46: Factors assisting farmers to choose and use fertilizers

The supporters of the farmers to choose relevant type of inorganic fertilizers (n =1,102)	**Percent**
Family, friends or neighbors	15.0
Local agro dealers	27.5
Agriculture extension providers	67.9
Local official/leader	33.1
Don't know	0.7
I would not ask someone else for advice	1.4
The encouraged agent which push the farmers to use inorganic fertilizers (n =1,102)	**Percent**
Having an agro dealers closer to me	17.1
Seeing a demonstration of the benefits of inorganic fertilizer on yields	18.7
Support from an extension worker on how to best access and use inorganic fertilizer	12.2
Improvements in the timeliness of delivery of inorganic fertilizer to my area	7.5
Lower prices for inorganic fertilizer with subsidies	76.9
Improved availability of inorganic fertilizer at my local agro dealers	8.8
Improved variety of inorganic fertilizers at my local agro dealers	10.9
Smaller packages of inorganic fertilizers that are more affordable	27.8
Promoting agent which push the farmers to increase uptake for their area of land (n =1,102)	**Percent**
Having an agro dealers closer to farmers	16.1
Seeing a demonstration of the benefits of inorganic fertilizer on yields, compared with organic	28.3
Support from an extension worker on how to best access and use inorganic fertilizer	15.2
Improvements in the timeliness of delivery of inorganic fertilizer to my area	5.4
Lower prices for inorganic fertilizer with government subsidies	73.1
Improved availability of inorganic fertilizer at my local agro dealers	5.4
Improved variety of inorganic fertilizers at my local agro dealers	9.0
Smaller packages of inorganic fertilizers that are more affordable	30.4

Source: Primary data, farmers survey, 2019

Lower prices for inorganic fertilizer with government subsidies Promoting agent, which push the farmers to increase uptake for their area of land. The results from the focus group discussions also showed that if it were not for the high cost of the inorganic fertilizers, farmers were willing to apply more fertilizers/ha, since they were aware of its importance.Other studies show that the farmers have accepted and are willing to adopt inorganic fertilizers in their farming system; but it is not affordable and accessible given the fact that they are subsistence producers (Nambiro and Okoth, 2012).

Seeing a demonstration of the benefits of inorganic fertilizer on yields, compared with organic was identified as a key factor Promoting agent that push the farmers to increase uptake for their area of land. This is in line with other studies, which state that knowledge of fertilizers was indicated as a factor, which pushes the farmers to use inorganic fertilizers. Knowledge especially through demonstrations plays an important role in selection of farming practices (Bentley 1989). This could be attributed to the properties of the field days where physical demonstrations is done, thus farmers are able to see and even have hands-on experience on the technology being disseminated (Murage et al., 2011). Improving farmers' understanding is an essential element in the development and application of integrated soil fertility management (ISFM) technologies (Deugd et al. 1998). This was also highlighted in KIIs where stakeholders indicated that, low usage of fertilizers, must be tackled through strategies that enhance knowledge and counter negative or inaccurate perceptions by farmers.This study therefore deduces that there is need to strengthen smallholder understanding of mineral fertilizers through demonstrations.

4.3.16 If the Surveyedfarmers plan to use inorganic fertilizers in the forthcoming seasons

This section of the survey intended to establish if the farmers plan to use inorganic fertilizers in the forthcoming seasons and whether they plan to use the same brand of inorganic fertilizers used in previous season 2019 B and the usage of liming materials. The results in table47 indicate thatmajority of the farmers (95.2%) planned to use inorganic fertilizer in the forthcoming seasons, and 90.6% of them intended to use the same brand of inorganic fertilizers used in previous seasons for the next seasons. This was also reflected in the FGDs discussions where farmers indicated"Our agricultural production has increased since we started using fertilizers and we use fertilizers in all agricultural seasons (A, B and C)and weare committed to using agriculture inputs". These results showthat, the farmers who used inorganic fertilizersare willingto continue using it in consequent seasons.

Table 47:Farmers' plan to use fertilizers in future

The farmers have planned to use inorganic fertilizer in the forthcoming seasons	Count	Percent
Definitely no	25	2.3

Probably no	4	0.4
Probably yes	24	2.2
Definitely yes	1049	95.2
Total	**1102**	**100.0**
The farmers intended to use the same brand of inorganic fertilizers for the next season	**Count**	**Percent**
Definitely no	57	5.2
Probably no	11	1.0
Probably yes	36	3.3
Definitely yes	998	90.6
Total	**1102**	**100.0**
The farmers have ever used any liming materials	**Count**	**Percent**
Yes	197	17.9
No	905	82.1
Total	**1102**	**100.0**
The types of liming materials used	**Count**	**Percent**
Lime	156	79.2
Travertine	41	20.8
Total	**197**	**100.0**

Source: Primary data, farmers survey, 2019

4.4. Perceptions of the farmers who were not using inorganic fertilizers in season 2019B

This part aims to explore the preferences of farmers who did not use inorganic fertilizers and the causes of not using inorganic fertilizers, the extent level of satisfaction in using organic fertilizers were explored, the access of natural produced fertilizers (organic), and the level of getting sufficient organic fertilizers. In the entire survey, 14.8% of the farmers used only the organic fertilizers, they are somewhat satisfied with using organic fertilizers (40.4%), and only 15% were very satisfied to use it. Most farmers who used organic fertilizers (64.7) said that, the organic fertilizers were insufficient and they did not have all the required nutrients for the crops. The sources of organic fertilizers were livestock (63.6%), and other organic fertilizers were from compostprepared byfarmers' cooperatives, neighbor and friends(table 48).

Table 48:Farmers' perceptions on why they do not use fertilizers

The farmers used organic fertilizers	**Count**	**Percent**
Yes	273	14.8
No	1573	85.2
Total	**1846**	**100.0**
The farmers were satisfied with the use of organic fertilizers	**Count**	**Percent**
Very dissatisfied	49	17.8
Somewhat dissatisfied	74	26.5
Somewhat satisfied	112	40.4
Very satisfied	42	15.0
Don't know	1	0.3
Total	**278**	**100.0**

The sources of inorganic fertilizers	Count	Percent
From farmer's livestock	177	63.6
From a neighbor/friend	51	18.4
From cooperative	1	0.3
Other (buying to made organic composts)	49	17.7
Total	**278**	**100.0**
The farmers were able to obtain all needed sufficient organic fertilizers	**Count**	**Percent**
Yes	98	35.3
No	180	64.7
Total	**278**	**100.0**

Source: Primary data, farmers survey, 2019

4.4.1 Reasons thatpush farmers to not using inorganic fertilizers and prefer to use organic fertilizers.

These part links the farmers' capacity, return and benefits. The findings in table 49indicate that, the farmers who do not use inorganic fertilizers were moderately aware that, the use of inorganic fertilizers has good results to good value for money spent, and has worth in the benefits it provides. The main reason of not using inorganic fertilizers, that the price of inorganic fertilizer is not affordable to some farmers was rated very highly, as also stated in previous findings; the farmers in CAT1 and CAT2 of ubudehe category have low purchasing power and they do not havecapacity to buy all the required fertilizersfor the total cultivated lands.

Table 49:Farmers' perception on why they do not use fertilizers

Items	n	Min	Max	Mean	Std. Deviation	Interpretation
The price of inorganic fertilizer is not affordable to the farmer	278	1	5	3.49	.800	Very high level
The farmers think that inorganic fertilizer has not a good value for money	278	1	5	1.92	.905	Moderate level
The price of inorganic fertilizers is not worth it for the benefits it provide	278	1	5	2.17	1.093	Moderate level

Source: Primary data, farmers survey, 2019

4.4.2 The perceptions of the farmers who previously used inorganic fertilizers,(before season 2019B) butdid not use inorganic fertilizers in 2019 Season B

This part of the survey assisted the researchers to know, the extent to which the farmers have previously used the inorganic fertilizers before 2019 Season B, and didn't used it in next seasons. 319 farmers who have previously used inorganic fertilizers anddid not use the

inorganic fertilizers in season 2019 B, they said that, they did not use inorganic fertilizers in season 2019 B due to it being expensivein comparison to their purchasing power (71.8%), other few farmers said different reasons with lower scores as it is indicated in the table 50, 69.0% of them said that, they have passed one year without using inorganic fertilizers, and 71.5% of them also said that, in time they had used inorganic fertilizers their prices were including Government subsidies. The types of fertilizers which were most used were DAP, UREA and NPK.

Table 50:Farmers' perceptions on why they don't use fertilizers in subsequent seasons

Farmers used inorganic fertilizers before 2019 Season B, and they are not currently use it	**Count**	**Percent**
Yes	319	42.9
No	425	57.1
Total	**744**	**100.0**
The reasons of not using it in season 2019B	**Count**	**Percent**
It is too expensive for me	229	71.8
I don't know how to access it	2	0.6
It is not available in my area	18	5.6
I don't know how to use it appropriately	14	4.4
There have been problems in distributing it to farmers in this area so I do not try	20	6.3
My neighbors/friends/family advise me to use organic	36	11.3
Total	**319**	**100.0**
The time passed without using inorganic fertilizers	**Count**	**Percent**
1 year ago	220	69.0
2 years ago	53	16.6
More than 2 years ago	46	14.4
Total	**319**	**100.0**
In time the farmers used inorganic fertilizers have got Government subsidies	**Count**	**Percent**
Yes	228	71.5
No	77	24.1
Don't know	14	4.4
Total	**319**	100.0
The types of fertilizers used in that previous seasons	**Count**	**Percent**
NPK	93	29.2
DAP	216	67.7
UREA	152	47.6
Other	1	0.3
Don’t know	6	1.9

Source: Primary data, farmers survey, 2019

4.4.3 The experiences faced by the farmers who previously used inorganic fertilizers and not use it in season 2019 B.

The experiences faced by the farmers were assessed through their satisfaction, the fertilizers prices, and to know, if they expect to use inorganic fertilizers in the future. Table 51 illustrates the findings. The findings show that, even if 319 farmers did not use inorganic fertilizers in 2019 Season B, they still scored 58.9% that were very satisfied with the results of havingpreviously used inorganic fertilizers. They said that, they were satisfied due to the yields obtained as a resultof using inorganic fertilizers (82.6%), and only 32 farmers were dissatisfied with some factors such as price, bad yieldsand of support in using the correct fertilizers, and they agreed that next season they will definitely continue to use inorganic fertilizers (70.5%) and probably (18.2%).

Table 51:Farmers' experiences in discontinued use of fertilizers

By previous experience the farmers were satisfied with the used inorganic fertilizers	**Count**	**Percent**
Very dissatisfied	3	0.9
Somewhat dissatisfied	29	9.1
Somewhat satisfied	99	31.0
Very satisfied	188	58.9
Total	**319**	**100.0**
The reasons of satisfaction	**Count**	**Percent**
The prices were acceptable to me	22	7.7
The quality of the fertilizer was good	16	5.6
I trusted the brand name of the fertilizer	5	1.7
My yields were better after using the fertilizer	237	82.6
I had support in using the fertilizer correctly	4	1.4
Other	3	1.0
Total	**287**	**100.0**
The reasons of dissatisfaction	**Count**	**Percent**
The prices were too high	8	25.0
My yields were the same or worse after using the fertilizer	8	25.0
I had little or no support in using the fertilizer correctly	4	12.5
Other (the absent support knowledge in using fertilizers)	12	37.5
Total	**32**	**100.0**
The farmers have expected to use the inorganic fertilizers for future	**Count**	**Percent**
Definitely no	12	3.8
Probably no	18	5.6
Probably yes	58	18.2
Definitely yes	225	70.5

Don't know	6	1.9
Total	**319**	**100.0**

Source: Primary data, farmers survey, 2019

4.4.4 The farmers' perceptions on choosing to use or not to use inorganic fertilizers

This section aimed toshow the farmers' perceptions about the factors that push them to use or not to use inorganic fertilizers.To measure the rates of perceptions the Four-Likert scales ranging 1 to 4 were used, 1: Strongly disagree, 2: Disagree, 3: Agree and 4: Strongly Agree. The mean score indiceswere used to show the perception levels in ranges of mean responses as indicated in table 52:

Table 52:Farmers' perception on choosing to use or not to use fertilizers

Mean range	***Description***	***Interpretation***
3.26 - 4.00	*Strongly Agree*	*Very High level*
3.25 – 2.75	*Agree*	*High level*
2.74 – 1.76	*Disagree/ Neutral*	*Moderate level*
1.75 – 1:00	*Strongly disagree*	*Low level*

https://www.researchgate.net/publication/276394797_Likert_Scale_Explored_and_Explained

The results as displayed in the table 53indicate that, the farmers moderately accept that, affordability, thinking that the organic fertilizer is better than inorganic, the availability of agriculture extension services, being registered in smart Nkunganire program, availability of agro dealers' shops, pre-pay for inputs, knowledge about the types of inorganic fertilizers were ranked at moderate levels with the average mean indices of " Mean = 2.49 to 1.76". This means that, the mentioned factors affect the level of the use of inorganic fertilizers.

In previous sections of this study,, the data shows that, the farmers in CAT1 and CAT2 Ubudehe categories did not fully afford the agriculture inputs, some farmers said that they prefer to use organic fertilizers because it does not have any negative effect to the land and to the life, In FGDs some farmers said that if they currently reduce the quantity of inorganic fertilizers than previous seasons this will negatively affect their land and crops, and others said that, the crops grown with inorganic fertilizers can cause cancer in human body. They also said that, the number of agro-dealers and extension services providers are still few than demand, in surveyed districts, there were 2 or 3 agro dealers within districts, the farmers obtained agriculture inputs through farmers' cooperatives at higher price than agro dealers, and sometimes, the requirements for getting inorganic fertilizers is pre-paid which discourage the

farmers who do not have enough money at hand and otherswho do not havemoney at the time of listing. Another challengeis registration in Smart Nkunganire Program.Some farmers who have basic and primary education andare not able use smart Nkunganire program, there is need to use telephone to register while some farmers do not havemobile phones. Thereis needto measure the cultivated land in square meters but some farmers do not know how to measure their land, and sometimes they do not have land title which can show the area measurements.

During the FGDs discussions, the farmers statedthat, the inorganic fertilizers are at times notdelivered on time.Some of farmers said that they don't trust the agro dealers;while others didn't expect the benefits from the use of inorganic fertilizers and some said that their landisfertile thereforethere is no need of using inorganic fertilizers.

According to the findings, the research found that, there is a need of sensitizing the farmers in using inorganic fertilizers, increasing of extension services providers and agro dealers at each sector within district, there is a need of special support for the farmers who do not have enough capacity of purchasing all needed inorganic fertilizers (CAT1 and CAT2 Ubudehe); the government of Rwanda through MINAGRI and RAB should maintain the subsidies to 50% instead of being 30% for inorganic fertilizers; to help the farmers in term of quantifying the inorganic used is needed, some farmers used hand, spoon, cup as recipients of measuring inorganic fertilizers, this can cause the overdose or under dose which can destroy the crops or land.

Table 53:Reasons, which push farmers to use or not to use fertilizers

The reasons that push the farmers in using or not using inorganic fertilizers	N	Min	Max	Mean	Std. Deviation	Interpretation (Rating)	Rank
Farmer could not afford inorganic fertilizer	1846	1	4	2.49	1.044	Moderate level	1
Farmer think organic fertilizer is better for improving yields	1846	1	4	2.13	.956	Moderate level	2
Extension services recommend using organic fertilizer	1846	1	4	2.13	.981	Moderate level	3
Farmer did not know how to get registered on Smart Nkunganire System	1846	1	4	1.97	1.025	Moderate level	4
There are no agro dealers shops near to where farmer live	1846	1	4	1.96	1.038	Moderate level	5
The requirement to pre-pay for inputs discourages me from using inorganic fertilizers	1846	1	4	1.81	.909	Moderate level	6
Farmer doesn't know enough about inorganic fertilizer, so I choose not to use it	1846	1	4	1.76	.853	Moderate level	7
Inorganic fertilizer is not delivered in time, so farmer choose not to use it	1846	1	4	1.72	.869	Low level	8
Farmer doesn't trust agro dealers	1846	1	4	1.63	.808	Low level	9

Farmerdoes not see the benefit of using inorganic fertilizer	1846	1	4	1.61	.802	Low level	10
My soil is fertile farmer does not need to use inorganic fertilizer	1846	1	4	1.60	.715	Low level	11
Average Mean Index	**1846**			**1.8918**		**Moderate level**	

Source: Primary data, farmers survey, 2019

4.4.5 Testing hypotheses on reasons reported by the farmers, which push them to use or not use inorganic fertilizers

The research needs to prove the reality of the factors and phenomenonon reported reasons for using or not using inorganic fertilizers, the data was normally distributed using z-score test whereby: (Z = 1.96, α = 0.05), The data was categorical ordered in scales (four- Likert scales), the confidence interval in sampling was (CL= 0.95 = 95%) and margin error as degree of precision with standard errors of (0.05 = 5%).Due to data characteristics, the CHI-SQUARE TEST was computed using statistical software with Non- Parametric Model. The test statistics produced the p-value/ asymptotic value. By interpretation, the test statistics showed that, all tested reported reasons which push the farmers in using or not using inorganic fertilizers were accepted, where all (p-value = 0.000) are less than (the standard error of e = 0.05). In the other words, the farmers have accepted the tested reasons that they direct or indirect play an influence in using and not using inorganic fertilizers. Table54 illustrates the test statistics.

