

# Agricultural Mechanization in Rwanda: Baseline Survey Findings

Alain Nzeyimana<sup>1</sup>; Leonidas Dusengemungu<sup>2</sup>; Jean de Dieu Nsabimana<sup>2</sup>;  
Oswald Shyirambere<sup>3</sup>

<sup>1</sup>RAB Team Member of Irrigation Scientist

<sup>2</sup>RAB Team Member of Socio-economist

<sup>3</sup>RAB Team Member of Crop Scientist

<sup>1,2,3</sup>Huye, Rwanda

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**Abstract:** In 2018, the Korea Africa Food & Agriculture Cooperation Initiative (KAFACI) conducted a baseline study across its African member countries with the objective of fostering cooperation for sustainable agricultural development, recognizing agricultural mechanization as a key driver. This report presents findings specific to Rwanda, focusing on the status of agricultural mechanization. Data were collected through three methods: desk review of secondary sources, household surveys, and key informant interviews.

Results on household characteristics indicated that male-headed households dominate (86%), with an average head age of 45.7 years. The average household size was 6.2 members (3.2 males and 3.0 females). Education levels remain low, with 60% of household heads having only primary education. Land ownership is primarily titled (59.5%) or rented (25.9%). Average landholding size was 2.20 ha, significantly higher than the 0.5 ha reported by NISR in 2017.

Findings show that major crops include maize (29.0%), beans (26.6%), Irish potatoes (9.7%), cassava (8.2%), rice (7.0%), and vegetables (5.5%). Most farmers practice monocropping (91.9%), while intercropping is limited (7.7%). Initial land preparation is predominantly manual (77.2%), with minimal use of oxen (2.1%). Tractor use remains low (12.8%), and ownership is limited (9.8%). Hiring costs are high, averaging 148,620 RWF (=162 USD). Casual labor (66.3%) is more common than family labor (32.2%).

## ➤ Concerning farm Operations and Mechanization Levels:

- Harrowing is largely manual (87.9%) while planting relies heavily on casual labor, which is inexpensive (744 RWF/day).
- Weeding is manual in most cases (87.1%), with limited chemical or mechanical methods (8.7%). It is observed that knapsack sprayers dominate (91.4%), while boom sprayers (5.7%) and motor blowers (2.9%) are rarely used.
- Fertilizer application is manual (99.1%) and pest and disease control is also widespread (96.8%), driven by the Fall Armyworm outbreak in maize since 2017.
- Harvesting is manual (98.9%), with threshing/shelling also largely manual (79.5%). Only 18.3% of farmers use shellers/threshers, at an average cost of 1,672 RWF per 100 kg.
- Sun drying is the dominant post-harvest method (98.5%), with mechanical dryers rarely used (1.5%).
- Irrigation is practiced by 56.7% of farmers, mainly using surface water (60.3%), followed by sprinkler (14.7%) and center pivot systems (14.7%).

Mechanization in livestock farming is minimal. Most activities are manual, with only chaff cutting showing limited mechanization (6%). Other operations remain at 0–1%.

The survey highlights significant constraints to agricultural mechanization in Rwanda, including high costs, limited access to machinery, and reliance on manual labor. Farmers proposed solutions, underscoring the urgent need to implement supportive mechanization policies and strategies.

**Keywords:** Mechanization, Baseline, Findings, Rwanda.

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## I. INTRODUCTION

### ➤ *Historical Background of Mechanization in Rwanda*

#### • *Preamble*

Farm power may be described as any source of energy that makes power available for farming operations. This includes animal power, wind power, hydro (water) power, electric power, solar power and internal combustion engine. Farm machinery, on the other hand, is a collection of machines for farm operations and includes all types of implements and devices for applying power on the farm, as ploughs, harrows, seed drills and planters, cultivators, harvesters, haying machines and tractors. Tractor is the most important machinery because it is the prime mover for all the implements. It is also the most used, most prone to wear and tear, and the most expensive item of all farm machinery. This is why it makes sense to consider it in all assessment related to agriculture mechanization.

#### • *Background*

Mechanization is the use of various levels of power sources and equipment in the production, processing and marketing of agricultural produce. Tools, implements, equipment and powered machinery which are engineering related interventions are essential and major inputs in agriculture. Such inputs contribute in saving labor, doing a better work, improving postharvest handling, facilitate irrigation and provide variety of instruments to monitor and control modern agricultural processes. The intensification and modernization of agricultural production is associated with the use of such better farm implements and increased power utilization level.

Appropriate choice and subsequent proper use of mechanized inputs in agriculture have a significant effect on overall agricultural production and productivity, *the profitability of farming* and on the environment in general. Hence, effective mechanization contributes to increase production in two major ways: the timeliness of operation and good quality of work. Moreover, the benefits achievable by using advanced and improved inputs such as irrigation, improved seeds, fertilizer and pesticides cannot be fully realized without an increased application of farm power. It can also relieve the growing seasonal labor constraints that are experienced by farmers in several parts of the country. It also helps compensate for the emigration of rural youth who are disenchanted with the drudgery involved in agriculture. Thus mechanization, contrary to the restricted opinion on labor displacement, stands to compliment human labor in improving agriculture production in Rwanda (Kathiresan, 2012).

In April 2009 the Ministry of Agriculture and Animal Resources has signed the first Memorandum of Understanding with Tong Yang Molson Co., Ltd of the Republic of South Korea. This MoU was a start to

demonstrate how the Government of Rwanda is fully committed to mechanize the agricultural sector. As matter of proof, in February 2010; His Excellency President of Rwanda Paul Kagame has launched officially the mechanization program at Kabuye workshop.

Initially, the mechanization program was an internally funded project coordinated by MINAGRI through its Rwandan Agriculture Development Authority (RADA). It started its activities during the 2008/2009 Fiscal year. In July 2010, the cabinet decision was taken to start an Irrigation and Mechanization Task Force. The Chairman and member of the Irrigation and Mechanization were nominated by the Cabinet and started the implementation of irrigation and mechanization activities in Rwanda. In September 2010, the first Mechanization Expert has joined the Task Force on Irrigation and Mechanization. In the same year, the first Mechanization Strategy document was prepared by Arumugam KATHIRESAN, Consultant<sup>1</sup>. In this document, 25 % farm operations were to be mechanized by 2017.

Some of its objectives were to promote mechanization options for rural farmers, develop local skills and strengthen capacity in agricultural mechanization and Promote mechanization in post-harvest activities. The Government of Rwanda has been heavily involved in giving different mechanization services in different areas. The aim of these services was to promote mechanization in the country through introduction of tractors and power tillers to mechanize some farm operations. Such interventions have resulted in some positive consequences as can be seen by the level of awareness created and level of mechanization achieved in the country through the supports of these interventions. The strategic goal was to achieve 25% of farm operations to become mechanized by 2017 and 50% by 2024, allowing one in every 4 Rwandan farmers to either own and/or hire mechanization services. Enabling access to the various farm mechanization options, development of technical ability and knowledge on farm machineries and implements, and improved agro-processing through mechanization will serve as the key drivers in this transformation(Kathiresan, 2012).

Hence, its mandate involved introduction and service delivery in farm machineries at substantial scale. The idea was to promote mechanization by provision of agricultural machineries through MINAGRI-RAB and assisting the farmers by direct hiring or purchasing system. In order to make the services available to the farming populace, special units called Village Mechanization Service Centers (VMSC) were established as machinery hiring (and selling) units.

<sup>1</sup> Arumugam K., 2010, Agricultural Mechanization Strategies for Rwanda, Shifting from subsistence Agriculture to Market-oriented Agriculture, MINAGRI, Kigali.

However, seeing the overall effectiveness of and level of achievement of such schemes, and the required subsidy pumped to support them, it is clear that government should slowly withdraw from these activities and concentrate on areas where its interventions are highly required and efficient.

The establishment of tractor hiring services was expected to make farmers have a better access to tractors and implements for various farm operations. However, due to different problems, this opportunity had not yet been fully exploited by farmers. Technical defects of some selected machineries, Irregular and untimely availability of tractors due to frequent breakdown, lack of spare parts and bureaucratic bottlenecks, small-scale family farms with small fields which are scatted and poor field infrastructure were some of these problems. Thus farm operations, especially land preparation, are still predominantly done manually.

In 2013, MINAGRI introduced private companies in mechanization where some of them are international and local respectively. Thus, to ensure the productive utilization of these costly machines, it was found important to transfer at least part of the machinery to the private sector. It was in that regard that some of those companies signed MOUs for hiring tractors for long time. This option was adapted in order to promote private companies as well as strengthening them. Unfortunately, after only one year, most of tractors hired to those private companies have been worse treated due to poor managerial skills of the beneficiaries. Different defects are still non-repairable due to high cost of spare parts needed in order to repair them. These all things added up to inflate the cost of government on managing tractors and machineries. Thus to insure the productive utilization of these costly machines, it was found important to transfer at least part of the machinery to the private sector. However, identifying appropriate target groups who will take over the responsibility of handling, managing and, above all, giving the required machinery services to the end users require special attention. Pointing out the best procedures to carry out the transfer process and determining the minimum number of tractors MINAGRI should retain for giving the pertinent services, whenever and wherever the private sector is not ready to do, requires special attention. Furthermore, guidelines to govern the required services MINAGRI should continue to give in facilitating better mechanization service delivery and make a firm ground for sustainable implementation of private-sector-lead mechanization in the country needs to be devised.

On the other hand, mechanization in developing countries has been much criticized because it often failed to be effective and has been blamed for rural unemployment and causing other adverse social effects. This was largely the result of experiences from the 1960s until the early 1980s, when large quantities of tractors were supplied to developing countries as gifts either from donors or on very advantageous loan terms. In particular, projects that were designed to provide tractor services through government agencies had a miserable record.

In most well developed countries, many of the activities to promote and develop mechanization will take place in the private sector, a sector which is capable of delivering several inputs and services efficiently. Hence, in developing nations as well, efforts need to be made by governments to ensure this sector function effectively, supported by the necessary training and extension, favorable fiscal policies, and research. The principal role of government in this context is not to substitute and give services, which can ideally be delivered by private sector. Rather, it is to strive to provide the conditions, or an enabling environment, for a largely self-sustaining development of the agricultural engineering sector.

It should also be noted that farmers should continue obtaining mechanization services, but through better and sustainable schemes. Such arrangements may demand government to transfer some or most of the farm machineries it runs in VMSCs to a more efficient and capable private system. This can be done either by transferring machines to individual farmers, to a private firm who can give the service at a reasonable and acceptable price, or through organizing a number of small holder farmers or other groups to participate in the joint use of such tractor, a concept usually referred to as 'multi-farm' use of agricultural machinery (FAO,1985).