Table 54:Test statistics on reasons why farmers do not use fertilizers

The reasons that push the farmers to use or not use inorganic fertilizers	**Chi-Square Value**	**Confidence interval**	**Degree of errors precisions**	**N (0,1) z-score**	**Asymp. Sig. (P-value)**	**Conclusion** P-value < 0.05
There are no agro dealer's shops near to where the farmer live	1025.771[a]	95%	0.05	1.96	0.000	Accept
Farmers do not see the benefit of using inorganic fertilizer	2187.277[a]	95%	0.05	1.96	0.000	Accept
Farmer think that organic fertilizer is better than inorganic fertilizers	928.030[a]	95%	0.05	1.96	0.000	Accept
Farmer could not easily afford inorganic fertilizers	537.830[a]	95%	0.05	1.96	0.000	Accept
The farmer did not know how to get registered on SNS	1042.754[a]	95%	0.05	1.96	0.000	Accept
Inorganic fertilizer is	1938.762[a]	95%	0.05	1.96	0.000	Accept

not delivered in time, so farmer chose not to use it						
Farmer doesn't know enough about inorganic fertilizer, so I choose not to use it	1714.780[a]	95%	0.05	1.96	0.000	Accept
Farmer doesn't trust agro dealers	2207.137[a]	95%	0.05	1.96	0.000	Accept
The requirement to pre-pay for inputs discourages farmers from using inorganic fertilizers	1541.156[a]	95%	0.05	1.96	0.000	Accept
The soil is fertile farmer does not need to use inorganic fertilizer	2219.146[a]	95%	0.05	1.96	0.000	Accept
Extension services recommend using organic fertilizer	807.895[a]	95%	0.05	1.96	0.000	Accept

Source: Primary data, farmers survey, 2019

4.5 The status of proximity to extension services by the surveyed farmers.

Proximity to extension services is a key component of CIP, and is very important to the farmers where they get in farm and non-farm trainings that help them to improve the agriculture activities and to acquire the knowledge about cropping, the use of fertilizers and planting and secure improved seeds. The results indicate that, 1345 out of 1845 farmers (72.9%) benefited from the extension services. The farmer's promoters (89.3%) and Government Extensionists/ Agronomists (28.6%) were the key extension services providers in surveyed 10 farmers, these extension services providers were complemented by the NGOs that engage in agriculture sector such as USAID HINGAWEZE Program, TUBURA One Acre Fund Project, etc.The most services provided were related to the use of inorganic fertilizers (88%), and others services such as postharvest management, planting, pest and disease control (5.9%), the farmers also ranked frequencies of the services received, they stated that at least one or twice in a season received extension services. They were also asked the source of information relatedto agriculture activities, wherebythey ranked radio (63.5%), Community meeting (47.8%) and local leaders (42.8%) as the main source of information in agriculture seasonal activities.

The farmers during FGD discussions stated that, even if they have access to fertilizers and extension services they wouldlike tohave more extension services on pest and disease control,because sometimes the crops are exposedto disease and pest attacks, which destroy their crops thus lowering the yields. Through the FGDs the farmers also indicated the need

for extension services on marketing(training on linking farmers to market). The farmers observed that sometimes they gethigh yieldsbut the produce does not meetthe required quality and standards to compete in the market. They also recommended to be provided with training on reducing post-harvest losses.

The study findings show that the government extension service providers were the main source of extension services. Other studies show that contact with extension agent could have a positive effect on use of inorganic fertilizers by farmers based on innovation- diffusion theory. Such contacts expose the farmers to availability of information and can be expected to stimulate adoption (Polson and Spencer, 1991). Farmer promoters were the agents who provided extension services to most of the farmers. Private sector actors such as Hinga Weze and One-Acre Fund (TUBURA) were also identified as providers of extension services to a large proportion of the surveyed farmers. This indicates that although farmers rely on government extension service when it comes to delivery of agricultural information, the private sector can collaborate with government for effective delivery of extension services and improved fertilizer usage among farmers.Table55 illustrates the findings.

Table 55:Farmers' access to extension services

The farmers received the agriculture's extensions services	**Count (n=1845)**	**Percent**
Yes	1345	72.9
No	501	27.1
Total	1846	100.0
The agents who provided extension services to the farmers	**Count (n=1345)**	**Percent**
Government Extensionists/ Agronomists	384	28.6
Cooperatives	262	19.5
Farmer promoters	1201	89.3
Private company	27	2.0
Media	160	11.9
I don't know	1	0.1
Other	82	6.1
The company that provided extension services	**Count (n=15)**	**Percent**
CIAT	1	6.7
HINGA WEZE	8	53.3
IKIGO DERNE	1	6.7
RAB/ MINAGRI/ URUGAGA IMBARAGA	1	6.7
SPF JOINT VENTURES	1	6.7
TUBURA	15	100.0
The Kind of extension services provided	**Count (1345)**	**Percent**
Fertilizer use/application	1184	88.0
Application rates explained	854	63.5
Application methods	614	45.7
Agricultural practices on input use	592	44.0
Other (Postharvest management, planting, pest and disease control)	79	5.9

The frequency/times that extension services have provided in season	Count (1345)	Percent
Once/ season	365	27.1
Twice/ season	301	22.4
More than twice/season	652	48.5
Once/year	15	1.1
None	5	0.4
I don't know	7	0.5
The main sources of information about agriculture news	**Count (1845)**	**Percent**
Friends/family	179	13.3
Radio	917	68.1
TV	44	3.3
Internet	3	0.2
Agrodealers	156	11.6
Local leaders	578	42.8
Newspapers	11	0.8
Community meetings	646	47.8
Cooperative meetings	162	12.0

Source: Primary data, farmers survey, 2019

4.5.1 Farmers' perceptions on the quality of extension services received by farmers

The farmers' perceptions were measured rating the perceptions level using mean score ranging 1 to 4. The perceptions were based to the farmers' level of agreements about the extent to which the extensions services provided to the farmers were relevant, available, affordable, sufficient time taken in training, increases the use and farmers 'knowledge to inputs, and major constraints facing the quality of provided services.Table 56 illustrates the findings:

Table 56:Farmers perception on quality of extension services

Items	N	Min	Max	Mean	Std. Dev	Interpretation	Rank
The topics trained by the extension agents are relevant to farmers needs	1345	1	4	3.19	.560	High level	1
The extension agents are easily available	1345	1	4	3.18	.629	High level	2
The time taken to travel so as to receive the information and advisory services provided is ok	1345	1	4	3.14	.616	High level	3
The cost of receiving the information and advisory services provided is affordable	1345	1	4	3.08	.737	High level	4
The extension services received has helped me know which type, when and how to apply fertilizers	1345	1	4	2.96	.736	High level	5
The extension services received has helped me increase the use of inorganic fertilizers	1345	1	4	2.95	.744	High level	6
The extension services received has helped me increase the use of improved seeds	1345	1	4	2.88	.743	High level	7

Average mean index	**1345**			**3.054**		**High level**	

Source: Primary data, farmers survey, 2019

The results in the table 57 show that, the extension services provided at high level score, 1345 out of 1846 farmers rated high level perceptions that the topics of the training were relevant to the farmers' needs; the extension agents were easy available; the time used in training and time to travel by farmers were enough; the services provided were affordable; the knowledge acquired by farmers in using inorganic fertilizers, planting and cropping of improved seeds were valued by the farmers. The above findings were explained through literature review, whereby the study established that in 2014, the Government of Rwanda adopted a new decentralized Agricultural extension model called TWIGIRE MUHINZI. The approach combines the farmer promoter and the Farmer field school approaches. Farmer Promoters reach all farmers with basic extension messages through mobilization of farmers and demonstration plots in each village (MINAGRI, 2014). The study through FGDs observed that a key advantage of Twigire Muhinzi extension approach is that geographic proximity and use of community-based frontline extension agents enhance accessibility of the service and help to quickly reach all farmers through mobilization and demonstration plots.

4.5.2 The significance effects of proximity to extension services received by farmers

The significance effects of proximity of extensions services were tested using CHI-SQUARE TEST distribution, the perceptions of farmers were rated using categorical and ordered score. To measure the significance effects between variables, it is important to understand the degree of associations between farmers score to each item.Table 57 indicates the decisions and conclusion drawn to accept or reject if there is or there is no significance effect between scores of perceptions.

Table 57:Significance effect of proximity to extension services by farmers

Items of farmers perceptions on proximity to extension services	**Chi-Square-Value**	**Confidence interval**	**Degree of errors precisions/ significance level**	**Asymp. Sig. (P-value)**	**Conclusion** **P-value < 0.05**
The topics trained by the extension agents are relevant to my needs	1546.155[a]	0.95	0.05	0.000	There is a positive Significance effect
The extension agents are easily available	1221.112[a]	0.95	0.05	0.000	There is a positive Significance effect
The cost of receiving the information and advisory services	1171.042[a]	0.95	0.05	0.000	There is a positive

provided is affordable					Significance effect
The time taken to travel so as to receive the information and advisory services provided by extension agents is ok	1328.930[a]	0.95	0.05	0.000	There is a positive Significance effect
The extension services received has helped me increase the use of improved seeds	839.080[a]	0.95	0.05	0.000	There is a positive Significance effect
The extension services received has helped me increase the use of inorganic fertilizers	886.902[a]	0.95	0.05	0.000	There is a positive Significance effect
The extension services received has helped me know which type, when and how to apply fertilizers	1006.896[a]	0.95	0.05	0.000	There is a positive Significance effect

Source: Primary data, farmers survey, 2019

Basing the results of statistical test in the above table where the p-value/ asymptotic values to all farmers' perceptions items are less than significance level of 0.05, the results provide evidence to conclude that, there is a positive effect of proximity to extensions services to farming activities in surveyed farmers of 10 districts. The experimental and agriculture gardens (schools of agriculture done in the gardens helps farmers to improve their skills) that are done at the field contribute a lot in the understanding the importance of using the in-organic fertilizers and the improved seeds. During the FGD discussions in Kirehe district, the farmers stated that "When the agriculture community facilitators teaching the farmers how to use the in-organic fertilizers, and the results of using fertilizers, they demonstrate in different plots. On one plot they apply organic fertilizers, on another plot they do not apply neither manure nor inorganic fertilizers, on the third plot they apply in-organic fertilizers only and on the fourth plot they apply a combination of in-organic and organic fertilizers. This experiment helps farmers to understand more the true results from using fertilizers". This means that, the provision of proximity extension services has played a major role in improving farmers' knowledge in using agriculture inputs (using fertilizers and improved seeds).

Even through, the results from 1345 farmers indicate high score and positive significance effects to the proximity of extensions services, Others 500 farmers, said that they experienced challenges on access to extensions services.

At least500 farmers from different districts highlighted the challenges in which the farmers in Musanze, Burera, Gatsibo, Kirehe and Kicukiro stated that the extension workers are not easily accessible. (10% - 30%) of the farmers reported that the farmers in Kirehe, Burera and Gatsibo have reported that, the extension workers do not have relevant and appropriate adviceprovided to them (13.1 – 44%); the farmers in Nyabihu, Musanze, Burera and Kirehe reported that, the extension support is not provided on a regular basis (12.3 -35%) the farmers

in Ruhango, Nyamasheke, Musanze and Gatsibo have reported that, there are not enough agents in the place (11.7 – 37.8%) Farmers in Nyanza, Nyamasheke, Burera, Gatsibo and Kirehe reported that they don't know the extension service program (10.5-18.1%).Table 58 illustrates the findings:

Table 58:Challenges in accessing extension services

10 Districts (500 farmers)	Extension workers not easily accessible	%	Extension workers do not give good advice	%	Extension support is not provided on a regular basis	%	Not enough agents in the place	%	Farmers do not know the available extension services	%
Gasabo	0	**0.0**	6	**9.8**	4	**2.0**	9	**3.1**	46	**5.9**
Kicukiro	1	**10.0**	2	**3.3**	6	**3.0**	0	**0.0**	18	**2.3**
Nyanza	0	**0.0**	0	**0.0**	2	**1.0**	9	**3.1**	113	**14.5**
Ruhango	0	**0.0**	0	**0.0**	2	**1.0**	34	**11.7**	62	**7.9**
Nyabihu	0	**0.0**	3	**4.9**	36	**17.7**	6	**2.1**	68	**8.7**
Nyamasheke	0	**0.0**	4	**6.6**	14	**6.9**	60	**20.6**	141	**18.1**
Musanze	2	**20.0**	1	**1.6**	30	**14.8**	55	**18.9**	36	**4.6**
Burera	3	**30.0**	10	**16.4**	25	**12.3**	5	**1.7**	82	**10.5**
Gatsibo	3	**30.0**	8	**13.1**	11	**5.4**	110	**37.8**	115	**14.7**
Kirehe	1	**10.0**	27	**44.3**	73	**36.0**	3	**1.0**	99	**12.7**
Total Choices	**10**	**100**	**61**	**100**	**203**	**100**	**291**	**100.0**	**780**	100

Source: Primary data, farmers survey, 2019

The findings from the FGD discussions identified various Challenges in accessing extension services in Rwanda such as Extension workers not easily accessible, Extension workers do not give good advice, Extension support is not provided on a regular basis Not enough agents in the place and Farmers do not know the available extension services.These challenges are also beingidentified by Wennink and Mur (2016), who observed that despite its positive contribution to the crop intensification, Twigire MUHINZI has some limitations to cope with emerging needs in Agriculture development; and by USAID2017, where various challenges were identified which lead to the extension support not being provided on a regular basisand Extension workers not being easily accessible.

4.6 The important choices of the farmers surveyed in adoption of improved agriculture

In this part the farmers surveyed were asked to score the agriculture needs in their activities, the scores were ranged in 4 Likert scaled 1= Low important, 2 = important, 3 = High important, 4= Very high important. The interpretations of the response scores were summarized in table59.

Table 59:Farmers ratings on importance of practicing improved agriculture

Mean range	***Description***	***Interpretation***
3.26 - 4.00	*Very High Important*	*Very Score*
3.25 – 2.75	*High Important*	*High Score*
2.74 – 1.76	*Important*	*Moderate Score*
1.75 – 1:00	*Low important*	*Low score*

The results from the farmer's perceptions in scoring the importance of their needs in agriculture activities show that the farmers have needs, which include;needs for cheaper fertilizer, cheaper seeds, improved understanding of how to use inputs, better quality seeds were score at very high level needs and ranking with an average mean index of (Mean score = 3.66 to 3.27). Other scored needs include better quality fertilizer, better extension services in the area, increased availability of seeds, increased varieties of seeds, increased availability of fertilizer, having more agro dealers in the area, improved choice over inputs use, improved timeliness of seed delivery, increased varieties of fertilizer.Improved timeliness of fertilizer delivery was scored at high level where their average mean indices liein interval range of 3.25 to 2.75 means that all means scored were 3.22 to 2.85 equivalent to high important.Table 60 illustrates the findings.

Table 60:Reasons why farmers practice improved agriculture

The needs for the farmers in improving their agriculture activities and productivity	**Min score**	**Max score**	**Mean range of score**	**Std. Dev**	**Interpretation**	**Rank of importanc e**
1. Cheaper fertilizer	1	4	3.66	.622	Very high important	1
2. Cheaper seeds	1	4	3.55	.686	Very high important	2
3. Improved understanding of how to use inputs	1	4	3.28	.790	Very high important	3
4. Better quality seeds	1	4	3.27	.852	Very high important	4
5. Better quality fertilizer	1	4	3.22	.931	High important	5
6. Better extension services in the area	1	4	3.13	.876	High important	6
7. Increased availability of seeds	1	4	3.13	.930	High important	7
8. Increased variety of seeds	1	4	3.03	.937	High important	8
9. Increased availability of fertilizer	1	4	3.00	1.006	High important	9

10. More agro dealers in the area	1	4	2.90	1.076	High important	10
11. Improved choice over inputs use	1	4	2.89	.959	High important	11
12. Improved timeliness of seed delivery	1	4	2.87	1.041	High important	12
13. Increased variety of fertilizer	1	4	2.86	.998	High important	13
14. Improved timeliness of fertilizer delivery	1	4	2.85	1.102	High important	14
Average mean Index			**3.187**		**High important**	

Source: Primary data, farmers survey, 2019

5.0 THE STATUS OF THE FARMERS IN CIP AND NON-CIP SITES IN USE OF INORGANIC FERTILIZERS; IMPROVED SEEDS ALONG WITH EXTENSION SERVICES

The findings of the survey provided information for comparison of the farmers within CIP and Non-CIP sites in regard to socio economic characteristic of Ubudehe category, membership to cooperatives, land size, crops grown, the use of agriculture inputs as well as knowledge, attitudes in using improved seeds and inorganic fertilizers.

5.1. The surveyed farmers' Ubudehe categories in CIP and Non CIP

Table 61:The surveyed farmers' Ubudehe categories in CIP and Non CIP

Ubudehe category before July 2019	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Category 1	84	9.7	157	16.0	241	13.1
Category 2	339	39.3	443	45.0	782	42.4
Category 3	438	50.8	384	39.0	822	44.5
Category 4	1	0.1	0	0.0	1	0.1
Total	**862**	**100.0**	**984**	**100.0**	**1,846**	**100.0**

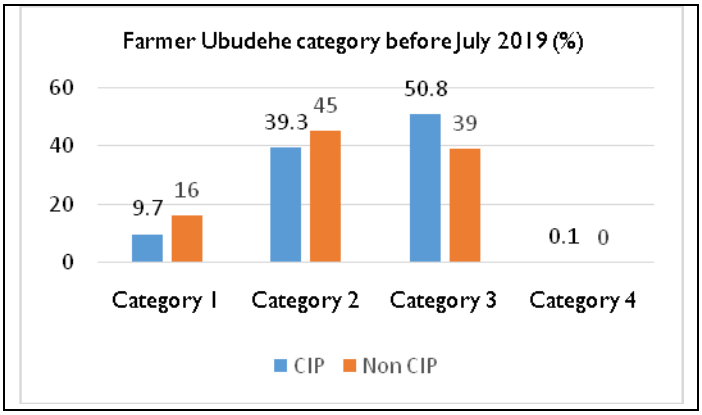

Figure 3:Farmers Ubudehe Category by July,2019

The results in table 61 indicate that, the farmers in ubudehe categories were normally distributed in CIP sites and Non-CIP sites whereby 49.2% in CIP and 61% in non CIP are belonging to Ubudehe category 1 and 2 respectively; These results indicate that, more farmers in Category one, Category two and Category three belong in farming activities.