- *Why should We Need to Mechanize Our Farms?*

Mechanization has different objectives, which are governed by the real farm conditions and overall vision of the agricultural sector. In Rwandan context almost all tillage activities are performed by hand tools, using exclusively human labor. Such exclusive use of hand tools and manual labor ultimately limits overall farm productivity, labor use efficiency, and farm output. Thus selective mechanization will have some or all of the following objectives in Rwanda;

- ✓ Improving labor productivity – The introduction of machinery is highly associated with improving labor productivity by means of which large area can be cultivated with in a limited labor input. This releases labor for employment in other sectors of the economy or enable to cultivation more land with the same labor force.
- ✓ Improve land productivity (PSTA4) – The purpose of mechanization here is to produce more from the existing land. Machinery is a complementary input, required to achieve higher land productivity and there are several technologies which increase output per unit of land cultivated.
- ✓ Increase cultivable area – whenever the rainfall pattern permits or there is irrigation potential, total area under cultivation can be increased or land that would be left fallow can be cultivated by using mechanization technologies
- ✓ Operational timeliness – completing farm operations at the desired optimum time is the other advantage of mechanization useful for Rwanda
- ✓ Enable to accomplish conventionally difficult to do jobs – Mechanized farmers can easily conduct operations

which otherwise would be difficult to do. Irrigating of wider area, dry planting, draining of problematic soils, etc. are other advantages

- ✓ Maintenance of postharvest quality of agricultural produce together with reduction of loss as well as on-and/or off- farm Value addition of agricultural products
- ✓ Generation of additional income and creation of additional areas of employment (entrepreneurship) and sustainable rural livelihoods which will not be otherwise
- ✓ Reduce drudgery in farming activities, thereby enhancing lifestyles;
- ✓ Provide agriculture-led industrialization and markets for rural economic growth are some of the importance of mechanization in our country.

• *Economic Analyses of Tractor Service in Rwanda.*

Any service rendered by private sector is eventually based on obtaining profit, and hence profitability has to be ascertained to make a move towards liberalization of assets. Price of tractor service reflect real cost of operation together with a profit margin. Such price, On the other hand, should be competitive with manual operation that can be easily obtained in the area and hence it is essential to compare the current costs of labour with the expected costs of machinery on the same bases. Normally, this is one of the key factors for farmers to use tractors or not. However, the opportunity cost of labor and other factors as positive aspects of timeliness, avoiding labor bottlenecks at critical times of cropping, improving crop establishment conditions, and quality of the work shall also be included on determining the real price of the service rendered by manual labor.

• *Assumptions for Economic Analysis*

The cost of owning and operating machinery in farming business is important to be known or estimated so as to establish the real price of the machine and making decision on whether the machine is worth for the buyer in recovering its cost and generating additional revenue as a profit to run the business. If the machine is found to be less profitable, the selling price has to be lowered so that the fixed cost on users could be acceptably reduced and buyers run the business sustainably, generating income for future recovery and expansion.

• *Existing Agricultural Mechanization*

Under the overall Mission “Partnering to create an enabling environment for agricultural transformation”, the

government recognizes that agriculture remains the backbone of the Rwandan society, economy, and identity. With an increasing population demanding affordable and nutritious foods, Rwanda will intensify its farm production in an environmentally responsible manner. Rwanda will promote an agri-food sector development that takes advantage of economic opportunities at home and abroad. Domestically, the government intends to boost the country’s agricultural productivity and incomes, and improve citizens’ access to healthy nutrition. Regionally, Rwanda will become a supplier of high-quality, sustainably produced agri-food products, especially for the increasingly demanding consumers in Africa’s growing urban centers. Globally, Rwanda will build its reputation and position itself as a major provider of high-value, specialty agricultural products.

➤ *Objectives of the Mechanization in Rwanda*

The specific objectives of the mechanization policy are to:

• *Short Term*

- ✓ Strengthen a private sector market led agricultural mechanization financing and service delivery; and
- ✓ Promote agricultural mechanization, public and private sector research and technology development, extension service delivery and capacity strengthening of farmers and other SMEs for efficiency and effectiveness.

• *Medium Term*

- ✓ Develop and enforce machinery performance standards for all locally manufactured and imported machines entering the market;
- ✓ Test all machinery, and evaluate before registering and accrediting suppliers and manufacturers.
- ✓ Promote youth and women participation in agricultural activities through agricultural mechanization.

• *Long Term*

- ✓ Provide a conducive environment for local assembly and manufacture of engines, machinery and equipment for agricultural production, processing and value addition.

➤ *Challenges, Policy Priorities and Interventions*

Table 1 Challenges, Policy Priorities and Interventions

CHALLENGES		POLICY PRIORITIES AND INTERVENTIONS
		DEMAND SIDE POLICIES
1	Lack of Coordination and Quality of Services Provided for Mechanization	GoR has established the Rwanda Centre of Excellence in Agricultural Mechanization (RCoEAM) that will provide leadership and coordination to ensure that mechanization is institutionalized, supported and delivered consistently to pursue excellence in farm machinery research and development, and capacity development.
2	Lack of a Specialized Mechanization Agro-park as a Special Economic Zone (SEZ)	There is a need for the creation of a special economic zone (SEZ) as an Agropark dedicated to mechanization in Rwanda. This has been suggested to operate as The Bugesera Mechanization Special Economic Zones (SEZ). The Rwanda Centre of Excellence in Agricultural Mechanization (RCoEAM) will use the Bugesera Mechanization Agropark as a demonstration center.

3	Limited role of the Private Sector in Driving the Mechanization Policy Agenda	GoR though the RCoEAM will facilitate both mechanization demand and supply sides to make credit affordable for agricultural machinery purchase. This means government will support all stakeholders through the “Triple Helix Model” in which GoR public institutions, private sector and academia are intertwined in a mutually supportive cooperative manner.
4	Insufficient Mechanization Research and Development (R&D)	GoR, though the RCoEAM, will improve R&D by supporting universities and polytechnics; including the Workforce Development Authority (WDA). Such support may include a Research Grants/Scholarship Program
5	Lack of Skills Development and Training needed along the entire value chain	There is need to promote basic skills in the operation and safety issues of power tillers, tractors etc. This includes hands-on training in the use and maintenance of machinery and implements for farmers, management of workshops by trained technicians and service providers; building skills for staff, operators and researchers at higher institutions of learning
6	Lack of supporting to Local Manufacturers	GoR, through the RCoEAM, will support Skills Development of Manufacturers directly engaged in the fabrication of agricultural machinery through WDA, TVET and Polytechnic.
7	Lack of proper delivery of Mechanization Services to Smallholder Farmers	GoR through the RCoEAM to explore benefits of the Chinese-Africa Machinery Corporation (YTO) and China-Africa Development Fund that focuses on the transfer of technology in the interests of smallholder farm development in Africa to support mechanization in Rwanda. The GoR will continue supporting land consolidation as one way of supporting mechanization in Rwanda, under ‘big farm mechanization’ as is done in other countries. GoR through the RCoEAM to support the promotion of private sector led Organized Farmer Cooperatives as one way of establishing strong mechanization business models that support private sector led supply of mechanization equipment and implements under Group ownership or hire service provision by an owner of agricultural machinery.
8	Need to create Stakeholder Mechanization Alliances, Networking and Linkages	Government will support alliances and networks created with farmer cooperatives, NGOs, as well as private sector actors. These alliances and networks are seen as platforms for strengthening capacities that facilitate farmer-to-farmer exchanges. The creation of the Private Sector Mechanization Forum as a mechanization knowledge sharing platform is seen to support the networks and linkages to farmers and farmer groups.
9	Lack of Mechanization Extension and Knowledge Creation	Under the CoE, the extension programs on mechanization will include front line demonstrations, agricultural machinery shows, media, publications and face-to-face contacts with farmers and co-operatives. Therefore, government will work with the private sector in sensitization campaigns, “road shows”, and demonstrations of benefits of irrigation, farm machinery, and post-harvest solutions.
10	Lack of Information Communication Technology (ICT) use in mechanization	The GoR will support the use of ICT in Agriculture Mechanization and technology exchange among relevant agencies and farmers, while improving farmers’ opportunities for improved income and livelihood security.
11	Lack of promotion of Mechanization in Agro-processing along the Value Chain	GoR will support secondary processing, where the form of the produce is changed (Tea (OCIRTHE), Coffee (OCIRCAFE), rice (ICM, Co-operatives), maize (MINIMEX), wheat and Soya bean processing, for example). Government intends to support value addition and post-harvest initiatives in such areas. Government puts particular emphasis on supporting postharvest machinery investments that will add value or create additional income for farmers.
12	Need to strengthen Custom-hire Services	GOR will support the youth in custom-hire enterprises and Private Ownership
<b>SUPPLY SIDE POLICIES</b>		
13	Unsupportive loan repayment mechanisms for Farmers’ Access to Mechanization Credit	GoR will support longer repayment period of loans and adjusting the term payments to the end of each agricultural season, instead of monthly and quarterly options. Government shall support Financing Farmers through Cooperatives
14	Clarity on Financing and Taxation for Mechanization services	Government through MINAGRI will continue refunding service providers the amount of VAT paid. Additionally, GOR shall provide more clarity and certainty to the private sector on duty and VAT exemptions.
15	Lack of Facilitative financial support for Public-Private investment in Mechanization and its uptake	In a PPP arrangement, GoR will support several financial support options: – <i>Mechanization Global Funding</i> : This will be implemented as a PPP, whereby Government would put 40 percent of total funding into a mechanization fund at a financial institution. – <i>Mini-Mobile Mechanization Enterprise Funding</i> : This will serve as a mini mobile Agricultural Equipment Hiring Enterprise (AEHE) suitable for the youth and cooperative ownership. – <i>Direct Machinery Ownership (DMO) Mechanization Funding</i> : this structure is designed to put machinery in the hands of farmers and cooperatives with the capacity to own such equipment. – <i>Mechanization Down-Payment Assistance Grant (MDPAG)</i> : This will be created as a special