5.2. The surveyed farmers' land size in CIP and Non CIP

Table 62:The surveyed farmers' land size in CIP and Non CIP

Plot size CIP-Non CIP				
Group of land cultivated in sqm (interval 10000 sqm)	**CIP**	**%**	**Non CIP**	**%**
Less than one hectare	685	79.5	829	84.2
1-1.9 hectare	117	13.6	120	12.2
2 -2.9 hectares	30	3.5	17	1.7
3 -3.9 hectares	10	1.2	9	0.9
4 -4.9 hectares	8	0.9	1	0.1
5 -5.9 hectares	8	0.9	2	0.2
7 -7.9 hectares	0	0.0	1	0.1
10 -10.9 hectares	1	0.1	0	0.0
12 -12.9 hectares	0	0.0	1	0.1
18 -18.9 hectares	1	0.1	0	0.0
More than 20 hectares	2	0.2	4	0.4

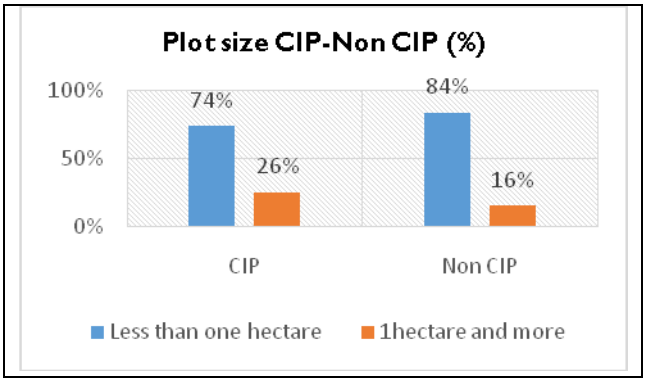

Figure 4:Plot sizes in CIP and Non CIP sites

The results in table 62 indicate that, the small hectares of cultivated land were observed in both CIP and Non CIP sites. A high proportion of farmers who have less than one hectare (79.5%) were located in CIP sites while 84.2% observed in non-CIP sites. These results illustrate that the size of cultivated of land are small plots, which are less than 1 hectare per household. These results also indicate that land size is not a limiting factor in adopting CIP site. The CIP site is an open program for small-farmer holders and large-scale farmers and in addition, the program helps the farmers to access agriculture services.

5.3. Membership to cooperatives

The surveyed farmers were sampled in both CIP (984) and Non-CIP sites (862); some farmers are the members of agriculture cooperatives, while others are not.

Table 63:Cooperative membership in CIP and Non -CIP sites

Cooperative membership in CIP and Non-CIP sites						
Cooperative member	**CIP**	**%**	**Non CIP**	**%**	**Total**	**%**
Yes	532	61.7	158	16.1	**690**	37.4
Non	330	38.3	826	83.9	**1,156**	62.6
Total	**862**	**100.0**	**984**	**100.0**	**1,846**	**100.0**

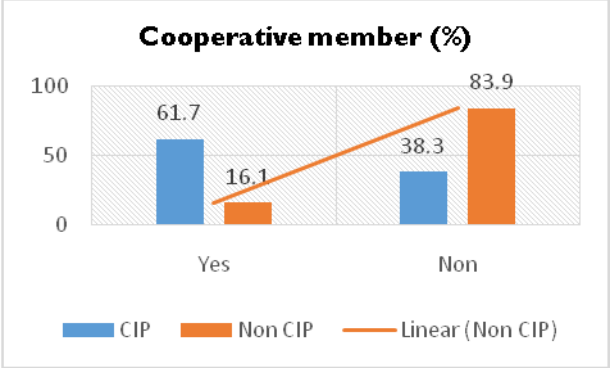

Figure 5:Cooperative membership in CIP &Non CIP sites

The table 63 indicates that the most of the farmers surveyed 61.7 % in CIP site are the members of agriculture cooperatives and only 16.1% of farmers who are in non-CIP site are also the cooperative members. Been members of cooperatives have various benefits especially collective acquisition of inputs. Farmers through the FGDs in Nyabihu and Gatsibo districts observed that, the cooperatives facilitate the farmers to get agriculture inputs and extension services in terms of accessibility and availability. These results indicate that organizing farmers into cooperatives improves the farmers' access to agriculture services.

5.4 Farmers' membership in cooperatives and use of inorganic fertilizers

Table 64:Farmers' membership in cooperatives and use of inorganic fertilizers

Are you in an agricultural cooperative?	**Did you use inorganic fertilizers during 2019 season B?**					
	Yes		**No**		**Total**	
	Count	%	Count	%	Count	%
Yes	570	51.7	120	16.1	690	37.4
Non	532	48.3	624	83.9	1,156	62.6
Total	**1,102**	**100.0**	**744**	**100.0**	**1,846**	**100.0**

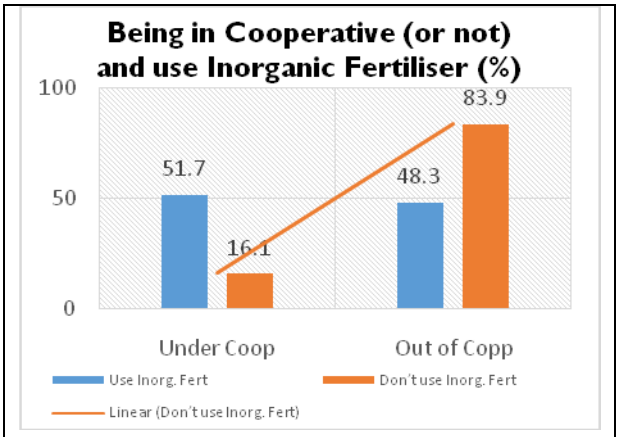

Figure 6:Relationship between belonging to a cooperative and use of inorganic fertilizers

The results in table 64 show that, among 1,102 farmers used inorganic fertilizers and 51.7% of them are members of agriculture cooperatives and 48.3% were not cooperative members. These results indicate that the cooperative may positively influence inputs use among the farmers.

5.5 Crops grown by farmers in CIP and Non CIP sites

Table 65:Crops grown by farmers in CIP and Non CIP sites

Crops grown by farmers in CIP and Non CIP sites						
Seeds grown	**CIP**		**Non CIP**		**Total**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Maize	563	29.2	676	29.8	1,239	29.5
Wheat	108	5.6	63	2.8	171	4.1
Rice	179	9.3	30	1.3	209	5.0
Beans	492	25.5	765	33.7	1,257	29.9
Soybean	23	1.2	27	1.2	50	1.2
Irish Potato	319	16.5	177	7.8	496	11.8
Cassava	131	6.8	323	14.2	454	10.8
Banana	65	3.4	110	4.9	175	4.2
Fruits	11	0.6	23	1.0	34	0.8
Vegetables	39	2.0	74	3.3	113	2.7

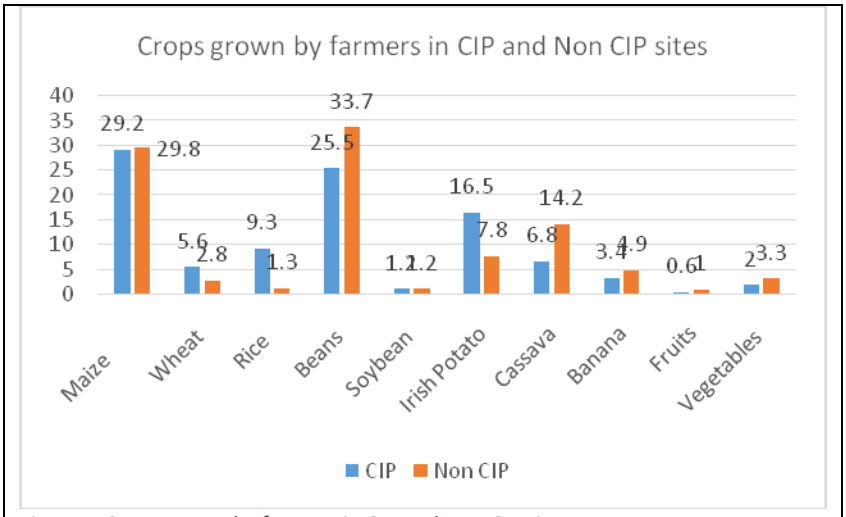

Figure 7:Crops grown by farmers in CIP and Non CIP sites

The results in the table 65 indicate the most cultivated crops in both CIP sites are Maize 29.2% and 29.8% respectively, the beans were also predominant crop, which represent 25.5 % in CIP sites and 33.7% in non CIP sites; in general, the predominant crops in two sites are Maize, Beans, Irish potatoes and cassava. The crops that need inorganic fertilizers are observed in CIP sites than Non CIP sites. And the crops who did not need more inorganic fertilizers are observed in Non CIP sites than CIP sites.

5.6 Average Quantity of Fertilizer used (kgs) CIP and Non-CIP sites

Table 66:Average quantity of fertilizer used (Kgs) in CIP and Non CIP sites

Average Quantity of Fertilizer used (kgs) CIP - Non CIP		
Type of fertilizer used	Percentage share in use of inorganic fertilizers	
	CIP	Non CIP
NPK	75.7	29.5
DAP	18.0	15.4
UREA	16.1	10.5
KCL/MOP	33.5	0.0
Amidas	50.0	0.0
Cereal	14.4	25.3
Winner	40.0	0.0
Diigro	0.0	2.0

The results in table66 indicate that, the most fertilizers used in season 2019B by the farmers in CIP and Non CIP Sites was NPK. The farmers in CIP sites used NPK at 75.7% and in non-CIP sites the NPK was used at (29.5%). There is a high coverage of using inorganic fertilizers is in CIP sites ranging from 0 -75.7%, which is much higher than in Non CIP sites where it ranges from 0 -29.5%.

5.7. Preference of the farmers in using either inorganic or organic fertilizers

Table 67:Preference of the farmers in using either inorganic or organic fertilizers

Which type of fertilizer do you generally prefer to use for your crops?	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Inorganic fertilizer only	37	4.3	20	2.0	57	3.1
Organic fertilizer only	88	10.2	329	33.4	417	22.6
I prefer inorganic but I add organic when needed	291	33.8	191	19.4	482	26.1
I prefer organic but I add inorganic when needed	432	50.1	423	43.0	855	46.3
I do not have a preference	14	1.6	21	2.1	35	1.9
Total	**862**	**100.0**	**984**	**100.0**	**1,846**	**100.0**

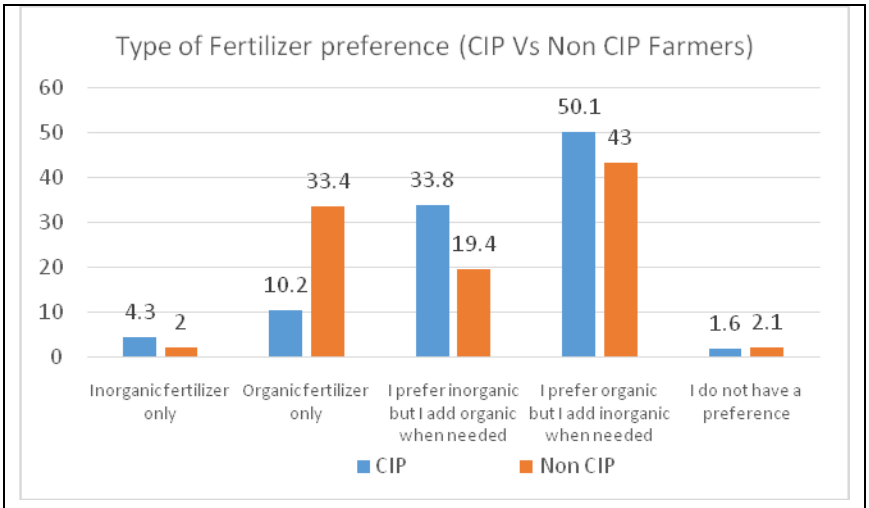

Figure 8:Types of fertilizer preference among CIP and Non CIP farmers

The results in table67 show that most respondents in CIP site have preferred to use inorganic fertilizers with adding organic fertilizers when needed (33.8%) while in non- CIP sites indeed prefers inorganic fertilizers with adding organic when needed (19.4%). The use of only inorganic fertilizers is 4.3% in CIP sites and 2.0% in non-CIP sites. The Findings reveal that the farmers refer to use inorganic fertilizers with adding some quantity of organic fertilizers that using the only inorganic fertilizers. This was confirmed by the farmers in the FGDs that to mix both inorganic and organic fertilizers in planting results in better productivity than using only one type of fertilizer.

5.8 The use of inorganic fertilizers by farmers within CIP and Non CIP sites in Season 2019B

Table 68:The use of inorganic fertilizers by farmers within CIP and Non CIP sites in season 2019B

Did you use inorganic fertilizers? during 2019 season B?	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Yes	695	80.6	407	41.4	1102	59.7
No	167	19.4	577	58.6	744	40.3
Total	**862**	**100.0**	**984**	**100.0**	**1846**	**100.0**

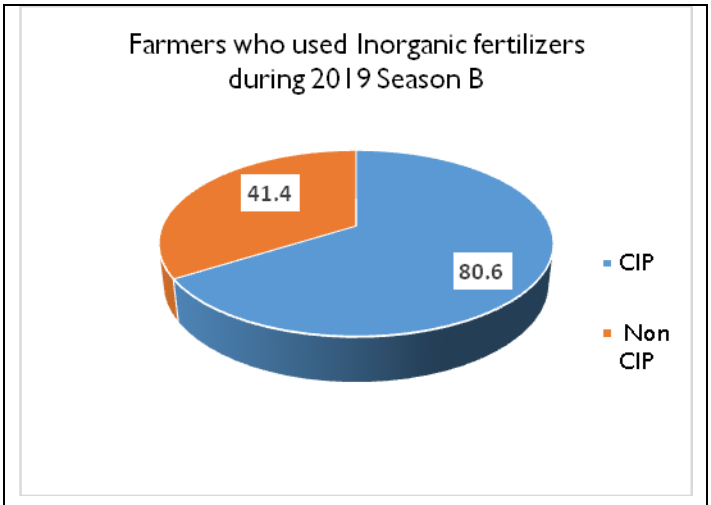

Figure 9:Proportion of farmers that used inorganic fertilizers in season 2019B

In season 2019 B, 80.6 % of the surveyed farmers in CIP site used inorganic fertilizers and only 41.4 % of farmers in non-CIP site used inorganic fertilizers. These results show that a higher number of farmers used inorganic fertilizers within CIP sites as compared to non-CIP sites where fewer farmers used inorganic fertilizers, hence an imbalance of fertilizers usage in CIP and Non-CIP sites.

5.9 The extent to which, the surveyed farmers agree that the cost of inorganic fertilizers is affordable by the farmers' category

Table 69:The extent to which the surveyed farmers agree that the cost of inorganic fertilizers is affordable by the farmers' category

To what extent do you agree, if at all, that the cost of inorganic fertilizer is affordable	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Strongly disagree	174	25.0	89	21.9	263	23.9
Disagree	169	24.3	96	23.6	265	24.0
Agree	226	32.5	128	31.4	354	32.1
Strongly agree	122	17.6	88	21.6	210	19.1
Don't know	4	0.6	6	1.5	10	0.9
Total	**695**	**100.0**	**407**	**100.0**	**1,102**	**100.0**

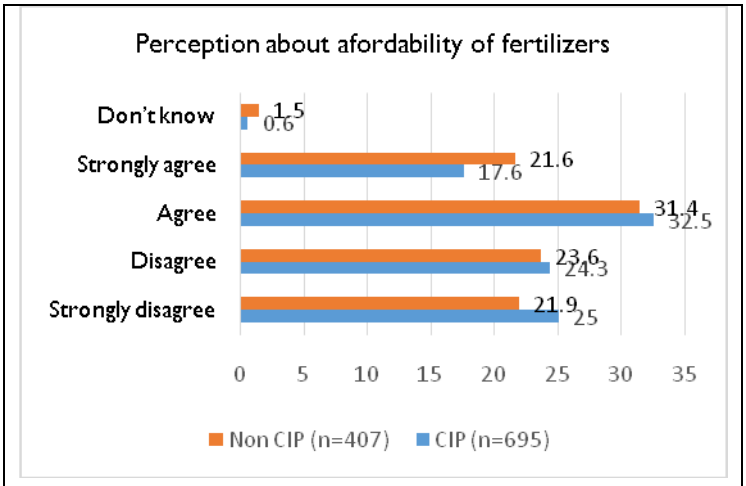

Figure 10:Surveyed farmers perception on affordability of fertilizers

The results in table 69 indicate that the farmers in CIP site 50.1% of 695 farmers agreed and strongly agreed, while 53% of only 407 farmers in non CIP sites said that the cost of inorganic fertilizers is affordable. This results show that a large number of farmers who used inorganic fertilizers are in CIP site (695) and little number of the users of inorganic fertilizers (407) are in non –CIP sites; means that the farmers in CIP site are well organized in terms of assessing agriculture services than ones who are not in CIP sites.

5.10. Satisfaction level of the farmers with the inorganic fertilizers they received, in CIP and non-CIP sites.

Table 70:Satisfaction level of the farmers with the inorganic fertilizers they received in CIP and non CIP sites.

How satisfied are you with using? the inorganic fertilizer you received?	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Very unsatisfied	4	0.6	5	1.2	9	0.8
Somewhat unsatisfied	9	1.3	7	1.7	16	1.5
Somewhat satisfied	190	27.3	122	30.0	312	28.3
Very satisfied	492	70.8	273	67.1	765	69.4
Don't know	0	0.0	0	0.0	0	0.0
Total	**695**	**100.0**	**407**	**100.0**	**1,102**	**100.0**

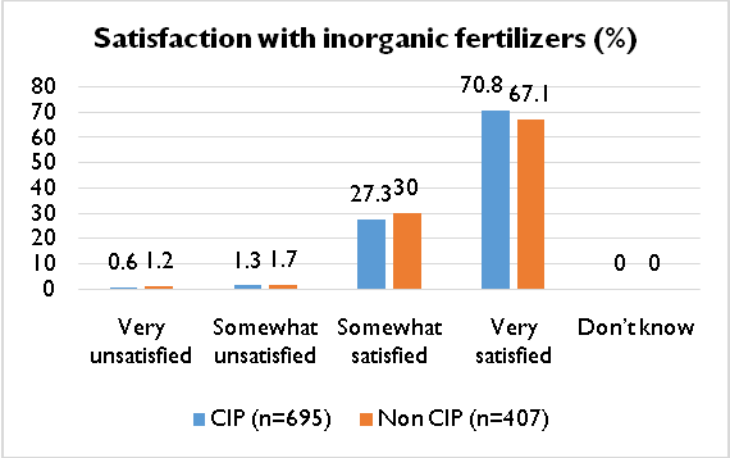

Figure 11:Farmers' satisfaction with inorganic fertilizers

The total number of the surveyed farmers who declared that they use inorganic fertilizers was 1,102 farmers, 695 of them are in CIP sites and 407 farmers are in non-CIP sites. The results in table 70indicate that within the CIP sites, 27.3% are somewhat satisfied and 70.8 %are very satisfied in using inorganic fertilizers, which they received. While in non –CIP sites 30.0 % are somewhat satisfied and 67.1 % are very satisfied in the use of inorganic fertilizers, which they received. Therefore, there is imbalance in satisfaction level in the use of inorganic fertilizers among farmers who were in CIP and those in Non-CIP sites.

5.11 Reported reasons that encourage the farmers to use inorganic fertilizers in CIP and non-CIP sites.

Table 71:Reported reasons that encourage the farmers to use inorganic fertilizers in CIP and non-CIP sites.

Which of the following reasons would encourage	CIP		Non CIP	
	Count	%	Count	%
Having an agro dealers closer to me	108	8.2	80	10.5
Seeing a demonstration of the benefits of inorganic fertilizer on yields	132	10.0	74	9.7
Support from an extension worker on how to best access and use inorganic fertilizer	78	5.9	56	7.3
Improvements in the timeliness of delivery of inorganic fertilizer to my area	52	4.0	31	4.1
Lower prices for inorganic fertilizer	534	40.6	313	41.1
Improved availability of inorganic fertiliser at my local agrodealers	58	4.4	39	5.1
Improved variety of inorganic fertilizers at my local agrodealers	78	5.9	42	5.5
Smaller packages of inorganic fertilizers that are more affordable	214	16.3	92	12.1
Other (specify)	60	4.6	35	4.6

The results in table 71 show the multiple answers that were provided by the surveyed farmers, the farmers were requested to provide and to rate the main reasons that would encourage

them to use more inorganic fertilizer. The reason given by a high proportion of farmers in CIP sites that push the farmers in use of inorganic fertilizers is lower price of inorganic fertilizers. The farmers in non CIP sites scored high to the reasons that push them to use inorganic fertilizers as the same reason with CIP site of lower price 41.1% %. These results show that the farmers who use the inorganic fertilizers are affordable to the price at 40%; while 60% of users have reported other reasons that push them to use inorganic fertilizers.

5.12 Farmers who had received extension services in CIP and Non CIP sites.

Table 72:Farmers who had received extension services in CIP and Non CIP sites

Have you ever received any extension service?	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Yes	692	80.3	653	66.4	1,345	72.9
No	170	19.7	331	33.6	501	27.1
Total	**862**	**100.0**	**984**	**100.0**	**1,846**	**100.0**

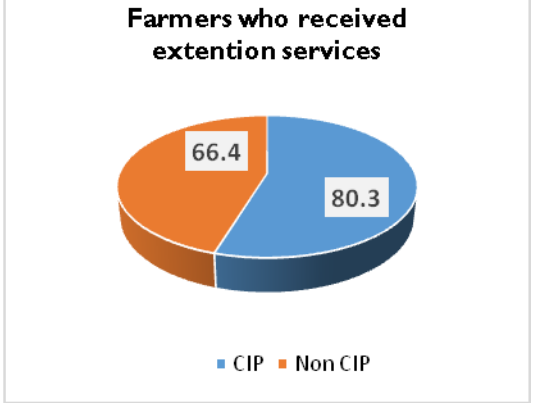

Figure 12:Proportion of farmers who received extension services in CIP & Non CIP sites

The results in table 72 indicate in general 72.9% of surveyed farmers received extension services. 80.3 % of farmers within CIP sites have received extension services and 66.4 % of non-CIP farmers have also received extension services.These results reveal that the extension services have more provided in CIP sites than non-CIP sites.

5.13 The use of inorganic fertilizers and received extension services

Table 73:The use of inorganic fertilizers and received extension services

Did you use inorganic fertilizers during 2019 season B?	Have you ever received any extension service					
	Yes		No		Total	
	Count	%	Count	%	Count	%
Yes	863	64.2	239	47.7	1,102	59.7
No	482	35.8	262	52.3	744	40.3

Total	**1,345**	**100.0**	**501**	**100.0**	**1,846**	**100.0**

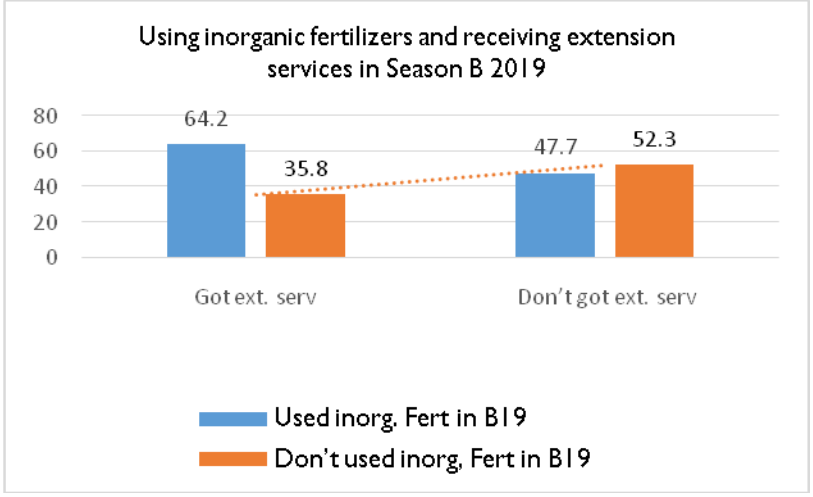

Figure 13:Proportion of farmers who received extension services and also used inorganic fertilizers

The results in table73 combine the farmers who received agriculture extension services and those who used inorganic fertilizers; the results show that, 64.2% who used inorganic fertilizers have also received agriculture extension services and 47.7% who use inorganic fertilizers did not receive extension services.

5.14 Perceptions of the farmers on how insufficient knowledge in using inorganic fertilizers resulted to not choosing to use it

Table 74:Perceptions of the farmers on how insufficient knowledge in using inorganic fertilizer affected their choice to not use the fertilizers.

I don't know enough about inorganic fertilizer, so, I choose not to use it	**Farmer category**					
	CIP		**Non CIP**		**Total**	
	Count	%	Count	%	Count	%
Strongly disagree	445	51.6	356	36.2	801	43.4
Disagree	364	42.2	439	44.6	803	43.5
Agree	39	4.5	116	11.8	155	8.4
Strongly agree	11	1.3	47	4.8	58	3.1
Don't know	3	0.3	26	2.6	29	1.6
Total	**862**	**100.0**	**984**	**100.0**	**1,846**	**100.0**

The results in table 74 show that in CIP sites, 6.8 % of the farmers agree and strongly agreed e that not having enough knowledge in using inorganic fertilizers, led them to choose not to use inorganic fertilizers. The farmers in Non CIP sites have scored 16.6% that agreed and strongly agreed that not having enough knowledge in using inorganic fertilizers led them to not using the inorganic fertilizers.

5.15 Perceptions level of the farmers who claim that the price of inorganic fertilizers is not affordable in CIP and Non CIP sites

Table 75:Perception level of farmers who claim that the price of inorganic fertilizers is not affordable, in CIP and Non CIP sites

The price of inorganic fertilizer is not affordable	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Strongly disagree	3	1.8	11	1.9	14	1.9
Disagree	13	7.8	33	5.7	46	6.2
Agree	74	44.3	226	39.2	300	40.3
Strongly agree	70	41.9	257	44.5	327	44.0
Don't know	7	4.2	50	8.7	57	7.7
Total	**167**	**100.0**	**577**	**100.0**	**744**	**100.0**

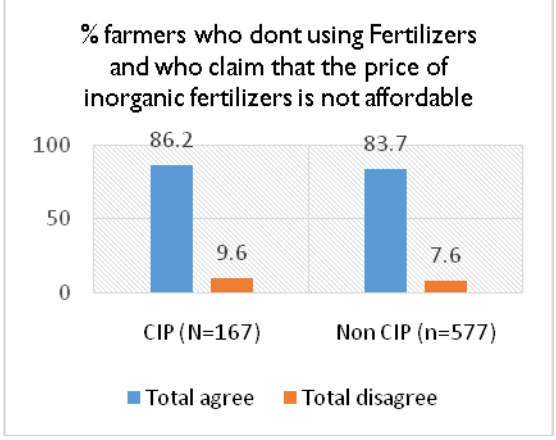

Figure 14:Proportion of farmers who do not use fertilizers and those that claim the price of inorganic fertilizers is not affordable

As indicated in table 75, in CIP sites the farmers responded to the statement that the price of inorganic fertilizer is not affordable (144 farmers) with agreed (44.3%) and Strongly agreed (41.9%). In Non CIP sites 577 farmers have reported the same statement that the price of inorganic fertilizers is not affordable; where 39.2% agreed and 44.5% with strongly agreed.

5.16 Farmers perceptions about satisfaction or dissatisfaction in using inorganic fertilizers by category of the farmers [n = 319]

Table 76:Farmers' perceptions about satisfaction or dissatisfaction in using inorganic fertilizers by category of the farmers

What was your experience in using inorganic fertilizer? Were you satisfied or dissatisfied? Please select the option that most applies to you	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Very dissatisfied	1	0.8	2	1.0	3	0.9
Somewhat dissatisfied	12	9.9	17	8.6	29	9.1
Somewhat satisfied	31	25.6	68	34.3	99	31.0

Very satisfied	77	63.6	111	56.1	188	58.9
Don't know	0	0.0	0	0.0	0	0.0
Total	121	100.0	198	100.0	319	100.0

Table 76 show that among 744 farmers who didn't use inorganic fertilizers in season 2019B, 319 of them had experience in usage of inorganic fertilizers in previous seasons, the 121 farmers who were in CIP sites reported that, they were satisfied on the use of inorganic fertilizers (25.6% somewhat satisfied) and 63.6% very satisfied). In Non CIP sites, the farmers who are previously use inorganic fertilizers but not used it in season 2019B were 198 farmers, they also scored their satisfaction in usage as somewhat satisfaction (34.3%) and very satisfied (56.1%). Dissatisfaction were in few rates where 10.7% in CIP sites and 9.6% in Non CIP sites.

5.17 The reasons of satisfaction in using inorganic fertilizers by the farmers' category

Table 77:The reasons for satisfaction in using inorganic fertilizers by the farmers' category.

Why were you satisfied in using inorganic fertilizers?	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
The prices were acceptable to me	6	5.6	16	8.9	22	7.7
The quality of the fertilizer was good	11	10.2	5	2.8	16	5.6
Farmer trusted the brand name of the fertilizer	3	2.8	2	1.1	5	1.7
The yields were better after using the fertilizer	87	80.6	150	83.8	237	82.6
Farmer had support in using the fertilizer correctly	0	0.0	4	2.2	4	1.4
Other	1	0.9	2	1.1	3	1.0
Total	**108**	**100.0**	**179**	**100.0**	**287**	**100.0**

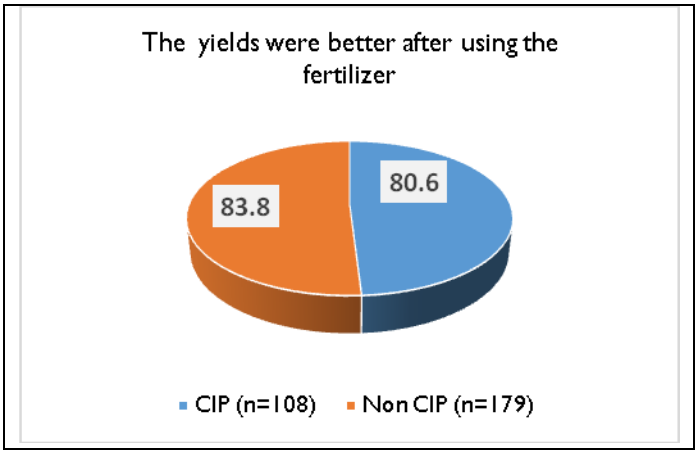

Figure 15:Proportion of farmers who agreed that the yields were better after using fertilizers

Table 77, show that only 287 farmers out of 319 have reported the reasons of their satisfaction; 108 farmers were in CIP sites and 178 farmers were in non-CIPsites. The results in table77 indicate that the high scored reasons of farmers' satisfaction in using inorganic fertilizers are that the yields were better after using the fertilizer (80.6%) in CIP sites and the same reasons scored innon-CIP sites (83.8%).

The reasons of dissatisfaction in using inorganic fertilizers by the farmers' category

Table 78:The reasons of dissatisfaction in using inorganic fertilizers by the farmers' category.

Why were you dissatisfied?	Farmer category (32 farmers)					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
The prices were too high	2	15.4	6	31.6	8	25.0
The quality of the fertilizer was poor	0	0.0	0	0.0	0	0.0
I did not trust the brand name of the fertilizer	0	0.0	0	0.0	0	0.0
My yields were the same or worse after using the fertilizer	3	23.1	5	26.3	8	25.0
I had little or no support in using the fertilizer correctly	3	23.1	1	5.3	4	12.5
Other	5	38.5	7	36.8	12	37.5
Total	**13**	**100.0**	**19**	**100.0**	**32**	**100.0**

Table 78, show that only a low count of farmers in both CIP (13 farmers) Non-CIP sites (19 farmers) were dissatisfied with the use of inorganic fertilizers. The reasons of dissatisfaction varied between CIP and Non CIP sites. The high scored dissatisfied farmers 23.1% in CIP and 26.3% in Non CIP have common reasons of not satisfied of using inorganic fertilizers because of the yields were the same or worse after using the fertilizers, these is linkage to overdose or under dose of using inorganic fertilizers as it was reported by FGDs of farmers in Burera and Musanze Districts.

5.18 Farmers' Perceptions in terms of knowledge of self-registration in Smart Nkunganire system

Table 79:Farmers perceptions in terms of knowledge of self-registration in smart Nkunganire system

I did not know how to get registered on Smart Nkunganire System	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Strongly disagree	412	47.8	331	33.6	743	40.2
Disagree	302	35.0	345	35.1	647	35.0
Agree	83	9.6	171	17.4	254	13.8
Strongly agree	63	7.3	112	11.4	175	9.5
Don't know	2	0.2	25	2.5	27	1.5
Total	**862**	**100.0**	**984**	**100.0**	**1,846**	**100.0**

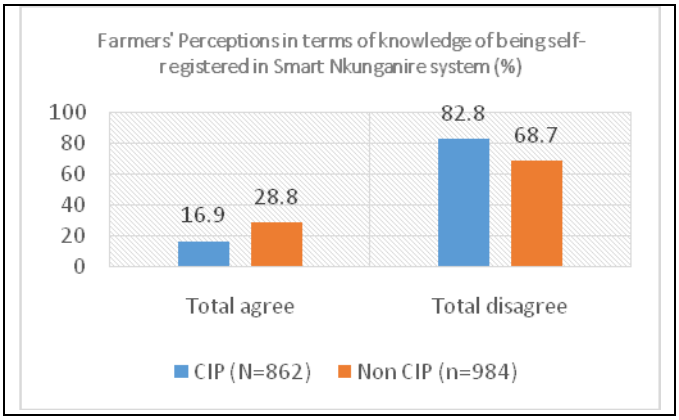

Figure 16:Farmers' perception on knowledge of self-registration in smart Nkunganire

The results in table 79indicate the extent to which the farmers have knowledge in self-registering in smart-Nkunganire system, in CIP sites, 9.6 % agreed and 7.6 % strongly agreed to not knowing how to perform self-registration in smart Nkunganire system. In Non CIP, 17.4 % agreed and 11.4 % strongly agreed to not knowing how to perform self-registration in smart Nkunganire system.

5.19 The extent to which the farmers agree that the cost of inorganic fertilizers is affordable

Table 80:The extent to which the farmers agree that the cost of inorganic fertilizers is affordable

To what extent do you agree, if at all, that the cost of inorganic fertilizer is affordable	Farmer category					
	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Strongly disagree	174	25.0	89	21.9	263	23.9
Disagree	169	24.3	96	23.6	265	24.0
Agree	226	32.5	128	31.4	354	32.1
Strongly agree	122	17.6	88	21.6	210	19.1
Don't know	4	0.6	6	1.5	10	0.9
Total	**695**	**100.0**	**407**	**100.0**	**1,102**	**100.0**

The results in table 80 indicate that a high proportion of farmers in CIP sites (695 farmers) either agreed (32.5% or strongly agreed (17.6%) that the price of inorganic fertilizers is affordable. While in non-CIP sites the farmers (407 farmers) rated low the extent to which the agreed or strongly agreed that price of inorganic fertilizers is affordable, at 31.4 % and 21.6% respectively.