		joint-financing grant program to help smallholder farmers in the purchase of mechanization equipment with the bank required down-payment. – <i>Off-taker Smallholder Aggregation Funding Model</i> : In the model, the off-takers work directly with farmers and build an aggregation structure that is part of their operational system.
16	Unavailability and unaffordability of spare parts	The GoR shall promote local business in rural areas by encouraging local entrepreneurs in setting up centers for machinery services and spare parts. Government will, therefore, support domestic equipment manufacturing with several tax reductions.
17	Taxes and Exemption for Machinery and Raw Materials	To create demand for mechanization in agro-processing, GOR recognized the need to review current tariff rates
18	Tax Related Exemptions for Machinery and Raw Materials	GOR will review mechanization import duties, withholding tax and value added tax.
19	Specialized Vehicles	GoR will revise the exemption requirements of specialized vehicles: trucks, heavy machines: bull dozers, tractors, folk lifts in support of mechanization
20	Clarity on future fiscal incentives in Free Economic Zones International Company with headquarters in Rwanda	GoR to clarify future Fiscal incentives for Free Economic Zones International Company with headquarters in Rwanda.
21	Clarity on Rates of tax	GOR to clarify income tax rates applicable to companies investing in agricultural mechanization.
22	Clarity on Investment Allowance	GOR to clarify investment allowance for investors who invest in Kigali in new or used assets.
23	Clarity on Training and Research Expenses	GOR to clarify Training and Research expenses incurred by a taxpayer to be considered deductible expenses from taxable profits
24	Clarity on Employment Oriented Tax Discounts	GoR to give more clarity on profit tax discounts to registered investors who employ a certain number of Rwandans.
25	Clarity on Discount on Export Earnings	GOR to clarify on tax discounts for companies that export commodities and services and bring into the country export revenue.
26	Need for clarity on Tax Holiday for Micro Finance Institutions	While companies that engage in micro finance activities, approved by competent authorities, are exempt from corporate income related taxes, there is need for GoR to clarify these and other additional incentives for investors.
27	Unclear deductions allowed for tax purposes	The GoR to give more guidelines on what deductible expenses are allowed related to mechanization.
<b>CROSS-CUTTING ISSUES</b>		
28	Gender roles in Agricultural Mechanization	The GoR shall encourage rural women entrepreneurs capable of setting up small-scale industries for processing and value addition in rural areas. Women shall also be encouraged to get involved in skills training.
29	The Role of Youth in Agricultural Mechanization	GoR will make deliberate efforts to promote technical training targeted at the youth to encourage them to work in agriculture as an occupation rather than as a means of subsistence.
30	Efficient Agriculture Waste Management /Re/Cycle Manufacturing	Promote Waste Management in Agriculture through organic fertilizer production through public-private partnerships. The production of bio-energy in the form of ethanol and bio-diesel could be promoted through this intervention.

➤ *Current Status-Published Papers as Reference*

- Rwanda Comprehensive Mechanization Policy which has been elaborated in collaboration with The International Finance Corporation (IFC)/World Bank in 2017,
- A Market Intelligence Study on Agricultural Mechanization in Rwanda (2018<sup>2</sup>)” was commissioned

<sup>2</sup> Marlou Rijk, Janske van Eijck, Piet Stevens and Jean Pierre Bizimana (2018), Market Intelligence Study on Agricultural Mechanization in Rwanda.

by WBG to inform the Government of Rwanda on mechanisation status. The study aimed to assess the status of the demand and supply of mechanization equipment and services, review the major challenges to scaling-up agricultural mechanization, and provide guidance on how to stimulate mechanization uptake in Rwanda

- The Strategic Plan for Agricultural Transformation in Rwanda (PSTA 4)

➤ *Problem Statement*

One of the major factors that hinder the development of agricultural sector of developing countries is the use of

backward or primitive farm implements and tools by the peasants to operate their land and raise livestock. Worldwide productivity studies likewise revealed that the more power and appropriate machinery is available on the farm, more will be the level of farm productivity. It is the use of improved machines, equipment, or other devices operated by different power sources, that would improve agricultural productivity, efficiency, quality of product, and reduce cost of production in agricultural production system. This is where Agricultural mechanization comes in to improve the situation.

Agriculture is the main occupation of the majority of Rwandan Farmers. The government has employed efforts in promoting the use of mechanized farming. Despite the government effort to enhance level of mechanization in Rwanda the low levels on adoption of mechanized farming is a key challenge. This has resulted into low productivity, low income and food insecurity. Studies abroad found that the adoption of farm mechanization is influenced by age, level of education, farming experience, farm size, gender, access to extension agent, cooperative membership, infrastructure development, technical skills and services, land conditions, access to financial services and access to farm machines influence the adoption of farm mechanization (Mwangi & Kariuki, 2015).

Getting information regarding existing agricultural mechanization practices, constraints or opportunities is still a big challenge in this field. This will also help in guiding the research agenda for agricultural mechanization, improvement of existing technologies and make technical and policy recommendations in Rwanda. The implementation of recommended technical and policy interventions will lead to the realization of measurable qualitative and quantitative outcomes through the improvement of productivity amongst the selected value chains ensuring improved farm production, incomes, and food & nutrition security.

#### ➤ Objectives of the study

The main objective of this study is to clearly assess the status of Agriculture mechanization in Rwanda.

The followings are the specific objectives:

- To identify the existing agricultural mechanization practices in Rwanda;
- To identify constraints and opportunities to the adoption of agricultural mechanization technologies and innovations;
- To propose interventions and research agenda;
- To formulate technical and policy recommendations for enhanced adoption of agricultural mechanization practices.

## II. METHODOLOGY

This study used three data collection techniques: desk review for secondary data, household's surveys and key informant interviews for primary data.

#### ➤ Study Area

The baseline survey was conducted in 14 selected districts of Rwanda (attachment 1): Gasabo (of Kigali-City), Bugesera, Rwamagana, Kirehe, Kayonza and Nyagatare (of Eastern Province), Nyabihu and Rusizi (of Western Province), Gicumbi, Musanze and Rulindo (Northern Province), Ruhango, Nyanza, and Nyaruguru (of Southern Province). With the collaboration of district agronomists the research team selected three sectors per district and between 16-24 farmers/cooperatives members for interviews as well as available key informants both users/non users of farm mechanization. In total 47 Sectors, 125 Cells and 188 Villages were covered.

#### ➤ Sampling Procedures

Preparatory workshop was held between the mechanization stakeholders and the National Project Investigator to discuss access to literature, sample size, suitability of the research tools to use in regards to types of data to collect, value chains selection and districts to be visited.

Selection of farmers used simple random sampling for individual farmers, cooperative members and key informants in possession of at least one of the eight targeted crop value-chains (wheat, maize, rice, cassava, Irish potatoes, beans, tea, sugar cane) and livestock value chain. The crop value-chains selected include priority crops selected by the Government of Rwanda for Crop Intensification Program (CIP, 2013). Perennial and non-perennial crops were taken into consideration to cover different production methods and machinery equipment used. The nine value chains (Attachment 1) selected were based on thorough desk research and their importance in Rwandan agriculture. Both users and non-users of agriculture mechanization were randomly selected.

The sample size was determined using the Cochran ((1963:75)<sup>3</sup>) formula:

$$n = \frac{z^2 \cdot p \cdot q}{e^2}$$

Where

n is the sample size

z is the confidence level according to the normal centered reduced law ( e.g a confidence level of 94%, z= 1.96)

p is the estimated proportion of an attribute that is present in the population, and q is 1-p. Thus p=q=1/2=0.5

e is the desired level of precision.

<sup>3</sup> Cochran, W. G. 1963. Sampling Techniques, 2nd Ed., New York: John Wiley and Sons, Inc.

This formula determines the number of persons to be interviewed according to the margin of error ( $e$ ) that can be tolerated on a proportion of responses  $p$ . The study wished to evaluate an extension program in which farmers were encouraged to adopt mechanization technologies. We assume there is a large population but that we do not know the variability in the proportion that will adopt the practice or not; therefore, we assume  $p=.5$  (maximum variability). Furthermore, suppose we desire a 94% confidence level and  $\pm 6\%$  precision  $=6/100$ . The resulting sample size is demonstrated as follows:

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5}{\left(\frac{6}{100}\right)^2} = \frac{3.8416 \times 0.25}{\frac{36}{10000}} = \frac{3.8416 \times 0.25 \times 10000}{36} = 267$$

The interview targeted a sample size of 267 people who included users/non users of farm mechanization. However, this target was over achieved and data were collected with 281 farmers/cooperative members which is equivalent to 105%.

#### ➤ *Data Collection Procedures*

- *Secondary Data*

Secondary data were obtained from policy documents on agriculture mechanization and reports from the Ministry of Agriculture and Animal Resources (MINAGRI), the Task force on Irrigation and Mechanization and the Rwanda Agricultural Board (RAB). Moreover, the study collected secondary information from research papers and publications such as Market Intelligence Study on Agricultural Mechanization in Rwanda, WB, 2018, etc.

- *Primary Data*

Primary data were collected through household's survey and key informant interviews. Data collection tools were made of a semi-structured questionnaire for HH survey and a checklist guide questions for key informants. The time for data collection was quite sufficient with respondents and varied between 45 minutes and 1 hour.

The two research tools for primary data were prepared on the basis of the specific objectives of the baseline study on mechanization in Rwanda.

Both semi-structured questionnaires and checklist guide were translated in Kinyarwanda language to ease data collection exercise.

Data were collected within three weeks from 19/11/2018 to 07/12/2018.

For key informant interviews, a total of 19 academic institutions, machine suppliers and service providers were also interviewed. This group consisted of 3 academic institutions, 5 machinery equipment suppliers (tractors and accessories, pre and post-harvest machines, irrigation equipment as well as other other machineries used in agricultural mechanization), 4 local manufacturers, one training institute manufacturing farm equipment and six (6)

mechanization service providers. Five (5) processing units (maize, rice, cassava (2), sugar cane and tea) were also interviewed, as well as two large scale farmers. RAB staff in Kabuye Mechanization Workshop was also interviewed. In total 26 stakeholders were interviewed during field visits.

The current status assessment was expected to provide policy recommendations for agricultural mechanization in Rwanda three field supervisors and 9 enumerators (Annexed list) were trained on the questionnaires used which were thereafter pre-tested and adjusted for smooth data collection. They were also trained on specific mechanization constraints and opportunities. Three teams were formed to complete the field data collection exercise. A data collection calendar was set for the 14 districts and executed (attachment)

- *Data Entry, Cleaning and Analysis*

Primary data were entered using Excel spreadsheet by enumerators under supervision of the socio-economists of RAB. After a cleaning exercise of the data, the analysis was done with SPSS software to generate descriptive statistics (frequencies, cross tabulations, variance and standard deviations).

### III. RESULTS AND DISCUSSIONS

#### ➤ *Socio-Economic Characteristics*

Results are related to socio-economic characteristics, land tenure and use, crops production activities, farm operations mechanized and equipment used, value addition & marketing, access to credit and knowledge on mechanization, farm assets and structures owned, constraints faced towards mechanizing agriculture, opportunities and proposed interventions.