5.20 The farmers in ubudehe categories perceptions on whether the price of inorganic fertilizers is affordable

Table 81:The farmers in ubudehe categories perceptions on whether the price of inorganic fertilizers is affordable

Ubudehe category before July 2019	To what extent do you agree, if at all, that the cost of inorganic fertilizer is affordable											
	Strongly disagree		Disagree		Agree		Strongly agree		Don't know		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Category 1	24	9.1	29	10.9	40	11.3	28	13.3	3	30.0	124	11.3
Category 2	109	41.4	95	35.8	148	41.8	89	42.4	3	30.0	444	40.3
Category 3	129	49.0	141	53.2	166	46.9	93	44.3	4	40.0	533	48.4
Category 4	1	.4	0	.0	0	.0	0	.0	0	.0	1	.1

Total	**263**	**100.0**	**265**	**100.0**	**354**	**100.0**	**210**	**100.0**	**10**	**100.0**	**1,102**	**100.0**

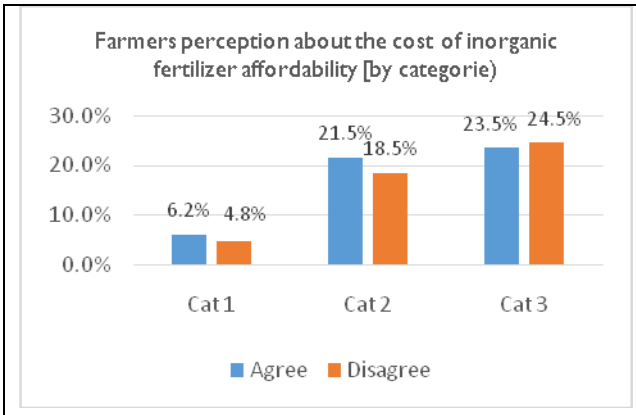

Figure 17:Farmers' perception about the cost of inorganic fertilizer affordability by Ubudehe categories

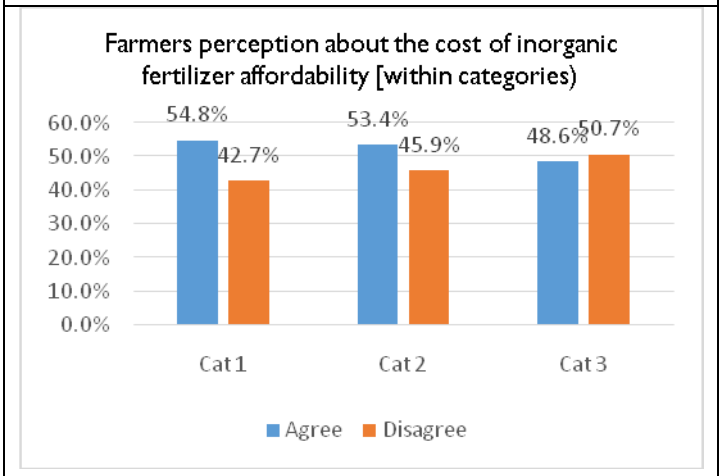

Figure 18:Farmers perception on the cost of inorganic fertilizer affordability within Ubudehe categories

The results in the table 81 indicate that ubudehe category is the key factor that can influence the use of inorganic fertilizer. The farmers who are in CAT3 (533 farmers) represent 48.4% and farmers in CAT 2 (444 farmers) represent 40.3% were the majority users of inorganic fertilizers than the farmers in CAT1 that represent 11.3% and CAT 4 represent 0.1%.

As it was indicated in previous results, 51.7% of farmers who use inorganic fertilizers were in agriculture cooperatives; these are linked to the proportion of farmers in CAT2 and CAT3 who declared that the price of inorganic fertilizers is affordable to them with their rating for strongly agree and agree in the above table.

5.21.The proportion of farmers registered in Smart Nkunganire system within CIP and non-CIP sites.

Table 82:The proportion of farmers registered in smart Nkunganire system within CIP and Non-CIP sites.

Are you registered on the Smart Nkunganire System developed by RAB and BK TechHouse?	**Farmer category**					
	CIP		**Non CIP**		**Total**	
	Count	**%**	**Count**	**%**	**Count**	**%**
Yes	576	66.8	359	36.5	935	50.7
No	261	30.3	596	60.6	857	46.4
Don't know	25	2.9	29	2.9	54	2.9

Total	**862**	**100.0**	**984**	**100.0**	**1,846**	**100.0**

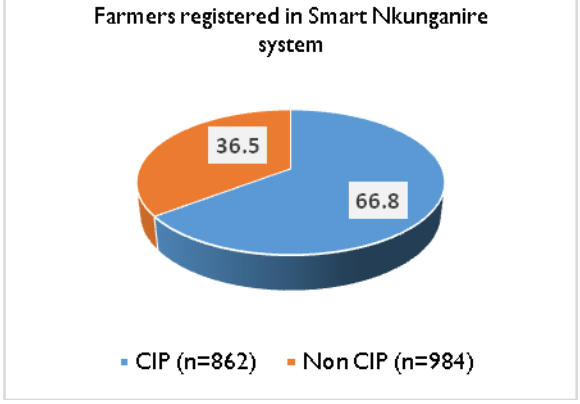

Figure 19:Proportion of farmers registered in Smart Nkunganire System in CIP & Non CIP sites

The results in the table 82 show that, 66.8% of farmers in CIP sites and 36.5% of farmers in Non-CIP sites were registered on the Smart Nkunganire System developed by RAB and BK TechHouse. These results also indicate that the farmers in CIP sites are aware of Smart Nkunganire System than the farmers who are in Non-CIP sites.

5.22. The proportion of farmers registered in Smart Nkunganire system cooperative membership

Table 83:The proportion of farmers registered in smart Nkunganire system cooperative membership

Are you registered on the Smart Nkunganire System developed? by RAB and BK TechHouse?	In Cooperative		Out of Cooperative		Total	
	Count	%	Count	%	Count	%
Yes	533	77.2	402	34.8	935	50.7
No	149	21.6	708	61.2	857	46.4
Don't know	8	1.2	46	4.0	54	2.9
Total	**690**	**100.0**	**1,156**	**100.0**	**1,846**	**100.0**

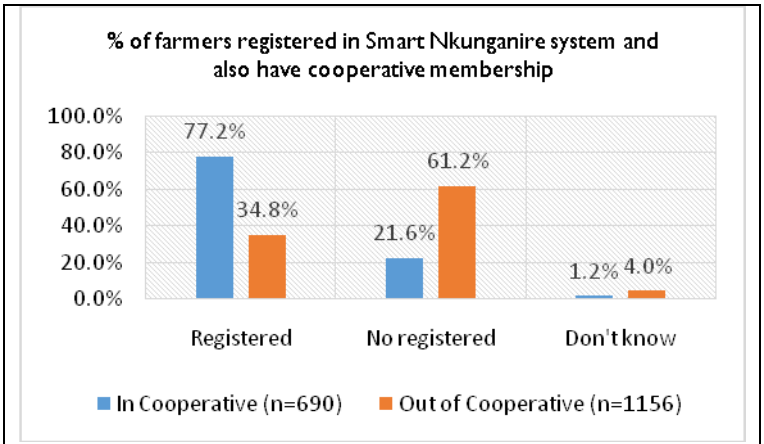

Figure 20:Percentage of farmers registered in Smart Nkunganire

system and are also members of cooperatives.

The results in the table 83 indicate that, the farmers who were registered in Smart Nkunganire System were 935 out of the total surveyed farmers of 1846. While 857 farmers were not registered in SMART Nkunganire system, and 54 out of 1846 didn't know about the system. The results further illustrate that 77.2% of the farmers registered with Smart Nkunganire System were the members of agriculture cooperatives against 21.6% who are in agriculture cooperatives with no registration in Smart Nkunganire system.

5. 23. Farmers Ubudehe category in relation to registration in smart Nkunganire system

Table 84: Farmers Ubudehe category in relation to registration in smart Nkunganire system

Ubudehe category before July 2019	**Are you registered on the Smart Nkunganire System developed by RAB and BK TechHouse?**							
	Yes		**No**		**Don't know**		**Total**	
	Count	%	Count	%	Count	%	Count	%
Category 1	81	8.7	153	17.9	7	13.0	241	13.1
Category 2	377	40.3	375	43.8	30	55.6	782	42.4
Category 3	476	50.9	329	38.4	17	31.5	822	44.5
Category 4	1	0.1	0	0.0	0	0.0	1	0.1
Total	**935**	**100.0**	**857**	**100.0**	**54**	**100.0**	**1,846**	**100.0**

The results in the table 84 indicate that 935 farmers were registered in smart Nkunganire system, and most of them (476 farmers) belong in ubudehe CAT3 (50.9%) and 377 farmers in CAT 2 (40.3%); the 857 farmers were not registered in Smart Nkungare; 375 of them are in CAT2 (43.8%) and 329 farmers in CAT 3 (38.4%). Only 54 farmers did not know how to be registered in Smart Nkunganire System.

5.24. The access to fertilizers in relation to farmers who are registered in smart Nkunganire system

Table 85:The access to fertilizers in relation to farmers who are registered in smart Nkunganire system

How easy was it to access? the fertilizers you were allocated?	**Are you registered on the Smart Nkunganire System developed by RAB and BK TechHouse?**							
	Registered		**No registered**		**Don't know**		**Total**	
	Count	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Very difficult	21	3.0	14	3.9	0	0.0	35	3.2
Somewhat difficult	105	14.8	59	16.6	8	22.2	172	15.6
Somewhat easy	456	64.2	204	57.3	23	63.9	683	62.0
Very easy	128	18.0	79	22.2	5	13.9	212	19.2
Total	**710**	**100.0**	**356**	**100.0**	**36**	**100.0**	**1,102**	**100.0**

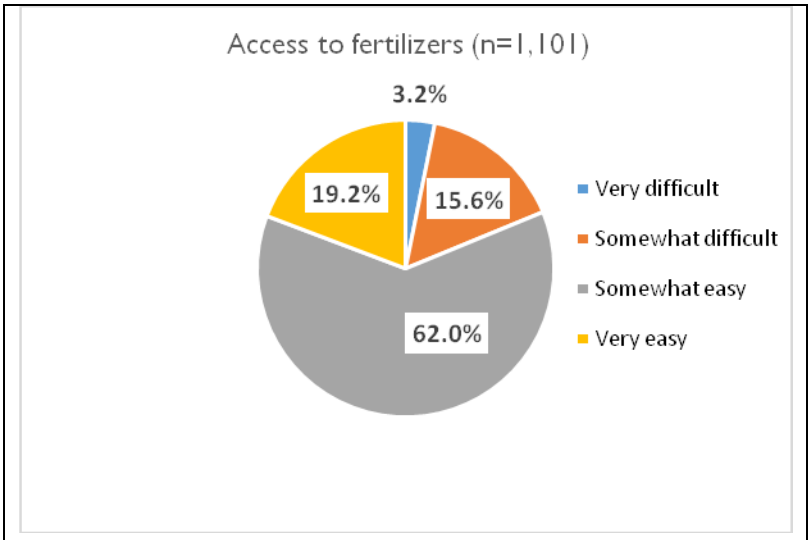

Figure 21:Perception of farmers on how registration with smart Nkunganire helps them to easily access inorganic fertilizers

The results in the table 85 indicate how been registered in Smart Nkunganire System helps farmers to easily access inorganic fertilizers; 710 farmers (64.4%) who were registered in Smart Nkunganire System, 64.2% with somewhat easy and 18.0% very easy stated that, being in smart Nkunganire help them to very easily access inorganic fertilizers, and only 37.3% of those not registered in Smart Nkunganire stated that they had very easy access of inorganic fertilizers.

5.25. Timeliness of receiving of inorganic fertilizers by the category of the farmers

Table 86:Timeliness of receiving of inorganic fertilizers by the category of the farmers

Did you receive the fertilizers at the right time?	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
Yes	646	92.9	352	86.5	998	90.6
No	49	7.1	55	13.5	104	9.4
Total	**695**	**100.0**	**407**	**100.0**	**1,102**	**100.0**

The results in the table 86 indicate that 998 out of 1102 farmers who used inorganic fertilizers got inorganic fertilizers on time. 695 of them were in CIP and 92.9% of them reported that the inorganic fertilizers were delivered on time, while the Non CIP farmers who use inorganic fertizers were 352 out of 995 farmers, 86.5% of 352 farmers in non CIP sites also reported that they got inorganic fertilizers on time. These results indicate that farmers who are in CIP sites have benefited to the timely distribution of inorganic fertilizers than the ones who are not in CIP sites.

5.26. The timeliness of receiving inorganic fertilizers with the farmers who were registered in Smart Nkunganire

Table 87:The timeliness of receiving inorganic fertilizers with the farmers who were registered in smart Nkunganire

Did you receive the fertilizers at the right time?	Registered in SMART Nkunganire							
	Yes		No		Don't know SNS		Total	
	Count	%	Count	%	Count	%	Count	%
Yes	648	91.3	316	88.8	34	94.4	998	90.6
No	62	8.7	40	11.2	2	5.6	104	9.4
Total	**710**	**100.0**	**356**	**100.0**	**36**	**100.0**	**1,102**	**100.0**

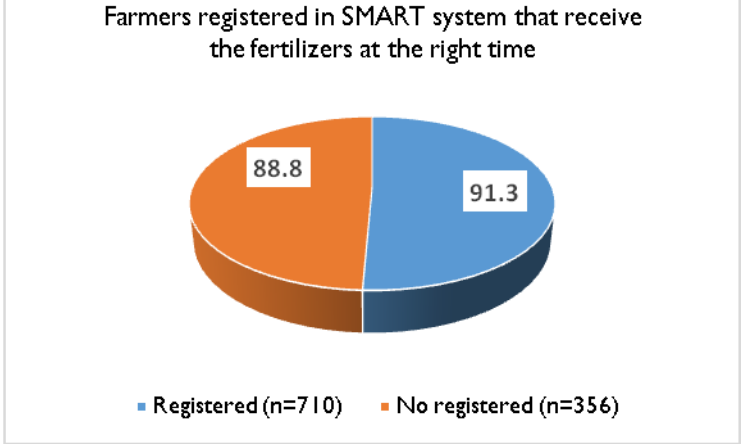

Figure 22:Percentage of farmers registered in Smart Nkunganire system that receive fertilizers at the right time

The results in the table 87 indicate that out of the 710 farmers who were registered in Smart Nkunganire, 91.3% of 648 farmers in CIP received inorganic fertilizers on time and for the 316 farmers who were not registered in Smart Nkunganire 88.8% of them got the inorganic fertilizers on time, these results indicate that to be registered in Smart Nkunganire system is one factor which, positively influence getting inorganic fertilizers on-time.

5.27. Reasons of not using inorganic fertilizers by farmers in CIP and Non CIP sites

Table 88:Reasons of not using inorganic fertilizers by farmers in CIP and Non CIP sites

What is the most reason for not using inorganic fertilizers?	CIP		Non CIP		Total	
	Count	%	Count	%	Count	%
No agrodealers shops in the neighborhood	5	3.0	9	1.6	14	1.9
Fertilizers did not impact yield previous seasons	2	1.2	5	0.9	7	0.9
Inorganic fertilizers are very expensive	71	42.5	289	50.1	360	48.4
Delay of fertilizers	1	0.6	8	1.4	9	1.2
Did not have knowledge on why to use fertilizer	20	12.0	105	18.2	125	16.8
Other	68	40.7	151	26.2	219	29.4
The prepayment model of total invoice for ordered fertilizers doesn't allow to purchase required quantities of fertilizers	0	0.0	10	1.7	10	1.3
Total	**167**	**100.0**	**577**	**100.0**	**744**	**100.0**

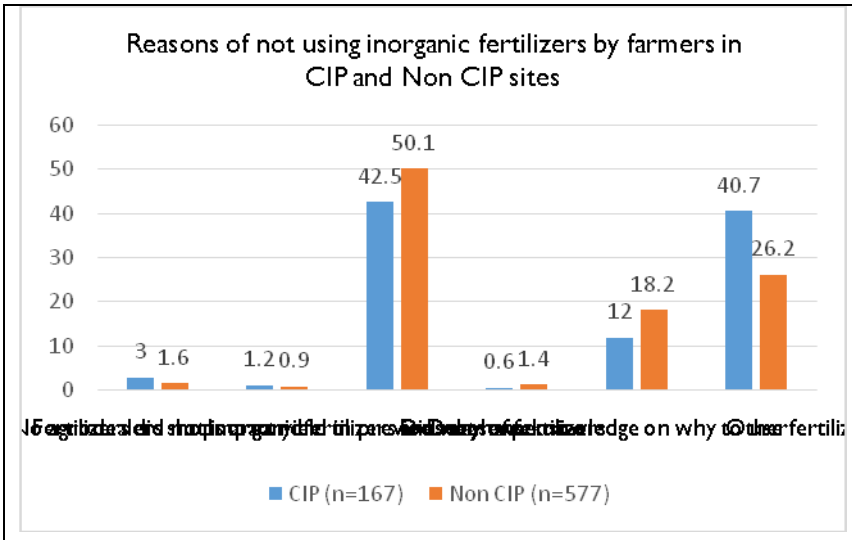

Figure 23:Reasons for not using inorganic fertilizers by farmers in CIP and Non CIP sites

The results in table 88 indicate that 744 farmers did not use inorganic fertilizers in 2019 season B within both CIP and Non CIP sites. The CIP sites have a small number of 167 farmers who did not use inorganic fertilizers. The majority of the farmers who didn't use inorganic fertilizers were in Non CIP sites (577 farmers). The most rated reason of not using inorganic fertilizers in CIP site (71 and 68 farmers out of 167) is inorganic fertilizers are very expensive (42.5) %) others reasons such as the mindsets that fertilizers harmed the crops (40.7%). In non-CIP, 577 of farmers did not use inorganic fertilizers, most of them (289 farmers (50.1%) reported inorganic fertilizers are very expensive) 105 farmers (18.2%) said that they did not have knowledge to use inorganic fertilizers, 151/577 farmers reported others.

5.28. Reasons of not using inorganic fertilizers by farmers in Ubudehe Categories

Table 89:Reasons of not using inorganic fertilizers by farmers in Ubudehe categories

What is the foremost reason behind not using inorganic fertilizers?	Cat (1-2)		Cat (3-4)		Total	
	Count	%	Count	%	Count	%
No agro-dealer's shops in the neighborhood	6	1.3	8	2.8	14	1.9
Fertilizers did not impact yield previous seasons	5	1.1	2	0.7	7	0.9
Inorganic fertilizers are very expensive	241	53.0	119	41.2	360	48.4
Delay of fertilizers	7	1.5	2	0.7	9	1.2
Did not have knowledge on why to use fertilizer	70	15.4	55	19.0	125	16.8
Other	120	26.4	99	34.3	219	29.4
The prepayment model of total invoice for ordered fertilizers doesn't allow to purchase required quantities of fertilizers	6	1.3	4	1.4	10	1.3
Total	**455**	**100.0**	**289**	**100.0**	**744**	**100.0**

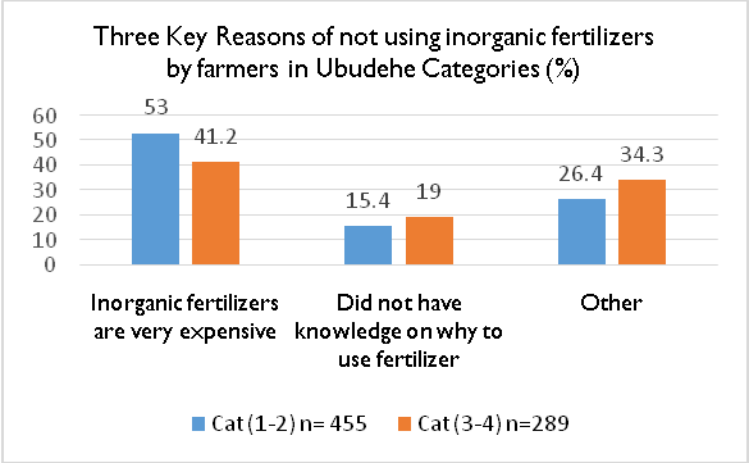

Figure 24:Three key reasons for not using inorganic fertilizers by farmers in Ubudehe categories

The results in the table 89 show the results provided by 744 farmers who did not use inorganic fertilizers in their ubudehe categories, and they have reported the reasons why they didn't use inorganic fertilizers, the high percentage share of the reasons are observed in the farmers of Ubudehe CAT1 and CAT2 (241 farmers 53%) who said the inorganic fertilizers are very expensive and 120 farmers 26.4% said other reasons include inorganic fertilizers harm the crops, small size of land do not need inorganic, etc. 119 out of 289 farmers (41.2%) reported expensive of inorganic fertilizers; and 19.0% do not have sufficient knowledge to use them and 34.3% said the same causes related mindsets of farmers in CAT1 and CAT2.

5.30. Satisfaction with yields, Availability, Accessibility, Affordability, Timeliness of Improved seeds and inorganic fertilizers

Table 90:Satisfaction with yields, availability, accessibility, affordability, timeliness of improved seeds and inorganic fertilizers

Satisfaction, Availability, Accessibility, Affordability, Timeliness		CIP	%	Non CIP	%	Total
How satisfied are you with the yield as a result of using the improved seeds and inorganic fertilizers	Very unsatisfied	14	3.1	13	3.6	27
	Somewhat unsatisfied	32	7.0	26	7.2	58
	Neither satisfied nor unsatisfied	57	12.4	86	23.8	143
	Somewhat satisfied	245	53.5	194	53.7	439
	Very satisfied	110	24.0	42	11.6	152
	Total	**458**	**100.0**	**361**	**100.0**	**819**
Improved seeds and inorganic fertilizers are easily available in my area (availability)	Strongly disagree	29	6.3	43	11.9	72
	Disagree	80	17.5	92	25.5	172
	Agree	244	53.3	199	55.1	443
	Strongly agree	105	22.9	27	7.5	132
	Total	**458**	**100.0**	**361**	**100.0**	**819**
Improved seeds and inorganic fertilizers are easily accessible (Accessibility)	Strongly disagree	25	5.5	34	9.4	60
	Disagree	70	15.3	86	23.8	156
	Agree	258	56.3	209	57.9	467
	Strongly agree	105	22.9	32	8.9	137
	Total	**458**	**100.0**	**361**	**100.0**	**819**
The cost of improved seeds and inorganic	Strongly disagree	49	10.7	44	12.2	93
	Disagree	132	28.8	141	39.1	274

fertilizers is affordable (Affordability)	Agree	210	45.9	149	41.3	359
	Strongly agree	67	14.6	27	7.5	94
	Total	**458**	**100.0**	**361**	**100.0**	**819**
Farmers receive improved seeds and inorganic fertilizers on due time at planting stage (timeliness)	Strongly disagree	9	1.97	26	7.2	35
	Disagree	48	10.48	66	18.3	114
	Agree	306	66.81	237	65.7	543
	Strongly agree	95	20.74	32	8.9	127
	Total	**458**	**100.00**	**361**	**100.0**	**819**

As it was observed in the previous results the farmers that used inorganic fertilizers were 1102 and 744 farmers didn't use inorganic fertilizers in 2019 season B. The only 819 farmers out of 1102 have answered on the variables in the above table; 458 farmers in CIP and 361 in non CIP site, the results in the table 90indicate the extents to which the farmers were satisfied with the yield as a result of using the improved seeds and inorganic fertilizers, as well as availability, accessibility, affordability, and timeliness of agriculture inputs of inorganic fertilizers and improved seeds.

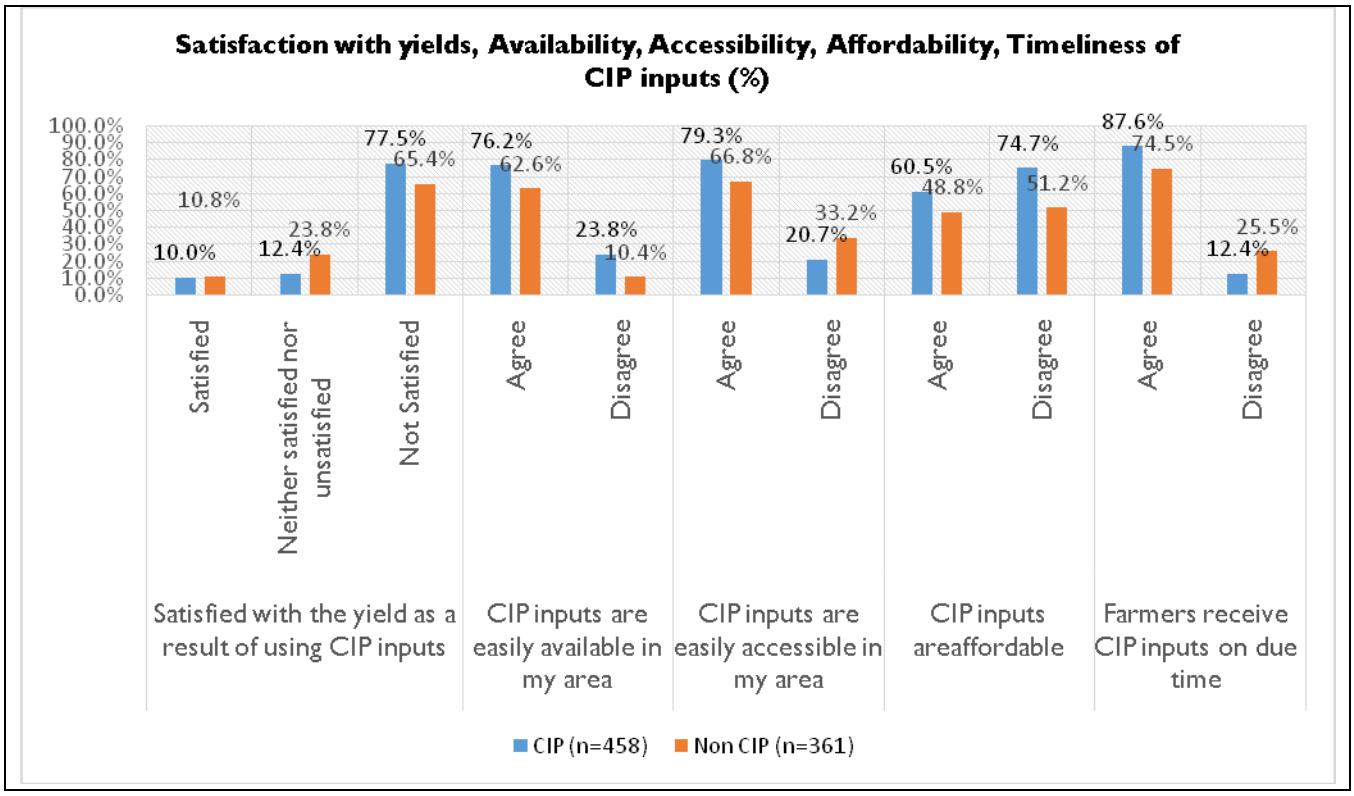

Figure 25:Farmers' satisfaction with yields, availability, accessibility, affordability, timeliness of inputs in CIP &Non CIP sites

These results were disaggregated according to CIP and Non CIP sites. The farmers in CIP sites were satisfied at 77.7% with the yield as a result of using the improved seeds and inorganic fertilizers while the farmers who are in Non CIP sites were satisfied at 65.3%. Regarding availability of inorganic fertilizers and improved seeds, the farmers reported that the inputs

were availed in CIP sites (76.2%)and in non-CIP sites (62.6%). Regarding accessibility of inorganic fertilizers and improved seeds, 79.2% of the farmers in CIP sites and 66.8% in non-CIP sites reported they are easily accessible. Regarding affordability of inputs, the farmers reported that, the inorganic fertilizers and improved seeds are affordable at 60.5% in CIP sites and 48.8% in non-CIP sites. Regarding timeliness of inputs delivery, the farmers reported that, the inorganic fertilizers and improved seeds are delivered on time at 87.5% in CIP sites and 74.6 % in Non CIP sites. These results show that the farmers in CIP sites are more advantaged in availability, accessibility, affordability and timeliness of agriculture inputs and services than the farmers in Non CIP sites.

5.31 Factors encouraging the use of more inorganic fertilizers

Table 91:Factors encouraging the use of more inorganic fertilizers

Actions that encourage you to use more inorganic fertilizer	CIP	Percent	Non-CIP	Percent
Having an agro dealers closer to me	108	8.2	80	10.5
Seeing a demonstration of the benefits of inorganic fertilizer on yields	132	10.0	74	9.7
Support from an extension worker on how to best access and use inorganic fertilizer	78	5.9	56	7.3
Improvements in the timeliness of delivery of inorganic fertilizer to my area	52	4.0	31	4.1
Lower prices for inorganic fertilizer	534	40.6	313	41.1
Improved availability of inorganic fertilizer at my local agro dealers	58	4.4	39	5.1
Improved variety of inorganic fertilizers at my local agro dealers	78	5.9	42	5.5
Smaller packages of inorganic fertilizers that are more affordable	214	16.3	92	12.1
Other	60	4.6	35	4.6

Farmers in both CIP and Non-CIP were asked about the factors encouraging them to apply more inorganic fertilizers than they do. The results highlighted in the table 91 reveal that factors were nearly perceived the same way by farmers on both sides. The most outstanding factor was the lower prices for inorganic fertilizer, where 41.1 percent of Non-CIP versus 40.5 percent for CIP farmers reported that lowering fertilizers prices would encourage them to use more inorganic fertilizer that they do. In addition, 16.3 percent CIP versus 12.1 percent Non-CIP of farmers stated that smaller packages of inorganic fertilizers that are more affordable could be encouraging factor to use more chemical fertilizers. Other factors cited were, such as having an agro dealers closer to farmers could be an encouraging factor where 8.2 percent of CIP versus 10.5 percent, while 10.0 percent of CIP versus 9.7 percent of farmers stated that seeing a demonstration of the benefits of inorganic fertilizer on yields could encourage them to apply more inorganic fertilizers than they do among other factors.

Table 92:Perceptions of reasons why farmers might choose not to use inorganic fertilizer

	Perceptions	***CIP***	***Percent***	***Non CIP***	***Percent***
There are no agro dealer's shops near to where I live	Agree	130	15.1	182	18.5
	Disagree	263	30.5	312	31.7
	Don't know	8	0.9	30	3.0
	Strongly agree	52	6.0	87	8.8
	Strongly disagree	409	47.4	373	37.9
	Total	**862**	**100.0**	**984**	**100.0**
	Perceptions	***CIP***	***Percent***	***Non CIP***	***Percent***
I do not see the benefit of using inorganic fertilizer	Agree	28	3.2	46	4.7
	Disagree	315	36.5	432	43.9
	Don't know	4	0.5	32	3.3
	Strongly agree	17	2.0	11	1.1
	Strongly disagree	498	57.8	463	47.1
	Total	**862**	**100.0**	**984**	**100.0**
	Perceptions	***CIP***	***Percent***	***Non CIP***	***Percent***
I think organic fertilizer is better	Agree	162	18.8	254	25.8
	Disagree	361	41.9	386	39.2
	Don't know	9	1.0	20	2.0
	Strongly agree	53	6.1	76	7.7
	Strongly disagree	277	32.1	248	25.2
	Total	**862**	**100.0**	**984**	**100.0**
	Perceptions	***CIP***	***Percent***	***Non CIP***	***Percent***
I could not afford inorganic fertilizer	Agree	194	22.5	298	30.3
	Disagree	361	41.9	249	25.3
	Don't know	3	0.3	12	1.2
	Strongly agree	78	9.0	287	29.2
	Strongly disagree	226	26.2	138	14.0
	Total	**862**	**100.0**	**984**	**100.0**
	Perceptions	***CIP***	***Percent***	***Non CIP***	***Percent***
I did not know how to get registered on SNS	Agree	83	9.6	171	17.4
	Disagree	302	35.0	345	35.1
	Don't know	2	0.2	25	2.5
	Strongly agree	63	7.3	112	11.4
	Strongly disagree	412	47.8	331	33.6
	Total	**862**	**100.0**	**984**	**100.0**
	Perceptions	***CIP***	***Percent***	***Non CIP***	***Percent***
Inorganic fertilizer is not delivered in time, so I choose not to use it	Agree	34	3.9	70	7.1
	Disagree	376	43.6	456	46.3
	Don't know	5	0.6	52	5.3
	Strongly agree	9	1.0	13	1.3
	Strongly disagree	438	50.8	393	39.9

	Total	**862**	**100.0**	**984**	**100.0**
I don't know enough about inorganic fertilizer, so I choose not to use it	***Perceptions***	***CIP***	***Percent***	***Non CIP***	***Percent***
	Agree	39	4.5	116	11.8
	Disagree	364	42.2	439	44.6
	Don't know	3	0.3	26	2.6
	Strongly agree	11	1.3	47	4.8
	Strongly disagree	445	51.6	356	36.2
	Total	**862**	**100.0**	**984**	**100.0**
I don't trust agro dealers	***Perceptions***	***CIP***	***Percent***	***Non CIP***	***Percent***
	Agree	20	2.3	37	3.8
	Disagree	352	40.8	453	46.0
	Don't know	7	0.8	37	3.8
	Strongly agree	9	1.0	13	1.3
	Strongly disagree	474	55.0	444	45.1
	Total	**862**	**100.0**	**984**	**100.0**
The requirement to pre-pay for inputs discourages me from using inorganic fertilizers	***Perceptions***	***CIP***	***Percent***	***Non CIP***	***Percent***
	Agree	76	8.8	114	11.6
	Disagree	348	40.4	420	42.7
	Don't know	3	0.3	39	4.0
	Strongly agree	22	2.6	37	3.8
	Strongly disagree	413	47.9	374	38.0
	Total	**862**	**100.0**	**984**	**100.0**
My soil is fertile I do not need to use inorganic fertilizer	***Perceptions***	***CIP***	***Percent***	***Non CIP***	***Percent***
	Agree	24	2.8	52	5.3
	Disagree	339	39.3	461	46.8
	Don't know	2	0.2	10	1.0
	Strongly agree	11	1.3	23	2.3
	Strongly disagree	486	56.4	438	44.5
	Total	**862**	**100.0**	**984**	**100.0**
Extension services recommend using organic fertilizer	***Perceptions***	***CIP***	***Percent***	***Non CIP***	***Percent***
	Agree	211	24.5	232	23.6
	Disagree	274	31.8	380	38.6
	Don't know	3	0.3	16	1.6
	Strongly agree	84	9.7	70	7.1
	Strongly disagree	290	33.6	286	29.1
	Total	**862**	**100.0**	**984**	**100.0**

Results in Table 92 show that farmers strongly disagree to the fact that not having agro dealer's shop near to where they live could be a reason to not use inorganic fertilizers, where 47.4 percent in CIP as opposed to 37.9 percent in Non-CIP strongly don't see consider it as a limiting factor to opt for inorganic fertilizers. However, 6.0 percent in CIP as opposed to 8.8 percent in Non-CIP strongly agree that not having agro dealer's shop near to where they live

could be a reason to not use inorganic fertilizers. 15.1 percent of farmers in CIP as opposed to 18.5 percent in Non-CIP agree that not having agro dealer's shop near to where they live could be a reason to not use inorganic fertilizers, whereas 30.5 percent of farmers in CIP as opposed to 31.7 percent in Non-CIP disagree to the fact that not having agro dealer's shop near to where they live could be a reason to not use inorganic fertilizers. Few farmers don't know whether this could be a hindering factor to not choose inorganic fertilizer, where the figures show that 0.9 percent of farmers in CIP as opposed to 3.0 percent in Non-CIP could not tell whether not having agro dealer's shop near to where they live could be a reason why they might choose to use inorganic fertilizers.

The findings show that 57.8 percent of farmers in CIP as opposed to 47.1 in Non-CIP strongly agree that they do not see the benefit of using inorganic fertilizer, which means that farmers recognize the importance of fertilizers in their farming. This was opposed by 2.0 percent of farmers in CIP as opposed to 1.1 percent in Non-CIP who strongly agree that they not seeing the benefit of using inorganic fertilizers as a reason why they might choose not to use them.On the other hand, 36.5 percent of farmers in CIP as opposed to 43.9 percent in Non-CIP disagree to the fact that not see the benefit of using inorganic fertilizer as a reason why they might choose not to use inorganic fertilizers. However, 3.2 percent of farmers in CIP as opposed to 4.7 percent in Non-CIP agree to this point. Only few farmers on both sides don't know whether this could be a reason why they might choose not to use inorganic fertilizers 0.5 percent of farmers in CIP as opposed to 3.3 percent in Non-CIP.