- *Socio-Economics Characteristics of Respondents*

The socio-economic characteristics such as gender, age and household size, education level and main occupation of household' heads were considered. In this section, a presentation of the basic socio-economic characteristics of households' heads in the 14 districts is made. Tables and graphical illustrations have been used.

- *Gender, Relation to the Household Head and Age of the Respondent*

Respondents were predominantly male heads of households (>86%). They are followed by spouses (11.3%). In Musanze, household heads were present at 100% in the survey. In general, the household head category, male respondents were significantly more than their female counterparts and this is corresponding to Rwandan culture when both husband and spouse are present on a household interview, males are favoured to respond despite the aggressive affirmative action in favour of women (>30%) in national governance and public service participation (GoR, 2003)<sup>4</sup>. The mean age is 45.7 years old and it indicates how respondents are experienced in farming activities.

<sup>4</sup> GoR, Constitution, 2003

Table 2 Gender, Relation to the Household Head and Age of the Respondent

District	Respondent Gender (%)		Relation to the Household Head? (%)			Average Age
	Male	Female	Household Head	Spouse	Child	
Nyagatare (n=22)	87.0	13.0	95.5	4.5	0.0	47.7
Kirehe (n=22)	81.8	18.2	95.5	4.5	0.0	43.5
Bugesera (n=21)	90.5	9.5	90.5	9.5	0.0	47.4
Rwamagana (n=18)	66.7	33.3	70.6	23.5	5.9	41.3
Kayonza (n=20)	65.0	35.0	80.0	15.0	5.0	48.2
Gicumbi (n=18)	77.8	22.2	78.9	10.5	10.5	45.3
Musanze (n=19)	84.2	15.8	100.0	0.0	0.0	42.8
Rulindo (n=19)	84.2	15.8	94.7	0.0	5.3	47.7
Nyabihu (n=21)	61.9	38.1	88.9	11.1	0.0	44.2
Ruhango (n=16)	75.0	25.0	87.5	12.5	0.0	47.6
Nyanza (n=20)	60.0	40.0	70.0	25.0	5.0	42.9
Gasabo (n=22)	86.4	13.6	90.9	9.1	0.0	48.6
Rusizi (n=18)	83.3	16.7	76.5	23.5	0.0	44.5
Nyaruguru (n=24)	79.2	20.8	87.5	12.5	0.0	47.0
<b>Total (n=281)</b>	<b>77.6</b>	<b>22.4</b>	<b>86.5</b>	<b>11.3</b>	<b>2.2</b>	<b>45.7</b>

- *Household Size*

Results show that in all group ages, males are more represented than females in terms of sex ratio. The average household size in the 14 districts surveyed was 6.2 members by household with the highest average of 7.2 members in Rusizi and the lowest average of 5.1 members in Rwamagana. This figure is higher than the NISR (2017)<sup>5</sup> results where findings show an average of 5.2 members by household.

Table 3 Age Groups and Household Size

District	Under 18 Years (n)		18 to 35 Years (n)		36 to 60 Years (n)		Over 60 Years (n)		Average HH Size (n)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Nyagatare (n=21)	1.29	1.48	1.14	1.38	0.76	0.81	0.14	0.14	3.3	3.8
Kirehe (n=21)	1.43	1.33	0.90	1.24	0.57	0.57	0.14	0.05	3.0	3.2
Bugesera (n=21)	1.67	2.10	0.62	1.14	0.90	0.62	0.10	0.05	3.3	3.9
Rwamagana (n=18)	1.22	1.00	0.78	0.83	0.50	0.50	0.11	0.17	2.6	2.5
Kayonza (n=19)	1.26	1.21	1.53	0.68	0.47	0.42	0.21	0.16	3.5	2.5
Gicumbi (n=19)	1.47	1.32	1.26	0.79	0.68	0.74	0.05	0.05	3.5	2.9
Musanze (n=19)	1.79	1.32	0.53	0.53	0.68	0.47	0.05	0.00	3.1	2.3
Rulindo (n=19)	1.37	1.47	1.00	1.16	0.68	0.79	0.00	0.05	3.1	3.5
Nyabihu (n=21)	1.48	1.62	0.71	1.14	0.67	0.67	0.05	0.00	2.9	3.4
Ruhango (n=16)	1.19	1.56	1.94	1.06	0.81	0.69	0.06	0.00	4.0	3.3
Nyanza (n=20)	0.80	0.90	1.20	0.75	0.55	0.85	0.15	0.05	2.7	2.6
Gasabo (n=21)	1.19	1.14	0.81	0.67	0.90	0.81	0.10	0.00	3.0	2.6
Rusizi (n=18)	2.22	1.17	1.11	1.22	0.83	0.72	0.00	0.00	4.2	3.1
Nyaruguru (n=24)	1.71	1.46	0.83	0.46	0.75	0.88	0.13	0.00	3.4	2.8
<b>Total (n=277)</b>	<b>1.44</b>	<b>1.37</b>	<b>1.01</b>	<b>0.93</b>	<b>0.70</b>	<b>0.69</b>	<b>0.09</b>	<b>0.05</b>	<b>3.2</b>	<b>3.0</b>

- *Education Level*

The survey revealed that approximately 60% of the household heads have at least primary education level. They are followed by secondary education level (18.2%) in all districts assessed. And it is good that university education level (11.2%) is also present in farming activities. The higher the education, the easier becomes the dissemination and adoption of technologies.

Table 4 Education Level of Household Heads

District	No formal Education (%)	Primary (%)	Secondary (%)	University (%)	Adult Education (%)
Nyagatare (n=21)	9.5	66.7	14.3	9.5	0.0
Kirehe (n=22)	9.1	68.2	9.1	9.1	4.5
Bugesera (n=21)	19.0	57.1	14.3	9.5	0.0

<sup>5</sup> NISR, 2017

Rwamagana (n=16)	18.8	68.8	6.3	6.3	0.0
Kayonza (n=20)	0.0	60.0	25.0	15.0	0.0
Gicumbi (n=17)	11.8	52.9	29.4	5.9	0.0
Musanze (n=19)	10.5	47.4	26.3	15.8	0.0
Rulindo (n=17)	23.5	64.7	0.0	11.8	0.0
Nyabihu (n=20)	15.0	50.0	25.0	5.0	5.0
Ruhango (n=15)	0.0	60.0	33.3	6.7	0.0
Nyanza (n=19)	5.3	31.6	42.1	21.1	0.0
Gasabo (n=20)	10.0	40.0	20.0	30.0	0.0
Rusizi (n=18)	33.3	55.6	11.1	0.0	0.0
Nyaruguru (n=24)	12.5	75.0	4.2	8.3	0.0
<b>Total (n=269)</b>	<b>12.6</b>	<b>57.2</b>	<b>18.2</b>	<b>11.2</b>	<b>.7</b>

- *Household head' main occupation*

The household heads' main occupation is farming with 83.0% of respondents. Kirehe and Nyabihu have 100% of farming as main activity while Gasabo district in Kigali City has 61.1% only. Those who have a formal employment (6.8%) execute their farming activities through hiring of casual labourers. High levels of formal employment were

found in Rusizi, Nyanza and Musanze (>15%). The combination of formal employment and farming (2.3%) is difficult and therefore done by few households' heads. Mixing farming and businesses (4.5%) is also at low level. This tends to explain why when farming faces climate disasters, life becomes hard in pure rural areas; farmers do not have alternatives.

Table 5 Household Heads 'Main Occupation (in %)

District	Formal Employment (%)	Farming (%)	Business (%)	Casual Laborer (%)	Both Formal Employment and Farming (%)	Both Farming and Business (%)
Nyagatare (n=19)	5.3	84.2	5.3	0.0	5.3	0.0
Kirehe (n=22)	0.0	100.0	0.0	0.0	0.0	0.0
Bugesera (n=21)	0.0	85.7	0.0	0.0	0.0	14.3
Rwamagana (n=18)	0.0	88.9	0.0	0.0	5.6	5.6
Kayonza (n=20)	5.0	80.0	0.0	0.0	10.0	5.0
Gicumbi (n=17)	5.9	82.4	5.9	0.0	0.0	5.9
Musanze (n=19)	15.8	78.9	0.0	0.0	5.3	0.0
Rulindo (n=18)	5.6	83.3	5.6	0.0	0.0	5.6
Nyabihu (n=19)	0.0	100.0	0.0	0.0	0.0	0.0
Ruhango (n=15)	0.0	86.7	0.0	13.3	0.0	0.0
Nyanza (n=18)	16.7	66.7	0.0	0.0	0.0	16.7
Gasabo (n=18)	11.1	61.1	11.1	5.6	5.6	5.6
Rusizi (n=18)	16.7	77.8	5.6	0.0	0.0	0.0
Nyaruguru (n=23)	13.0	82.6	0.0	0.0	0.0	4.3
<b>Total (n=265)</b>	<b>6.8</b>	<b>83.0</b>	<b>2.3</b>	<b>1.1</b>	<b>2.3</b>	<b>4.5</b>

- *Land Tenure and Use*

Mechanization is in every sense a technology related to land tenure, land use and crops grown as described in the sections below.

- *Land Tenure*

The fact that majority of the interviewers are land owners (up to 59.5%) compared to the renting people means that farmers have intension to use the land as routine for their survival as rent from their elders, and tend to keep using local means in their dairy agriculture activities.

Indeed, this could contribute to reduction of expenses and use of machineries to alleviate their tedious job. If renting people (25.9%) are investors they will definitely use machineries as they have to effectively do everything on time and this will call for many investors in agriculture production to adopt effectively mechanization.

In general, land ownership is with title (59.5%) or rented (25.9%). The average cost of rented land per year 300,775 Frw which is somehow expensive when it is calculated in US dollars (equivalent to 329USD/ha/year).

Table 6 Land Title, Communal Land and Rented Land Status (in %)

District	Owned with Title (%)	Owned without Title (%)	Communal (%)	Rented (%)	Cost of Rented Land per Year? (Frw/ha)
Nyagatare (n=22)	48.6	11.4	11.4	28.6	271671
Kirehe (n=22)	64.7	11.8	2.9	20.6	184476
Bugesera (n=21)	58.1	3.2	12.9	25.8	431429

Rwamagana (n=18)	48.3	10.3	3.4	37.9	75291
Kayonza (n=20)	60.0	16.0	0.0	24.0	103024
Gicumbi (n=18)	68.0	0.0	4.0	28.0	289583
Musanze (n=19)	69.2	0.0	0.0	30.8	943452
Rulindo (n=19)	63.0	11.1	18.5	7.4	66667
Nyabihu (n=21)	69.0	6.9	0.0	24.1	591667
Ruhango (n=16)	50.0	3.1	6.3	40.6	120008
Nyanza (n=20)	67.9	0.0	7.1	25.0	59200
Gasabo (n=22)	43.8	18.8	12.5	25.0	94750
Rusizi (n=18)	53.1	3.1	12.5	31.3	438447
Nyaruguru (n=24)	75.0	3.1	9.4	12.5	45397
<b>Total (n=281)</b>	<b>59.5</b>	<b>7.2</b>	<b>7.4</b>	<b>25.9</b>	<b>300775</b>

- *Land use*

The average land size owned is 2.20 ha while the average land area under crops is 2.37ha prevailing that mechanization could be easily adopted, as long as the average land size is big compared to the national average (0.6ha/household-reference).

The average land size is 2.20 ha which is higher than NISR results of 2017 (0.5ha per household). The average land under pasture is 0.57 ha; most livestock is under zero grazing following the law of 2012 (search reference)

Table 7 Average Land Owned in ha, Land Under Crop Production and Land Under Pasture (in %)

District	Average Land Size Owned (in ha) ?	Average Land Size Rented (in ha) ?	Average Land Area Under Crops (in ha) ?	Average Land Area Under Pasture (in ha) ?
Nyagatare (n=22)	5.52	2.33	6.01	1.73
Kirehe (n=22)	1.23	0.81	4.47	0.06
Bugesera (n=20)	1.36	0.29	1.19	0.05
Rwamagana (n=18)	0.96	0.27	0.77	0.41
Kayonza (n=19)	7.42	0.33	3.63	4.53
Gicumbi (n=19)	0.83	0.16	0.92	0.01
Musanze (n=19)	0.81	0.17	0.89	0.00
Rulindo (n=19)	1.20	0.02	1.40	0.01
Nyabihu (n=21)	0.74	0.29	0.44	0.25
Ruhango (n=16)	4.06	3.44	6.28	0.29
Nyanza (n=20)	2.54	0.73	2.99	0.05
Gasabo (n=22)	2.74	0.42	2.56	0.45
Rusizi (n=18)	0.71	0.17	0.83	0.00
Nyaruguru (n=24)	0.97	0.03	0.88	0.01
<b>Average (n=279)</b>	<b>2.20</b>	<b>0.65</b>	<b>2.37</b>	<b>0.57</b>

- *Major Crops Grown*

Major crop grown are respectively maize (29.0%), beans (26.6%), Irish potatoes (9.7%), cassava (8.2%), rice (7.0%) and vegetables (5.5%). All these crops are priority crop selected by Crop Intensification Program (CIP) implemented by RAB/MINAGRI/Districts since 2007. They might be associated to land use consolidation, calling for

adoption and use of agriculture mechanization to ease the job. The low level of vegetables plantation reveals to us that there is a need to increase vegetables cultivation. Indeed, even if grown on very low rate (5.5%), vegetables are grown mainly by people oriented to agribusinesses; so, the use of machineries might be encouraged enough to be adopted by those farmers.

Table 8 Major Crops Grown in Surveyed District

District	Major Crops Grown (%)						
	Maize	Beans	Irish Potatoes	Cassava	Rice	vegetables	Other Crops*
Nyagatare (n=23)	34.0	19.1	2.1	2.1	12.8	17.0	13.0
Kirehe (n=22)	45.1	31.4	0.0	9.8	3.9	2.0	7.8
Bugesera (n=18)	28.1	34.4	0.0	3.1	0.0	9.4	25.0
Rwamagana (n=18)	33.3	23.1	5.1	0.0	28.2	2.6	7.7
Kayonza (n=20)	37.0	33.3	3.7	7.4	3.7	5.6	9.3
Gicumbi (n=19)	14.3	37.1	31.4	0.0	0.0	0.0	17.1
Musanze (n=19)	19.0	11.9	42.9	0.0	0.0	0.0	26.8
Rulindo (n=19)	27.7	23.4	17.0	0.0	0.0	4.3	27.7
Nyabihu (n=20)	23.8	19.0	23.8	0.0	0.0	11.9	21.4

Ruhango (n=16)	14.7	23.5	2.9	38.2	2.9	5.9	11.8
Nyanza (n=20)	27.3	29.5	2.3	29.5	4.5	4.5	2.3
Gasabo (n=22)	26.3	21.1	0.0	7.9	18.4	7.9	18.4
Rusizi (n=18)	35.7	23.8	0.0	9.5	21.4	7.1	6.0
Nyaruguru (n=24)	28.0	40.0	8.0	10.0	4.0	0.0	6.8
<b>Total (n=278)</b>	<b>29.0</b>	<b>26.6</b>	<b>9.7</b>	<b>8.2</b>	<b>7.0</b>	<b>5.5</b>	<b>13.9</b>

- *Cropping system*

The big majority (91.9%) are farming in pure stand while intercropping (7.7%) tends to progressively reduce. Farmers have understood the losses incurred when crops are mixed due to high competition of crops for soil nutrients. This shows also that there is a way to mobilize them for

remarkable land use consolidation. If the intercropping system shows more benefits compared to mono-cropping, there will be need to efficiently study which crops may be intercropped, in which way they should be intercropped for easy mechanization, etc.

Table 9 Major Cropping System in Surveyed Districts

District	Cropping System (%)		
	Pure Stand	Intercrop	Both
Nyagatare (n=23)	100.0	0.0	0.0
Kirehe (n=21)	85.7	14.3	0.0
Bugesera (n=19)	89.5	10.5	0.0
Rwamagana (n=16)	100.0	0.0	0.0
Kayonza (n=20)	75.0	20.0	5.0
Gicumbi (n=17)	100.0	0.0	0.0
Musanze (n=19)	89.5	10.5	0.0
Rulindo (n=19)	100.0	0.0	0.0
Nyabihu (n=18)	94.4	5.6	0.0
Ruhango (n=16)	93.8	6.3	0.0
Nyanza (n=20)	90.0	10.0	0.0
Gasabo (n=20)	85.0	15.0	0.0
Rusizi (n=12)	91.7	8.3	0.0
Nyaruguru (n=20)	95.0	5.0	0.0
<b>Total (n=259)</b>	<b>91.9</b>	<b>7.7</b>	<b>.4</b>

- *Crop Production Activities*

Crop production activities are described and linked to the farm mechanization operations in Rwanda.

Rwandans do not commonly use animal traction. The use of tractors (12.8%) reveals the low level of agriculture mechanization in Rwanda.

- *First Land Preparation (1<sup>st</sup> tillage)*

- ✓ *The Use of Oxen and Tractors in the 1<sup>st</sup> Land Preparation*

Generally, the 1st land preparation is done manually (77.2%). The use of oxen (2.1%) is very low because

Table 10 Use of Machinery in 1<sup>st</sup> Land Preparation (1<sup>st</sup> tillage)

District	Type of 1st Land Preparation (%)			
	Using Oxen	Using Tractors	Manual	Both Tractor and Manual
Nyagatare (n=23)	0.0	60.9	17.4	21.7
Kirehe (n=22)	0.0	9.1	77.3	13.6
Bugesera (n=21)	0.0	9.5	85.7	4.8
Rwamagana (n=18)	11.1	0.0	83.3	5.6
Kayonza (n=20)	5.0	20.0	75.0	0.0
Gicumbi (n=19)	0.0	0.0	89.5	10.5
Musanze (n=19)	0.0	0.0	89.5	10.5
Rulindo (n=19)	5.3	0.0	94.7	0.0
Nyabihu (n=21)	4.8	0.0	95.2	0.0
Ruhango (n=16)	0.0	6.3	62.5	31.3
Nyanza (n=20)	0.0	25.0	60.0	15.0
Gasabo (n=22)	4.5	18.2	77.3	0.0

Rusizi (n=18)	0.0	11.1	88.9	0.0
Nyaruguru (n=23)	0.0	8.7	91.3	0.0
<b>Total (n=281)</b>	<b>2.1</b>	<b>12.8</b>	<b>77.2</b>	<b>7.8</b>

✓ *Tractor Ownership and Average Cost Of 1<sup>st</sup> Land Preparation*

Tractors ownership is very low (9.8%) while the average cost of hiring a tractor for 1<sup>st</sup> land preparation is high (148,620 Frw equals to 162 Usd). The expectation to reach farm mechanization dissemination at 25% in 2020 is lowed by this finding.

Table 11 Tractor Ownership and Average Cost

District	Tractor Ownership (%)			Average Cost (Frw)
	Own	Hired	Both Own and Hired	
Nyagatare (n=19)	10.5	89.5	0.0	195295
Kirehe (n=4)	25.0	50.0	25.0	37133
Bugesera (n=3)	33.3	66.7	0.0	90200
Rwamagana (1)	0.0	100.0	0.0	280000
Kayonza (n=4)	25.0	75.0	0.0	78500
Musanze (n=1)	0.0	100.0	0.0	20000
Ruhango (n=6)	0.0	100.0	0.0	55000
Nyanza (n=6)	0.0	100.0	0.0	77833
Gasabo (n=4)	0.0	75.0	25.0	507500
Rusizi (n=1)	0.0	100.0	0.0	2000
Nyaruguru (n=2)	0.0	100.0	0.0	21000
<b>Total (n=51)</b>	<b>9.8</b>	<b>86.3</b>	<b>3.9</b>	<b>148620</b>

✓ *Type of Manual Labour Used*

Casual labour is mainly used by 66.3% while family labour is 32.2%. Hired labor is low (1.5%) The average cost at 1st land preparation is 62,075 Frw/ha equals to 621 Frw/are.

Table 12 Types of Manual Labour Used and Average Cost per ha

District	Types of Manual Labour Used (%)			Average Cost per ha (Frw)
	Casual Labour	Family	Hired Permanent	
Nyagatare (n=9)	83.4	16.7	0.0	51167
Kirehe (n=20)	55.0	45.0	0.0	87824
Bugesera (n=19)	68.4	31.6	0.0	72369
Rwamagana (n=17)	73.5	26.5	0.0	42563
Kayonza (n=16)	53.2	37.6	9.4	68250
Gicumbi (n=19)	58.0	42.2	0.0	43353
Musanze (n=19)	68.5	31.7	0.0	74387
Rulindo (n=17)	61.7	32.3	5.9	41085
Nyabihu (n=19)	47.4	50.0	2.6	31675
Ruhango (n=15)	93.4	6.7	0.0	114006
Nyanza (n=15)	93.4	6.7	0.0	85867
Gasabo (n=16)	81.3	18.8	0.0	78186
Rusizi (n=14)	64.3	35.8	0.0	33492
Nyaruguru (n=21)	50.1	47.7	2.4	15392
<b>Total (n=236)</b>	<b>66.3</b>	<b>32.2</b>	<b>1.5</b>	<b>62075</b>

✓ *Gender Involvement in the First Land Preparation*

Males and females participate in 1<sup>st</sup> land preparation at 37.7%. Youth male participate (26.2%) more than youth female (23.6%).