41.9 percent of farmers in CIP as opposed to 39.2 percent in Non-CIP disagree that they think that organic fertilizer is better as a reason why they choose not to use inorganic fertilizers. However, 18.8 9 percent of farmers in CIP as opposed to 25.8 percent in Non-CIP agree to this fact. On the other hand, 32.1 percent of farmers in CIP as opposed to 25.2 percent in Non-CIP strongly disagree that considering organic fertilizer as better as reason why they might choose not to use inorganic fertilizers. 6.1 percent of farmers in CIP as opposed to 7.7 percent in Non-CIP strongly agree to this fact. Only few farmers on both sides don't know whether this could be a reason why they might choose not to use inorganic fertilizers 1 percent of farmers in CIP as opposed to 2 percent in Non-CIP.

Most interviewed farmers disagree to the fact that not affording inorganic fertilizers could be a reason why they might choose not to use them (41.9 percent of farmers in CIP and 25.3 percent in Non-CIP). While 22.5 percent of farmers in CIP and 30.3 in Non-CIP agree to the statement. 26.2 farmers in CIP versus 14.0 percent in Non CIP strongly disagree to the fact that not affording inorganic fertilizers could be a reason why they might choose not to use them, while only 9.0percent of farmers in CIP as opposed to 29.2 percent in Non CIP strongly agree to the statement. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to using inorganic fertilizers,0.3 and 1.2 respectively. Alike, famers Strongly disagree to the fact that not having knowledge to get registered on Smart

Nkunganire System as a reason why they might choose not to use inorganic fertilizers where 47.8 farmers in CIP as opposed to 33.6 Non-CIP strongly disagree.

In addition, 35 percent in CIP versus 35.1 for No CIP also disagree to the statement. However, 7.3 percent farmers in CIP as opposed to11.4 Non-CIP strongly agree whereas 9.6 percent in CIP versus 17.4 for No CIP agree with this statement. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to opt for inorganic fertilizers,0.2 percent of farmers and 2.5 percent respectively.

Majority of interviewed famers Strongly disagree to the fact that Inorganic fertilizer is not delivered in time as a reason why they might choose not to use inorganic fertilizers where 50.8 percent of farmers in CIP as opposed to 39.9 Non-CIP strongly disagree. In addition, 43.6 percent in CIP versus 46.3 for Non CIP also disagree to the statement. However, 3.9 percent farmers in CIP as opposed to 7.1 Non-CIP agree whereas 1.0 percent in CIP versus 1.3 for Non CIP strongly agree with this statement. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to opt for inorganic fertilizers, 0.6 percent of farmers and 5.5 percent respectively.

In the same line interviewed famers Strongly disagree to the fact that not having enough knowledge about inorganic fertilizers as a reason why they might choose not to use inorganic fertilizers where 51.6 percent of farmers in CIP as opposed to 36.2 Non-CIP strongly disagree. In addition, 42.2 percent in CIP versus 44.6for No CIP also disagree to the statement. However, 4.5 percent farmers in CIP as opposed to 11.8 Non-CIP agree whereas 1.3 percent in CIP versus 4.8 for Non CIP strongly agree with this statement. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to opt for inorganic fertilizers, 0.3 percent of farmers and 2.6 percent respectively.

Regarding the farmer's trust towards agro dealers, the farmers had the same perception, where most farmers Strongly disagree to the statement 55.0 percent of farmers in CIP as opposed to 45.1 Non-CIP. On the same, 40.8 percent of farmers in CIP as opposed to 46.0 for Non-CIP disagree with the fact that farmer's trust towards agro dealers as a reason why they might choose not to use inorganic fertilizers. In contrast 2.3 percent of farmers in CIP as opposed to 3.8 percent in Non-CIP agree to the statement while 1.0 percent of farmers in CIP as opposed to 1.3 percent in Non-CIP Strongly agree. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to opt for inorganic fertilizers, 0.8 percent of farmers and 3.8 percent respectively.

Regarding requirement to pre-pay for inputs discourages me from using inorganic fertilizers; the majority of farmers Strongly disagree to the statement, shown by 47.9 percent of farmers in CIP as opposed to 38 percent for Non-CIP. The same, 40.4 percent of farmers in CIP as opposed to 42.7 for Non-CIP Disagree with the fact that pre-pay for inputs discourages farmers as a reason why they might choose not to use inorganic fertilizers. In contrast 8.8 percent of farmers in CIP as opposed to 11.6 percent in Non-CIP Agree to the statement while 2.6

percent of farmers in CIP as opposed to 3.8 percent in Non-CIP Strongly agree. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to opt for inorganic fertilizers, 0.3 percent of farmers and 4 percent respectively.

Following the statement "My soil is fertile I do not need to use inorganic fertilizer", majority of farmers Strongly disagree to the statement, shown by 56.4 percent of farmers in CIP as opposed to 44.5 percent for Non-CIP. The same, 39.3 percent of farmers in CIP as opposed to 46.8 for Non-CIP Disagree with the fact that soil is fertile as a reason why they might choose not to use inorganic fertilizers. In contrast 2.8 percent of farmers in CIP as opposed to 5.3 percent in Non-CIP Agree to the statement while 1.3 percent of farmers in CIP as opposed to 2.3 percent in Non-CIP Strongly agree. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to opt for inorganic fertilizers, 0.2 percent of farmers and 1 percent respectively.

Farmers where asked to which extent the extension services recommend using organic fertilizer as reason why they might choose not to use inorganic fertilizers. The results show that 33.6 percent of farmers in CIP as opposed to 29.1 percent for Non-CIP Strongly disagree. Alike, 31.8 percent of farmers in CIP as opposed to 38.6 for Non-CIP Disagree with the fact that extension services recommend the use of organic as a reason why they might choose not to use inorganic fertilizers. In contrast, 24.5 percent of farmers in CIP as opposed to 23.6 percent in Non-CIP Agree that extension services recommend using organic fertilizer as reason why farmers might choose not to use inorganic fertilizers while 9.7 percent of farmers in CIP as opposed to 7.1 percent in Non-CIP Strongly agree. Few of interviewed farmers in both CIP and Non-CIP do not know whether this could be a hindering reason to opt for inorganic fertilizers, 0.3 percent of farmers and 1.6 percent respectively.

5.33 Actions that promote an increase in the uptake of inorganic fertilizer

Table 93:Actions that promote an increase in the uptake of inorganic fertilizers

The actions would promote an increase in the uptake of inorganic fertilizer	***CIP***	***Percent***	***Non CIP***	***Percent***
Having an agro dealer closer to me	145	8.7	180	9.2
Seeing a demonstration of the benefits of inorganic fertilizer o n yields, compared with organic	255	15.3	346	17.6
Support from an extension worker on how to best access and use inorganic fertilizer	145	8.7	237	12.1
Improvements in the timeliness of delivery of inorganic fertilizer to my area	44	2.6	48	2.4
Lower prices for inorganic fertilizer	645	38.8	711	36.2
Improved availability of inorganic fertilizer at my local agro dealer	40	2.4	43	2.2
Improved variety of inorganic fertilizers at my local agro dealer	70	4.2	59	3.0
Smaller packages of inorganic fertilizers that are more affordable	275	16.5	279	14.2
Other	44	2.6	61	3.1

Regarding the actions which could promote an increase in the uptake of inorganic fertilizers in farmers' areas, the findings a indicated in table 93 identified lower prices for inorganic fertilizers as upfront action to promote an increase use of inorganic fertilizers among farmers, where 38.8 percent of farmers in CIP versus 36.2 percent in Non-CIP agree on this fact. This view is also shared by farmers where 15.3 percent of farmers in CIP as opposed to 17.6 percent for Non-CIP agree that seeing a demonstration of the benefits of inorganic fertilizer on yields, compared with organic could be determinant action that increases the uptake of inorganic fertilizers in their areas. In addition, when it comes to avail smaller packages of inorganic fertilizers that are more affordable to farmers where 16.5 percent of farmers in CIP versus 14.2 percent in Non-CIP associated this action to an increased uptake of the inorganic fertilizers. Other factors mentioned are Support from an extension worker on how to best access and use inorganic fertilizer, having an agro dealer closer to farmers, Improved variety of inorganic fertilizers at my local agro dealer, Improvements in the timeliness of delivery of inorganic fertilizer to my area and Improved availability of inorganic fertilizer at my local agro dealer among others.

5.34 Factors concerning improving productivity and improving yield from farms

Table 94:Factors concerning improving productivity and improving yield from farms

Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non-CIP***	***Percent***
Cheaper fertilizer	Very High important	652	75.6	692	70.3
	High Important	171	19.8	222	22.6
	Important	37	4.3	52	5.3
	Low important	2	0.2	18	1.8
	Total	**862**	**100.0**	**984**	**100.0**
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non-CIP***	***Percent***
Cheaper seeds	Very High important	560	65.0	635	64.5
	High Important	239	27.7	254	25.8
	Important	58	6.7	76	7.7
	Low important	5	0.6	19	1.9
	Total	**862**	**100.0**	**984**	**100.0**
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non-CIP***	***Percent***
Better quality fertilizer	Very High important	456	52.9	518	52.6
	Important	192	22.3	236	24.0
	High Important	180	20.9	193	19.6
	Low important	34	3.9	37	3.8
	Total	**862**	**100.0**	**984**	**100.0**
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non-CIP***	***Percent***
Better quality seeds	Very High important	443	51.4	511	51.9
	High Important	240	27.8	230	23.4
	Important	169	19.6	220	22.4
	Low important	10	1.2	23	2.3
	Total	**862**	**100.0**	**984**	**100.0**
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***
Increased availability of fertilizer	Very High important	357	41.4	447	45.4
	Important	248	28.8	286	29.1
	High Important	182	21.1	194	19.7
	Low important	75	8.7	57	5.8
	Total	**862**	**100.0**	**984**	100.0
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***
Increased availability of seeds	Very High important	406	47.1	463	47.1
	Important	237	27.5	278	28.3
	High Important	191	22.2	211	21.4
	Low important	28	3.2	32	3.3
	Total	**862**	**100.0**	**984**	**100.0**
Factors concerning improving productivity	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***

and improving yield from farms					
Increased variety of fertilizer	Very High important	293	34.0	342	34.8
	Important	248	28.8	313	31.8
	High Important	239	27.7	241	24.5
	Low important	82	9.5	88	8.9
	Total	**862**	**100.0**	**984**	**100.0**
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	*Percent*
Increased variety of seeds	Very High important	367	42.6	373	37.9
	High Important	258	29.9	260	26.4
	Important	198	23.0	292	29.7
	Low important	39	4.5	59	6.0
	Total	**862**	**100.0**	**984**	100.0
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***
Improved timeliness of fertilizer delivery	Very High important	326	37.8	406	41.3
	Important	228	26.5	256	26.0
	High Important	161	18.7	202	20.5
	Low important	147	17.1	120	12.2
	Total	**862**	**100.0**	**984**	100.0
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***
Improved timeliness of seed delivery	Very High important	294	34.1	399	40.5
	Important	244	28.3	268	27.2
	High Important	217	25.2	218	22.2
	Low important	107	12.4	99	10.1
	Total	**862**	**100.0**	**984**	100.0
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***
More agro dealers in the area	Very High important	312	36.2	413	42.0
	High Important	204	23.7	275	27.9
	Important	191	22.2	189	19.2
	Low important	155	18.0	107	10.9
	Total	**862**	**100.0**	**984**	100.0
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***
Better extension services in the area	Very High important	364	42.2	401	40.8
	High Important	286	33.2	348	35.4
	Important	174	20.2	195	19.8
	Low important	38	4.4	40	4.1
	Total	**862**	**100.0**	**984**	100.0
Factors concerning improving productivity and improving yield from farms	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***
Improved choice over inputs use	Very High important	309	35.8	328	33.3
	Important	256	29.7	332	33.7
	High Important	236	27.4	262	26.6
	Low important	61	7.1	62	6.3
	Total	**862**	**100.0**	**984**	100.0
Factors concerning improving productivity	***Modalities***	***CIP***	***Percent***	***Non CIP***	***Percent***

and improving yield from farms					
Improved understanding of how to use inputs	Very High important	407	47.2	476	48.4
	High Important	306	35.5	324	32.9
	Important	137	15.9	168	17.1
	Low important	12	1.4	16	1.6
	Total	**862**	**100.0**	**984**	100.0

Farmers were asked about most important factors concerning improving productivity. The findings in table 94states that 75.6 percent of farmers in CIP as opposed to 70.3 percent for Non CIP reported the cheaper fertilizers as utmost factor in improving crop yield, 65 percent of farmers in CIP versus 64.5 percent for Non CIP state cheaper seeds as a strong factor to improve the productivity. In addition to the affordability of fertilizers and seeds, the better quality of both fertilizers and seeds was highlighted by farmers as outstanding factor in improving yields on farms, where 52.9 percent in CIP versus 52.6 percent in Non-CIP and 51.4 in CIP versus 51.9 percent in Non-CIP respectively. Besides, 47.2 percent in CIP versus 48.4 in Non-CIP mentioned the improved understanding of how to use inputs among farmers as an important factor as well. Other important factors cited were increased fertilizers and seeds availability, increased variety of fertilizer ad seeds. Furthermore, farmers mentioned the improved timeliness of fertilizer and seeds delivery, more agro dealers in the area, better extension services an improved choice over inputs use among important factors for improving crop productivity.

CHAPTER 6: DISCUSSION OF THE FINDINGS

6.1 Socio-economic and Demographic characteristics of the surveyed farmers and linked determinants in use of improved seeds and fertilizers

The average household head is about 44.5 years old and, the majority are between 25 to 49 years old, most are married (87.3 percent) with some level of primary education (64.9%). These findings therefore indicate that most of the farmers are youth with primary levels of education. The most of surveyed farmers (64.9%) have primary level of education and 24.3% did not attend any formal school. The education level of the farmers is critical in terms of knowledge of using improved seeds and inorganic fertilizers, the inorganic fertilizers and improved seeds have scientific names (i. e micronutrients and compounds/blend but the farmers who haven't high level of education use colors, smelling to differentiate the types of inputs especially fertilizers (UREA white and DAP Yellow), to measure the quantity of fertilizers in each planting hole, the farmers who cannot read proposed the measurements, use unstandardized measures of hand, spoon, etc. and as a result there is under or over utilization of fertilizers, which can harm the crops. Some of the farmers, due to ignorance said that, inorganic fertilizers are precursors of human body cancer and other chronic diseases. Some of them are not able to do registration in smart Nkunganire program using mobile telephone due to the low literacy level.

The training materials on use of agriculture inputs in Rwanda although prepared in the local language, the farmers have to be literate so as to understand them. The study observed that the inability to understand training material due to illiteracy is a barrier experienced by the farmers.About 89.2 % of the respondents in the study were found to have either no education, or at most primary education. With such a poor educational background farmers cannot take the advantage of written materials such as leaflets that are often made available by RAB, Instead they mostly depend on the information made available by word of mouth from the farmer promoters,FFS Facilitators and agronomists and NGOs such as One Acre Fund Therefore, farmers' access to information depends largely on whether there are sufficient extension workers, whether the extension workers are trained and equipped with necessary support to hold face to face trainings with the farmers.

Studies show that Education upgrades individuals' knowledge and skills. Better-educated people can undertake better management. Formal institutional education, albeit the main means for gaining knowledge, non-formal education or extension educational programs are particularly useful for adults and have been known to be successful. The study therefore recommends a national Extension education program focusing on knowledge and skills required for proper application of agriculture inputs in Rwanda.

About 98.2 percent of the surveyed farmers practice farming (crops and livestock) as a main economic occupation, and 85.3% own the land where they cultivate. The government implements the Twigire Muhinzi national extension system, by supporting farmers' promoters and extension services providers who help the farmers in farm training, planting, how to use fertilizers, 1345 out of 1846 farmers (72.9%) received the extension services, and more than 90% of extension services were provided more than twice in one season. This study also found that the more frequent the extension services the better the farmers' perception in using fertilizers. Other studies also show that increasing extension contact reduces the problems of small-scale farmers in adopting new technologies(Bhuyian, 2002).

55.4% of surveyed farmers belong to Category one and Category two of Ubudehe Clusters. This indicates that most of the surveyed farmers are within low household income levels. The prices for agriculture inputs are reasonable but, the purchasing power of some farmers who are belonging in CAT1 and CAT2 of ubudehe category is still low compare to the required fertilizers and improved seeds, the surveyed farmers 55.5% of them are in CAT1 and CAT2. The low purchasing power is explained by their annual expenditure of 86,213 Rwf (Quantile1-Poorest) and 139,671Rwf (Quantile 2-Poor), and their monthly farm wages lie in range of 21,013 and 24,721 Rwf and non-farm wage of 24,985 and 31,233 Rwf. These farmers have land and they do not have enough capacity of purchasing power to buy total required amount of fertilizers for their total land. If they provide rent of their land to the farmers who have capacity to buy inorganic fertilizers, after seasons when they change the quantity of fertilizers from high to lower quantity, the crops experience very low yields. The government subsidies in agriculture inputs are very important to help farmers to get inputs, according to their perceptions, when the government subsidies have stopped, some farmers will not able to continue in using inorganic fertilizers and can make a reduce in agriculture productivity and make negative impact on food security. Changing the government subsidies from 50% to 30%, this affect the capacity of farmers in buying the inorganic fertilizers and improved seeds. Some farmers reduce the quantity sold.

Among the surveyed farmers, only 37.4% belong to agriculture cooperatives. Studies show that Farmers' associations and cooperatives can have a positive influence on agricultural communities by accelerating the development process, ensuring a more equal distribution of income and enhancing democratic decision-making and relations. This can overcome the economies of scale via collective acquisition of inputs. Therefore, more farmers need to be encouraged to join cooperatives and these agriculture cooperatives should be strengthened so as to play this role effectively.