Table 13 Gender Involvement in the First Land Preparation

District	Gender Involved in Land Preparation (%)					
	Adult Male	Adult Female	Children	Both Male and Female	Youth Male	Youth Female
Nyagatare (n=8)	0.0	0.0	0.0	41.2	29.4	29.4
Kirehe (n=19)	9.8	12.2	0.0	36.6	22.0	19.5
Bugesera (n=20)	2.6	2.6	0.0	48.7	23.1	23.1
Rwamagana (n=17)	13.5	5.4	0.0	27.0	29.7	24.3
Kayonza (n=15)	9.7	9.7	0.0	35.5	25.8	19.4

Gicumbi (n=16)	8.6	8.6	0.0	37.1	22.9	22.9
Musanze (n=18)	9.3	9.3	7.0	34.9	20.9	18.6
Rulindo (n=15)	8.1	5.4	0.0	35.1	27.0	24.3
Nyabihu (n=11)	0.0	0.0	0.0	44.0	28.0	28.0
Ruhango (n=16)	4.8	4.8	0.0	35.7	28.6	26.2
Nyanza (n=15)	6.8	6.8	0.0	34.1	29.5	22.7
Gasabo (n=14)	2.9	0.0	0.0	37.1	31.4	28.6
Rusizi (n=9)	4.5	0.0	0.0	36.4	27.3	31.8
Nyaruguru (n=12)	0.0	0.0	0.0	54.5	22.7	22.7
<b>Total (n=207)</b>	<b>6.4</b>	<b>5.3</b>	<b>0.6</b>	<b>37.7</b>	<b>26.2</b>	<b>23.8</b>

- *Harrowing*

- ✓ *The Use of Oxen and Tractors in Harrowing*

Harrowing activity is almost done manually (87.9%). The use of oxen at harrowing level is not found in the case of Rwanda while use of tractors is also low (12.1%). This demonstrates low level of mechanization in harrowing exercise.

Table 14 Harrowing Types

District	Type of Harrowing (%)	
	Using Tractors	Manual
Nyagatare (n=16)	50.0	50.0
Kirehe (n=12)	8.3	91.7
Bugesera (n=8)	12.5	87.5
Rwamagana (n=14)	0.0	100.0
Kayonza (n=12)	25.0	75.0
Gicumbi (n=11)	0.0	100.0
Musanze (n=8)	0.0	100.0
Rulindo (n=12)	0.0	100.0
Nyabihu (n=8)	0.0	100.0
Ruhango (n=8)	12.5	87.5
Nyanza (n=5)	0.0	100.0
Gasabo (n=12)	25.0	75.0
Rusizi (n=6)	0.0	100.0
Nyaruguru (n=8)	0.0	100.0
<b>Total (n=140)</b>	<b>12.1</b>	<b>87.9</b>

- ✓ *Tractor Ownership and Average Cost Of 2<sup>nd</sup> Land Preparation*

Hiring tractors is common for 73.3% but the average cost (40,500 Frw) is a bit higher for second land preparation. The district that excels in hiring tractors is Nyagatare with 8 respondents corresponding to 87.5%. This district is located

near the border of Uganda where farmers have bigger land size with almost flat landscape and insufficient manpower. On this question, other districts have got 1 or 2 respondents only (Table...) which demonstrates how 2nd land preparation is rarely done.

Table 15 Tractor Ownership and Average Cost

District	Tractor Ownership (%)		Average Cost (Frw)
	Own	Hired	
Nyagatare (n=8)	12.5	87.5	58000
Kirehe (n=1)	100.0	0.0	15000
Bugesera (n=1)	0.0	100.0	-
Kayonza (n=2)	100.0	0.0	10500
Ruhango (n=1)	0.0	100.0	30000
Gasabo (n=2)	0.0	100.0	43333
<b>Total (n=15)</b>	<b>26.7</b>	<b>73.3</b>	<b>40500</b>

- ✓ *Gender Involved in the 2<sup>nd</sup> Land Preparation*

Both males and females (>36%) engage in second land preparation as they do for the first land preparation. Male and female work together generally on farm. Youth male and female are also present in this activity at respectively

26.5% and 24.2% with high participation in Nyabihu district (>33%) while the lowest participation of Youth is in Kirehe (7.1%). Child rights are respected in the sense that only 1.2% is involved in this activity.

Table 16 Gender Involvement in Second Land Preparation

District	Gender Involved in the 2 <sup>nd</sup> Land Preparation (%)					
	Adult Male	Adult Female	Children	Both Male and Female	Youth Male	Youth Female
Nyagatare (n=8)	0.0	0.0	0.0	40.0	30.0	30.0
Kirehe (n=10)	14.3	21.4	0.0	50.0	7.1	7.1
Bugesera (n=13)	3.6	3.6	0.0	42.9	25.0	25.0
Rwamagana (n=11)	19.0	9.5	0.0	23.8	28.6	19.0
Kayonza (n=11)	4.2	8.3	0.0	37.5	29.2	20.8
Gicumbi (n=9)	11.8	11.8	0.0	41.2	17.6	17.6
Musanze (n=17)	9.8	9.8	7.3	31.7	22.0	19.5
Rulindo (n=12)	3.1	0.0	0.0	34.4	31.3	31.3
Nyabihu (n=5)	0.0	0.0	0.0	33.3	33.3	33.3
Ruhango (n=9)	8.0	8.0	0.0	32.0	28.0	24.0
Nyanza (n=13)	4.9	4.9	0.0	31.7	31.7	26.8
Gasabo (n=12)	3.6	0.0	0.0	39.3	28.6	28.6
Rusizi (n=7)	11.1	5.6	5.6	33.3	22.2	22.2
Nyaruguru (n=9)	0.0	0.0	0.0	47.4	26.3	26.3
<b>Total (n=146)</b>	<b>6.4</b>	<b>5.5</b>	<b>1.2</b>	<b>36.2</b>	<b>26.5</b>	<b>24.2</b>

- *Planting*

- ✓ *Type of Planting Labour*

Casual labor is cheap (744Frw/a) and commonly used on farm at 56.3%. Both family and casual labour use is found at 22.8% with high percentages in Bugesera (44.4%) and Kayonza (38.9%) and low percentages in Ruhango, Nyanza and Gasabo where the household employ casual labor respectively at 100%, 85.0% and 75.0%.

Table 17 Types of Manual Labor at Planting Time

District	Type of Manual Labour Used (%)				Average Cost per a (Frw)
	Family	Hired Permanent	Casual Labour	Both Family and Casual Labour	
Nyagatare (n=21)	9.5	4.8	71.4	14.3	511
Kirehe (n=21)	23.8	0.0	47.6	28.6	914
Bugesera (n=18)	16.7	0.0	38.9	44.4	727
Rwamagana (n=16)	12.5	0.0	56.3	31.3	553
Kayonza (n=18)	11.1	5.6	44.4	38.9	1191
Gicumbi (n=19)	31.6	0.0	52.6	15.8	1163
Musanze (n=18)	22.2	0.0	55.6	22.2	805
Rulindo (n=16)	25.0	6.3	43.8	25.0	817
Nyabihu (n=19)	47.4	5.3	31.6	15.8	306
Ruhango (n=16)	0.0	0.0	100.0	0.0	423
Nyanza (n=20)	0.0	0.0	85.0	15.0	593
Gasabo (n=16)	0.0	0.0	75.0	25.0	1079
Rusizi (n=15)	26.7	0.0	53.3	20.0	529
Nyaruguru (n=21)	38.1	0.0	38.1	23.8	643
<b>Total (n=254)</b>	<b>19.3</b>	<b>1.6</b>	<b>56.3</b>	<b>22.8</b>	<b>744</b>

- ✓ *How Do You Plant?*

Farmers use generally their hands (95.3%) while planting maize. Those who use tractor planters (3.1%) are very few and again this figure shows the low level of mechanization in planting activity. Open furrows implement used before planting maize is found only in Bugesera, Kayonza and Gasabo (6.3%). These are also used in general at very low level (1.6%).

Table 18 Machinery Used to Plant Maize

District	How Do You Plant Your Maize (%)		
	Manually	Use Tractor Planter	Open Furrows then Plant
Nyagatare (n=19)	89.5	10.5	0.0
Kirehe (n=20)	95.0	5.0	0.0
Bugesera (n=16)	87.5	6.3	6.3
Rwamagana (n=10)	100.0	0.0	0.0

Kayonza (n=16)	81.3	12.5	6.3
Gicumbi (n=14)	100.0	0.0	0.0
Musanze (n=11)	100.0	0.0	0.0
Rulindo (n=12)	100.0	0.0	0.0
Nyabihu (n=13)	100.0	0.0	0.0
Ruhango (n=9)	100.0	0.0	0.0
Nyanza (n=12)	100.0	0.0	0.0
Gasabo (n=16)	93.8	0.0	6.3
Rusizi (n=8)	100.0	0.0	0.0
Nyaruguru (n=16)	100.0	0.0	0.0
<b>Total (n=192)</b>	<b>95.3</b>	<b>3.1</b>	<b>1.6</b>

✓ *Gender Involved in Planting*

Both male and female (39.4%) involvement in planting is followed by youth both male (25.2%) and female (24.2%). Again more youth involvement in planting activities is found in Nyanza, Ruhango, Rulindo and Rwamagana with more than 28% participation.

Table 19 Gender Involvement in Planting

District	Gender Involved in Planting (%)					
	Adult Male	Adult Female	Children	Both Male and Female	Youth Male	Youth Female
Nyagatare (n=17)	2.5	5.0	0.0	37.5	27.5	27.5
Kirehe (n=21)	9.3	9.3	0.0	44.2	20.9	16.3
Bugesera (n=16)	3.6	7.1	0.0	53.6	17.9	17.9
Rwamagana (n=15)	9.4	3.1	0.0	34.4	28.1	25.0
Kayonza (n=17)	11.4	8.6	0.0	37.1	22.9	20.0
Gicumbi (n=16)	8.6	8.6	0.0	37.1	22.9	22.9
Musanze (n=18)	9.5	9.5	7.1	33.3	19.0	21.4
Rulindo (n=15)	2.9	0.0	0.0	40.0	28.6	28.6
Nyabihu (n=11)	8.7	0.0	0.0	39.1	26.1	26.1
Ruhango (n=14)	5.1	10.3	2.6	30.8	28.2	23.1
Nyanza (n=16)	0.0	0.0	0.0	36.4	31.8	31.8
Gasabo (n=17)	2.6	2.6	0.0	42.1	26.3	26.3
Rusizi (n=10)	0.0	0.0	0.0	45.5	27.3	27.3
Nyaruguru (n=12)	0.0	0.0	0.0	50.0	25.0	25.0
<b>Total (n=215)</b>	<b>5.4</b>	<b>5.0</b>	<b>0.8</b>	<b>39.4</b>	<b>25.2</b>	<b>24.2</b>

• *First Weeding*

✓ *Type of the 1<sup>st</sup> Weeding and Spraying Equipment*

The survey aimed to find out if there is any mechanization used at weeding level and spraying of chemicals. Results reveal that the first weeding is manual

(87.1%) and it is rarely done using both chemical and mechanical (8.7%). The knapsack (91.4%) is the most used tool by farmers while boom sprayer (5.7%) is not. For spraying, both boom sprayers and motor blowers are used at 2.9%.

Table 20 Machinery at First Weeding and Spraying Equipment

District	Type of the 1 <sup>st</sup> Weeding (%)			Spraying Equipment if Chemicals are Used (%)		
	Manual	Both Manual and Chemical	Both Chemical and Mechanical	Boom Sprayer	Knapsack	Both Boom Sprayer and Motor Blower
Nyagatare (n=23)	91.3	4.3	4.3	0.0	50.0	50.0
Kirehe (n=20)	90.0	5.0	5.0	0.0	100.0	0.0
Bugesera (n=20)	80.0	10.0	10.0	0.0	100.0	0.0
Rwamagana (n=17)	88.2	0.0	11.8	33.3	66.7	0.0
Kayonza (n=19)	47.4	31.6	21.1	10.0	90.0	0.0
Gicumbi (n=18)	100.0	0.0	0.0	-	-	-
Musanze (n=19)	78.9	5.3	15.8	0.0	100.0	0.0
Rulindo (n=19)	94.7	0.0	5.3	0.0	100.0	0.0
Nyabihu (n=19)	89.5	0.0	10.5	0.0	100.0	0.0
Ruhango (n=15)	100.0	0.0	0.0	-	-	-
Nyanza (n=20)	95.0	0.0	5.0	0.0	100.0	0.0

Gasabo (n=20)	70.0	0.0	30.0	0.0	100.0	0.0
Rusizi (n=15)	100.0	0.0	0.0	-	-	-
Nyaruguru (n=20)	100.0	0.0	0.0	-	-	-
<b>Total (n=264)</b>	<b>87.1</b>	<b>4.2</b>	<b>8.7</b>	<b>5.7</b>	<b>91.4</b>	<b>2.9</b>

✓ *Type of Manual Labour Used in 1<sup>st</sup> Weeding*

Casual labor at 1<sup>st</sup> weeding is 780 Frw per are. It is used by the majority of farmers (71.4%) followed by family labor (26.5%). Very few farmers use hired labor (2.1%) at first weeding.

Table 21 Types of Manual Labor

District	Type of Manual Labour Used in 1 <sup>st</sup> Weeding (%)			Average Cost per a in Frw
	Casual Labour	Family	Hired Permanent	
Nyagatare (n=20)	92.5	7.5	0.0	459
Kirehe (n=19)	60.5	39.5	0.0	1925
Bugesera (n=20)	62.5	37.5	0.0	1243
Rwamagana (n=12)	70.8	29.2	0.0	515
Kayonza (n=19)	63.2	31.6	5.3	1172
Gicumbi (n=17)	61.8	35.3	2.9	539
Musanze (n=19)	68.4	31.6	0.0	671
Rulindo (n=16)	65.6	21.9	12.5	886
Nyabihu (n=13)	53.8	42.3	3.8	317
Ruhango (n=14)	96.4	3.6	0.0	618
Nyanza (n=19)	92.1	2.6	5.3	638
Gasabo (n=17)	82.4	17.6	0.0	779
Rusizi (n=13)	69.2	30.8	0.0	500
Nyaruguru (n=18)	58.3	41.7	0.0	508
<b>Total (n=236)</b>	<b>71.4</b>	<b>26.5</b>	<b>2.1</b>	<b>780</b>

✓ *Gender Involved in 1<sup>st</sup> Weeding*

Both males and females (37.5%) are involved in 1<sup>st</sup> weeding activity whereas in the past, weeding was a women

activity. Youth is also involved for male (25.2%) and female (24.9%). Children are only used in Musanze (6.8%) and Rusizi (3.7%). Other districts follow the child right.

Table 22 Gender Involvement in First Weeding

District	Gender Involved in 1 <sup>st</sup> Weeding (%)					
	Adult Male	Adult Female	Children	Both Male and Female	Youth Male	Youth Female
Nyagatare (n=19)	2.3	4.5	0.0	38.6	27.3	27.3
Kirehe (n=21)	8.2	10.2	0.0	36.7	24.5	20.4
Bugesera (n=18)	3.0	3.0	0.0	54.5	21.2	18.2
Rwamagana (n=12)	6.7	16.7	0.0	23.3	30.0	23.3
Kayonza (n=19)	5.1	7.7	0.0	38.5	23.1	25.6
Gicumbi (n=16)	6.7	6.7	0.0	43.3	23.3	20.0
Musanze (n=19)	9.1	11.4	6.8	34.1	18.2	20.5
Rulindo (n=15)	5.3	2.6	0.0	34.2	28.9	28.9
Nyabihu (n=13)	3.4	3.4	0.0	37.9	27.6	27.6
Ruhango (n=15)	7.3	9.8	0.0	31.7	26.8	24.4
Nyanza (n=20)	3.4	3.4	0.0	34.5	31.0	27.6
Gasabo (n=18)	2.4	2.4	0.0	40.5	26.2	28.6
Rusizi (n=11)	3.7	7.4	3.7	37.0	22.2	25.9
Nyaruguru (n=15)	3.7	3.7	0.0	44.4	18.5	29.6
<b>Total (n=231)</b>	<b>5.1</b>	<b>6.6</b>	<b>0.8</b>	<b>37.5</b>	<b>25.2</b>	<b>24.9</b>

✓ *First Weeding Equipment*

99.5% were using hoes to weed and 0.5% that used machete to weed was reported in Kayonza district where soils are fertile and allow such tool to be used for weeding.

• *Second Weeding and Pest Control*

✓ *Type of the 2<sup>nd</sup> Weeding and Spraying Equipment*

The 2<sup>nd</sup> weeding is largely manual (67.7%) followed by both manual and chemical (31.8%). Knapsack (95.4%) is mostly used for spraying activity. Use of other spraying

equipment if chemicals are applied is not significant. So, mechanization is to be exploited in this area.

Table 23 Types of Second Weeding and Spraying Equipment

District	Type of the 2 <sup>nd</sup> Weeding (%)			Spraying Equipment if Chemicals are Used (%)		
	Manual	Both Manual and Chemical	Both Chemical and Mechanical	Boom Sprayer	Knapsack	Both Boom Sprayer and Motor Blower
Nyagatare (n=18)	66.7	27.8	5.6	0.0	83.3	16.7
Kirehe (n=20)	60.0	40.0	0.0	0.0	100.0	0.0
Bugesera (n=13)	69.2	30.8	0.0	0.0	100.0	0.0
Rwamagana (n=12)	66.7	33.3	0.0	0.0	100.0	0.0
Kayonza (n=15)	60.0	40.0	0.0	0.0	100.0	0.0
Gicumbi (n=14)	71.4	28.6	0.0	0.0	100.0	0.0
Musanze (n=19)	47.4	52.6	0.0	0.0	100.0	0.0
Rulindo (n=13)	61.5	38.5	0.0	0.0	100.0	0.0
Nyabihu (n=11)	81.8	18.2	0.0	0.0	100.0	0.0
Ruhango (n=14)	57.1	42.9	0.0	0.0	100.0	0.0
Nyanza (n=25)	86.7	13.3	0.0	100.0	0.0	0.0
Gasabo (n=14)	64.3	35.7	0.0	0.0	100.0	0.0
Rusizi (n=9)	66.7	33.3	0.0	0.0	100.0	0.0
Nyaruguru (n=14)	100.0	0.0	0.0	-	-	-
<b>Total (n=201)</b>	<b>67.7</b>	<b>31.8</b>	<b>.5</b>	<b>3.1</b>	<b>95.4</b>	<b>1.5</b>

✓ *Type of Manual Labour Used in 2<sup>nd</sup> Weeding*

The average cost is 799 Frw/are for the 2<sup>nd</sup> weeding. Casual labor is used at 71.6% for this activity.

Table 24 Types of Manual Labour at First Weeding and Average Cost

District	Type of Manual Labour Used in 1 <sup>st</sup> Weeding (%)			Average Cost per are (Frw)
	Casual labour	Family	Hired Permanent	
Nyagatare (n=14)	92.9	7.1	0.0	587
Kirehe (n=18)	63.9	36.1	0.0	832
Bugesera (n=12)	66.7	33.3	0.0	1244
Rwamagana (n=11)	59.1	40.9	0.0	526
Kayonza (n=16)	56.3	37.5	6.3	1228
Gicumbi (n=12)	58.3	41.7	0.0	620
Musanze (n=16)	66.7	33.3	0.0	772
Rulindo (n=10)	60.0	30.0	10.0	896
Nyabihu (n=9)	61.1	27.8	11.1	389
Ruhango (n=15)	86.7	6.7	6.7	788
Nyanza (n=15)	100.0	0.0	0.0	634
Gasabo (n=11)	90.9	9.1	0.0	1143
Rusizi (n=10)	70.0	30.0	0.0	695
Nyaruguru (n=13)	61.5	38.5	0.0	656
<b>Total (n=181)</b>	<b>71.6</b>	<b>26.2</b>	<b>2.2</b>	<b>799</b>

✓ *Gender Involved in the 2<sup>nd</sup> Weeding*

In the 2<sup>nd</sup> weeding, both adult male and females at participate 39.6% while youth male and female participate almost equally respectively 25.3% and 24.1%

Table 25 Gender Involvement in Second Weeding

District	Gender Involved in 1 <sup>st</sup> Weeding (%)					
	Adult Male	Adult Female	Children	Both Male and Female	Youth Male	Youth Female
Nyagatare (n=195)	0.0	0.0	0.0	42.9	28.6	28.6
Kirehe (n=19)	9.3	11.6	0.0	37.2	23.3	18.6
Bugesera (n=13)	0.0	0.0	0.0	54.2	25.0	20.8
Rwamagana (n=11)	10.0	20.0	0.0	30.0	20.0	20.0
Kayonza (n=15)	6.3	6.3	0.0	37.5	25.0	25.0
Gicumbi (n=13)	11.5	11.5	0.0	38.5	19.2	19.2

Musanze (n=18)	7.9	10.5	5.3	36.8	21.1	18.4
Rulindo (n=8)	5.6	0.0	0.0	38.9	27.8	27.8
Nyabihu (n=8)	0.0	0.0	0.0	44.4	27.8	27.8
Ruhango (n=15)	7.1	7.1	2.4	33.3	26.2	23.8
Nyanza (n=16)	0.0	0.0	0.0	36.4	31.8	31.8
Gasabo (n=14)	3.7	3.7	0.0	44.4	25.9	22.2
Rusizi (n=8)	0.0	0.0	0.0	44.4	27.8	27.8
Nyaruguru (n=11)	0.0	4.5	0.0	45.5	22.7	27.3
<b>Total (n=184)</b>	<b>4.7</b>	<b>5.7</b>	<b>0.7</b>	<b>39.6</b>	<b>25.3</b>	<b>24.1</b>

✓ *2<sup>nd</sup> Weeding Equipment*

The second weeding is totally (100%) performed by hoes and no mechanization identified at this level.