50.7% are registered in SMART-Nkunganire program. The system was introduced to address challenges that were being experienced in the inputs management and distribution, whereby the old system was resulting in huge heaps of paperwork because of lack of an efficient system and waste of seeds owing to lack of accurate data on farming activities. However, as much as it

solved these challenges, it caused new challenges in that each farmer must own a smart phone, and also be literate as to calculate the farm size in meter squared to be able to register. It also takes a long time to consolidate the farmers needs and communicate the same to RAB and consequently to the importers. The farmers expressed this as a key barrier, and there is need for improved efficiency of the system.

Most farmers cultivate land which is less than one hectare (82.0%), and the predominant crops grown in season B, 2019 are beans (68.1%) followed by maize (67.2%), Irish potatoes and cassava represent 26.9% and 24.6% respectively. Farmers grow a variety of crops on the same piece of land, either as mono-crop or in intercrops. Most of the farmers own less than a ha of land, which is very small even to cater for the family household food requirements, since the average family size is 5 family members. By growing diverse types of crops, farmers seek to intensify the use of the available land. Among the crops predominantly grown by the farmers, it is only maize which is covered by the crop subsidy program. Therefore, farmers are faced with non-availability of improved seeds and inorganic fertilizers for those crops not covered under the subsidy program.

6.2 The policy environment and how it determines the fertilizers and seeds usage among the farmers

CIP Subsidy policy: According to Rwanda Agricultural Board, Under Crop Intensification Programme (CIP), the use of improved seeds has risen from 3% in 2006 to 12.5% in 2018 in small-scale farms and 53.1% for large-scale farmers. Most of the certified seed used in the country is mobilized through the Crop Intensification Program (CIP); however, this is only for three crops of maize, wheat and soybeans. The farmers outside CIP seem not to have an avenue for procuring certified seeds and even the farmers within CIP access to certified seeds is limited to the three crops covered by the subsidy program. Access to certified seeds outside the subsidy program are not guaranteed.

- **Importation policy:** The government issues permit for importation of fertilizers only to a limited number of companies, hence very few importers(4) in the country. These companies also have to import only the amount advised by RAB, through the contracts once they win the tender bids.RAB establishes the required amount through consolidation of the orders as submitted by the farmers through the smart Nkunganire system. However, there are delays in RAB communicating this information to the importers.
- **Seed marketing:** The Government of Rwanda encourages the private sector to invest in seeds and fertilizers marketing and distribution as stated in both the agriculture policy and the PSTA4.However, the government controls the seed regulation and distribution and guides the pricing of the seeds and fertilizers, through the ministerial guidelines released

every year. Therefore, seed and fertilizer pricing is not liberalized nor bargained between, distributors and users.

- **Private sector stakeholders indicate that the current government controlled marketing and distribution system are significantly affecting their growth:** There is a well-established private seed producers' system and according to RAB, there are 15 active seed companies for the four crops covered by the subsidy program. However, RAB manages the seeds sector such that these producers do not benefit from a free marketing system because they sell all their seeds to RAB as opposed to selling the quality seeds to an open market. These seed producers should be autonomous (not producing for RAB), business- oriented local seed businesses. RAB should take up a supportive and facilitating role instead of the current role of managing the seeds system.
- **Fertilizer marketing:** The government policies do not provide clear guidelines on the companies' roles and responsibilities in the fertilizer market. Some companies cited unfair playing ground and lack of even competition among the companies because in some cases, importers are also retailers).

Distribution system

- ***Warehousing:*** The distribution is overseen by APTC and it is mandatory for an APTC staff to be stationed at the private companies' warehouses. APTC staffs manning the respective companies' warehouses are not enough and yet they have to authorize release of the inputs to the agro dealers.
- ***Distribution channel:*** Current Government policies mandate the number and location of agro dealers, creating efficient market reach while causing many of them to be unprofitable. The companies should be left to be selective in targeting their products and prioritize supply to key retailers especially in zones of high demand for the fertilizers.

6.3 Barriers to achieving increase in inorganic fertilizer and improved seeds Usage

6.3.1 Barriers as identified by Private companies (importers)

- ***Policies not been fully implemented:*** The government is actively encouraging private seed companies to develop hybrid seed production programs in Rwanda. For example, Western seed, one-acre Fund and RAB have a tripartite agreement on production of hybrid maize. The interviews conducted and discussions with the private companies producing hybrid maize established that production of hybrid maize faces numerous challenges, and indeed some of the private seed companies feel they are being discouraged from participating in the market. The following barriers were identified;

- Late payments for the delivered fertilizers and seeds (some companies have not been paid for the last two years). Although districts are the official purchaser of hybrid seed, the districts do not have direct contacts with the seller. Instead the companies submit their invoices through RAB, as a result, the seed companies are financially exposed for an inordinate length of time and subject to payment withholding if RAB's delivery of the invoices to districts is late as is the case most of the times.
- Rwandan fertilizer and seeds importation policy does not enable them to work efficiently and profitably. (Phytosanitary testing by RALIS takes a long time (2-3 weeks), by the time the results are out, it's too late to import on time, at times the rains have already started) and yet these products are already tested at country of origin.
- As a result, the importing companies require additional time and incur additional cost to get the same phytosanitary inspection from Rwanda that they have already obtained from inspectors in exporting countries.
- Rwandan fertilizer and seeds distribution policy is not favorable to the importers. For instance, the study observed that APTC does not have enough staff in each of the importers warehouse to speed up operations and in some cases APTC staff deny agrodealers to pick up inputs from the warehouse even on presentation of the Bank deposit slip on the flimsy reason that the agrodealer did not make a telephone call beforehand.
-

❖ **Inadequate demand forecast system:** RAB determines which seeds and fertilizers are to be made available in the country.However, those decisions often come late and close to planting. The late decision on hybrids, coupled with the slow seed import process, makes it difficult and in some cases impossible for seed to arrive in time for planting. As a result, farmers are forced to plant different maize varieties, often OPV maize from the informal system, and the seed importers are left with dead stock.

❖ **Inconsistency in subsidy strategy:** There is no evidence of when the government plans to phase out subsidies, which make planning for seed and fertilizer companies very difficult and contributes to their unwillingness to invest in the market.

6.3.2 Barriers as identified by seed producers

Key challenges, which face the seed producers/multipliers in, include the following;

- Insufficient post-harvest equipment (driers, storage),
- Absence of mechanization
- Land availability to meet seed production requirements (isolation for hybrid)
- Insufficiency of irrigation facilities leading to the rain fed seed production negatively affecting the quality of seeds,
- Inadequate knowhow on hybrid seed production

- Inadequate seed processing facilities.
- Limited market (only sell to RAB)
- Some delay of payment of suppliers invoices by RAB

6.3.3 Barriers as identified by Farmers

The constraints as observed by the farmers, is that they do not know the scientific names and types of inorganic fertilizers specifically the micronutrients and compounds/blends, the insufficient knowledge in using fertilizers with no standardized recipients cause the destroy of crops and other negative effects from unstandardized recipient's measurements (spoon, hand, others). Regarding the affordability of prices, the FGDs and individual farmers said that, the citizens in Ubudehe category of one and two have a land to cultivate but there are not able to afford the prices of fertilizers for their total land; their purchasing powers are limited to get money which can help them to buy the inorganic fertilizers for planting the total land they possess.

The reasons hindering use of improved inputs, particularly fertilizer and seed are identified as follows:

- The price of inputs is an issue for farmers. From the interviews with farmers, most of them consider fertilizers and seed expensive despite the fact that most receive it at a heavily subsidized price.
- Availability of inputs at the right time- was also identified by a large proportion of farmers, who stated that fertilizer delivery has been delayed and it has not been available when they need it, particularly at the start of the season. This was explained by the importation policy, whereby delays occur as the importers wait for RALIS to provide permit /permission for importation.
- The inputs suitability another issue highlighted by farmers, in terms of Preference- Although farmers have identified through practice the variety suitable for their respective areas, these varieties are not always available and farmers are forced to plant the available varieties. This was the case with Panner breeds, which farmers prefer but have were available in season 2019A.
- Poor seed quality; Persistent issues with seed quality sold to farmers, specially the local varieties, which experience low germination rates.
- The seeds multipliers are still few in surveyed districts, and subsidies for improved seeds are limited to only Maize, Soybean and Wheat, whereas the farmers of Rwanda grow more than six principal crops.
- Some farmers said that they prefer to use organic fertilizers (from livestock or compost made) because it does not have any negative effect to the land and on humans Unfortunately the organic fertilizers are not sufficient as compared to the total requirements in terms of fertilizers.

- Some improved maize seeds sold by the agro dealers are not adapted to the Rwandan agriculture seasons (Case of Kirehe and Burera); Farmers complained of different varieties been offered at the markets and yet these varieties require different growing conditions.
- Sometimes farmers experience delayed planting due to the delay of supplying the improved seeds to the agro-dealers'outlets.
- Inefficient use of inorganic fertilizers have many negative effects to land and crops, when farmers change to lower quantities of inorganic fertilizers used in seasons A and B, farmers experience very poor yields; Some farmers stated that the inorganic fertilizers have destroyed their fertile land, and crops grown using inorganic fertilizers cause cancer to humans.
- Collaboration between farmers and agro dealers are sometimes not very good. Farmers claimed that the agrodealers did not give balance, which is less than 5 and 10 Frw coins denomination. The farmers stated that the agro dealers did not refund that little balance due to insufficiency of coins.
- The subsidies are limited to inorganic fertilizers and improved seeds, not for pest and disease control chemicals, the farmers need subsidies in pesticides for pest and disease control.
- Sometimes the farmers do not get market for their yield
- Low quality of yields, which are not accepted by buyers due to inefficiency of postharvest practices.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusions

The findings of this study revealed the following as important determinants of fertilizers and seeds use

- ✓ **High cost of inputs:**Although farmers are happy with the good yields from the hybrid seeds, they complained about the high cost of obtaining them. Farmers acknowledge the benefit of high yields as a result of using improved seeds however they state that the cost of acquiring these seeds is still too high even under the subsidy and hence they are not able to use the hybrid seeds in all seasons. This is aggravated by the fact that majority of the farmers belong in Category One and Two of Ubudehe Cluster and their purchasing power is quite low. Farmers are inclined to buy the locally grown seed based on the lower costs rather than on the high production characteristics. Some of the imported hybrid although of higher quality but are been discouraged in favour of the locally produced seeds. Cost is therefore a key determinant for the use of seeds.
- ✓ **Registration with Smart-Nkunganire:** - Registration with Smart-Nkunganire program has a positive influence on the farmers' usage of seeds and fertilizers. It is mandatory to register with smart Nkunganire so as to order for the specific amount and type of inputs required. Those who do not register cannot benefit from the subsidy program. Introduction of new technology (Smart Nkunganire registration and request fertilizers) vis a vis to the limited knowledge to use electronic devices; the required data to use smart Nkunganire system such as size of land in square meters, which are not easily computed by farmers with limited level of education are the main determinants of not registering with Smart Nkunganire.
- ✓ **Types of crops grown:** Farmers use improved seeds only for those crops under the seed subsidy program. Since farmers grow many crops for the crops not included in the seed subsidy program, they prefer to use own selection seeds from previous harvest. Although some farmers would like to use certified seeds for the other crops, these seeds are not locally available. The study established that the only amount of improved seeds used by the surveyed farmers, is the one supplied under the seed subsidy program.
- ✓ **Types of seeds and fertilizers availed at the local agro dealers:** Farmers (through their cooperatives) do not have direct linkage with the seeds and fertilizer companies to allow them order directly for what they need. Therefore, the farmers buy what the government avails to the agro dealers and the farmers' preferences may not be locally available.
- ✓ **Farmers' knowledge and mindset:** The provision of proximity extension services has played a major role in improving farmers' knowledge in using agriculture inputs (using fertilizers and improved seeds). The advisory services provided by the extension workers

play a key role in the farmers' mindset on whether to use or not use inorganic fertilizers and improved seeds.

- ✓ **Administrative issues:** Regarding to the findings; the farmers in FGDs in Nyanza, Nyabihu and Burera districts, proposed that there is a need of prioritizing to prepare the inputs request list at least two months before requesting inputs, and there is a need to train and to facilitate the farmers how to do request using smart-Nkunganire using mobile phones because some of farmers do not know how to use telephone to apply for inputs

7.2 Recommendations

7.2.1 Policy Actions that should be addressed;

a. Inclusion of more crops under the seeds and fertilizers program
b. Establishment of guidelines on good practices that facilitate marketing of seeds and fertilizers outside the CIP subsidy program
c. Clear, long term time-bound strategy for the subsidy program to allow companies plan accordingly
d. Basing to the findings, the government subsidies should be maintained at a level to match the farmer's capacities. The farmers who belong in Category one and two should be advocated in getting special support, they have land to cultivate but they do not have the capacity to buy inorganic fertilizers for their total cultivated land.
e. Clear fertilizer strategy with specified private companies' roles and responsibilities in the fertilizer market thereby eliminating unfair playing ground (For instance where importers are also retailers in some cases)
f. The establishment and support of cooperatives and community-based fertilizer and seeds purchasing networks at village level.
g. Fertilizer procurement based on soil maps for the country such that for each agro ecological region, the nutrient deficiencies are identified and the nutrient requirements are established
h. Introduction of inorganic fertilizers tailored to local crop and soil requirements in the country

7.2.2 Recommendation to improve private sector involvement in inputs sector

- Import supply chain: Respecting the phytosanitary tests in the country /port of origin considering they are in COMESA. This will reduce the days the fertilizers remain at the port awaiting permission to import into the country.
- RAB should Provide data on the fertilizer requirements per region based on aggregated demand

Strategies for importing fertilizer on a timely basis

- Bidding for tender: Allotment of tenders on time to allow a company to supply the fertilizer in a timely manner. The annual RAB tender bid applications are distributed toward the beginning of the year, allowing suppliers one month after winning the bid to supply the fertilizer. The one-month window is not adequate.

•Market creationthrough extension services -The Government agencies should work with the private companies to provide extension services to farmers and build model farms that will help drive demand for fertilizer. Blanket training should be avoided and focus should be on target extension training to a particular geographical area or to a particular crop producer that will help drive the greatest demand for fertilizer.

Strategies to improve Seed production

- Create a favorable environment for a better organization of seed production and marketing activities and actors. Development of a seed strategy followed by annual seed action plans
- Training of seed producers and controlling the quality of seed storage and selling conditions
- Seed producers should be supported to have access to irrigation systems to avoid poor quality during seed production due to drought.
- Create a favorable environment for the transfer of seed production and marketing activities from RAB to the private sector.
- Seed quality Promotion-There is very few seed quality supervisors from RAB-far from the number required. Therefore, there is need for adequate training of staff to strengthen and operationalize RAB regional units for seed quality promotion.
- Establish financing mechanisms adapted to the seed sector for improved access to credit by the seed multipliers.
- Develop and implement policy on commercial seed Quality-Farmers complained of low quality seeds, therefore the need for enhancement of policy on the control of multiplication fields, the follow-up of operators after harvest, processing and packaging.

7.2.3 Recommendations to improve farmers' usage of agriculture inputs

- The government should effect reforms in the targeting of input subsidies beneficiaries in terms of withdrawing particular households, i.e. large scale producers, and therefore allow a channel of scarce public resources to agricultural households in need. Furthermore, assess and incorporate into the policy design a potential process of graduation from the subsidies to ensure the exit strategy is not only concerned with termination of the programme such that an exit that leave supported beneficiaries able to pursue sustainable independent livelihoods is put in place.

- The government subsidies in agriculture activities are very important in helping farmers to get inputs. According to their perceptions, if the government subsidies stopped, some farmers will not be able to continue using inorganic fertilizers and can cause a decline in agriculture productivity and make negative impact on food security. The poverty reduction programs should be sustained to increase the purchasing power of the farmers and later help the farmers to have the capacity of buying the agriculture inputs without government subsidies.
- Put in place the program to support the farmers who have poor purchasing powers and who belong in CAT1 and CAT 2 of ubudehe to access the inorganic fertilizers.
- The Ministry of agriculture (MINAGRI) should maintain or increase the rates of fertilizers and seeds subsidies for increased access and availability of inorganic fertilizers to Rwandan farmers.
- ***Improving farmers access to credit***

  There is need to improve access to credit by farmers, through the following measures;

  - Establish agreement with a local bank so as to link Twigire farmer groups and the farmers' cooperatives to credit services by using group guarantees to enable them to procure fertilizers and improved seed.
  - Identify resource-poor households in UBUDEHE 1 &2 and extend to them fertilizer and seed-grants
  - Creating output driven-financing institutions where farmers can pay loans via crops produced. This can be through the aggregator models by the farmers' cooperatives
  - Lending to groups of farmers at a village level. Extending microfinance loans to farmer collectives since participating farmers hold one another accountable for the repayment of the loan.
  - Gradual reduction of the fertilizer and seeds subsidies for farmers in category 3 &4 as an exit plan
  - Creating direct linkage between the farmers and the seeds and fertilizers companies
  - Support the cooperatives to enable them manage the link between smallholder farmers and the seeds and fertilizer companies
- ***Changing the farmers' mindset toward inorganic fertilizers use***

There is a need for strong mobilization in using inorganic fertilizers to farmers who have wrong information on the negative effects of inorganic fertilizers. The government should therefore undertake campaigns to promote fertilizer use and provide factual information using multiple platforms so as to reach all farmers especially those out of the CIP programme, through the following;

- Design and disseminate factual information related to fertilizer use via posters, leaflets (also translated into Kinyarwanda);
- Apply a variety of methods and tools to encourage the mind-set change among farmers and other actors in the fertilizer value chain; such as setting up effective demonstrations and field days in partnership with both the private sector and Non-Government Organizations (NGOs) to visualize the impact of fertilizers;
- Provide logistical support to the agriculture extension agents especially the FFS facilitators and farmer promoters who are in close contact with the farmers.

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ANNEXES

ANNEX 1. Terms of References

ANNEX 2. Survey tools

Survey Questionnaire_STUDY ON DETERMIN

Survey-Key informants guide for distri

Survey-Key informants guide for seeds

Survey-Key informants guide for Fertili

SURVEY-KEY INFORMANTS GUIDE FOR AGRODEA

Survey-Key informants guidelines for MI