• *Top Dressing Fertilizer*

The mode of fertilizer application is manually (99.1%) and granular ((99.1%) is the common form used.

✓ *Fertilizer Application and Average Cost of Application*

Table 26 Mode of Fertilizer Application Forms and Average Cost per are

District	Mode of Fertilizer Application (%)		Form of Fertilizer Application (%)		Average Cost of Fertilizer Application/are in (FRW)
	Manually	Mechanically	Granular	Foliar	
Nyagatare (n=21)	95.2	4.8	100.0	0.0	827
Kirehe (n=22)	100.0	0.0	95.2	4.8	1065
Bugesera (n=17)	94.1	5.9	100.0	0.0	2933
Rwamagana (n=16)	100.0	0.0	100.0	0.0	400
Kayonza (n=16)	100.0	0.0	100.0	0.0	865
Gicumbi (n=18)	100.0	0.0	100.0	0.0	866
Musanze (n=19)	100.0	0.0	100.0	0.0	1129
Rulindo (n=14)	100.0	0.0	100.0	0.0	288
Nyabihu (n=18)	100.0	0.0	100.0	0.0	312
Ruhango (n=10)	100.0	0.0	100.0	0.0	751
Nyanza (n=16)	100.0	0.0	93.3	6.7	425
Gasabo (n=15)	100.0	0.0	100.0	0.0	1228
Rusizi (n=13)	100.0	0.0	100.0	0.0	640
Nyaruguru (n=19)	100.0	0.0	100.0	0.0	709
<b>Total (n=234)</b>	<b>99.1</b>	<b>0.9</b>	<b>99.1</b>	<b>0.9</b>	<b>927</b>

✓ *Manure Application and Average Cost of Application*

The great majority of farmers apply manure manually (99.1%). Mechanical use is below 1%. The average cost of manure application is 919 FRW/are.

Table 27 Mode of Manure Application and Average Cost

District	Mode of Manure Application (%)		Average Cost of Manure Application/are in (FRW)
	Manually	Mechanically	
Nyagatare (n=19)	100.0	0.0	688
Kirehe (n=22)	100.0	0.0	859
Bugesera (n=18)	100.0	0.0	2090
Rwamagana (n=8)	100.0	0.0	247
Kayonza (n=13)	100.0	0.0	1250
Gicumbi (n=18)	100.0	0.0	1299
Musanze (n=18)	100.0	0.0	1396
Rulindo (n=14)	92.9	7.1	273
Nyabihu (n=19)	100.0	0.0	313
Ruhango (n=15)	100.0	0.0	743
Nyanza (n=15)	100.0	0.0	299
Gasabo (n=11)	100.0	0.0	1537
Rusizi (n=12)	100.0	0.0	800
Nyaruguru (n=20)	95.0	5.0	688
<b>Total (n=222)</b>	<b>99.1</b>	<b>0.9</b>	<b>919</b>

- *Use of Pesticides*

The use of chemicals for pests and disease control is at 96.8% mainly due to the Fall Army Worm (FAW) which invaded maize production since 2017. Knapsack is mostly used (97.9%) while the spraying activity cost is 620 Frw/are.

✓ *The Use of Chemicals for Pests and Disease Control, Mode of Application and Average Cost for Spraying One are.*

Table 28 Use of Chemicals in Pests and Diseases Control

District	Did You Use Chemicals for Pests and Disease Control? (%)		Mode of Applying Chemicals (%)			Average Cost for Spraying per are (FRW)
	Yes	No	Aircraft	Boom Sprayer	Knapsack	
Nyagatare (n=21)	100.0	0.0	0.0	10.0	90.0	649
Kirehe (n=21)	100.0	0.0	4.8	0.0	95.2	1266
Bugesera (n=18)	94.4	5.6	0.0	0.0	100.0	522
Rwamagana (n=14)	100.0	0.0	0.0	6.3	93.8	368
Kayonza (n=17)	100.0	0.0	6.3	0.0	93.8	733
Gicumbi (n=18)	100.0	0.0	0.0	0.0	100.0	501
Musanze (n=19)	100.0	0.0	0.0	0.0	100.0	1193
Rulindo (n=15)	100.0	0.0	0.0	0.0	100.0	145
Nyabihu (n=20)	90.0	10.0	0.0	0.0	100.0	185
Ruhango (n=13)	100.0	0.0	0.0	0.0	100.0	592
Nyanza (n=17)	88.2	11.8	0.0	0.0	100.0	588
Gasabo (n=18)	94.4	5.6	0.0	0.0	100.0	340
Rusizi (n=16)	100.0	0.0	0.0	0.0	100.0	538
Nyaruguru (n=21)	90.5	9.5	0.0	0.0	100.0	692
<b>Total (n=248)</b>	<b>96.8</b>	<b>3.2</b>	<b>.8</b>	<b>1.3</b>	<b>97.9</b>	<b>620</b>

- *Harvesting*

Harvesting system is manual (98.9%) with 100% in Kirehe, Bugesera and Rwamagana, Gicumbi, Musanze, Rulindo, Nyabihu, Ruhango, Nyanza, Gasabo, Rusizi and Nyaruguru respectively. The use of machinery in harvesting is 1.1% which is very low in a developing country.

✓ *Harvesting System Used*

Table 29 Types of Harvesting Systems

District	Type of Harvesting System Used	
	Manual	Machine
Nyagatare (n=21)	90.5	9.5
Kirehe (n=22)	100.0	0.0
Bugesera (n=21)	100.0	0.0
Rwamagana (n=18)	100.0	0.0
Kayonza (n=19)	94.7	5.3
Gicumbi (n=19)	100.0	0.0
Musanze (n=19)	100.0	0.0
Rulindo (n=18)	100.0	0.0
Nyabihu (n=19)	100.0	0.0
Ruhango (n=15)	100.0	0.0
Nyanza (n=19)	100.0	0.0
Gasabo (n=21)	100.0	0.0
Rusizi (n=14)	100.0	0.0
Nyaruguru (n=21)	100.0	0.0
<b>Total (n=265)</b>	<b>98.9</b>	<b>1.1</b>

63.1% of farmers use casual labour in harvesting with an average man-day of  $\pm 2$  and an average cost of 902Frw/are equivalent to 1 USD.

✓ *Labour Used in Harvesting, Average Man Day per are and Average Cost of Harvesting per are*

Table 30 Types of Labour in Harvesting Activities and Cost per are

District	Labour Used in Harvesting (%)				If Manual, Number of Man- Days per are	Average Cost of Harvesting per are (Frw)
	Casual Labour	Family	Contracted	Hired Permanent		
Nyagatare (n=20)	72.5	15.0	7.5	5.0	1.9	798
Kirehe (n=20)	59.2	31.7	7.5	1.7	1.5	991
Bugesera (n=20)	50.0	45.0	5.0	0.0	1.7	1009
Rwamagana (n=15)	70.0	26.7	0.0	3.3	2.1	503
Kayonza (n=19)	65.8	26.3	2.6	5.3	1.5	1116
Gicumbi (n=19)	63.2	36.8	0.0	0.0	1.1	823
Musanze (n=19)	71.1	23.7	5.3	0.0	1.9	1054
Rulindo (n=17)	55.9	38.2	5.9	0.0	2.5	1142
Nyabihu (n=20)	35.0	45.0	20.0	0.0	1.4	423
Ruhango (n=15)	83.3	6.7	6.7	3.3	2.0	1497
Nyanza (n=19)	78.9	5.3	15.8	0.0	1.9	561
Gasabo (n=20)	64.2	24.2	10.0	1.7	1.5	948
Rusizi (n=14)	71.4	25.0	0.0	3.6	1.6	867
Nyaruguru (n=20)	52.5	37.5	10.0	0.0	1.3	815
<b>Total (n=257)</b>	<b>63.1</b>	<b>28.1</b>	<b>7.2</b>	<b>1.6</b>	<b>1.7</b>	<b>902</b>

- *Post-Harvesting Handling*

- ✓ *Shelling/Threshing*

The majority of farmers do the shelling/threshing manually (79.5%), only 18.3% use shellers/threshers for an average cost of 1672 Frw/100 kg which is approximately equivalent to 17 Frw/1 Kg.

- ✓ *Shelling/Threshing Method and Average Cost of Shelling/Threshing 100kg*

Table 31 Use of Machinery in Shelling/Threshing Activity and Average Cost per 100 kg

District	How Do You Shell/Thresh? (%)			Average Cost of Shelling/Threshing 100Kg (Frw)
	Manually	Sheller/Thresher	Both Manually and Sheller/Thresher	
Nyagatare (n=18)	44.4	55.6	0.0	7050
Kirehe (n=21)	38.1	52.4	9.5	881
Bugesera (n=15)	86.7	13.3	0.0	973
Rwamagana (n=18)	77.8	11.1	11.1	1813
Kayonza (n=19)	57.9	42.1	0.0	777
Gicumbi (n=15)	100.0	0.0	0.0	767
Musanze (n=10)	90.0	10.0	0.0	880
Rulindo (n=14)	100.0	0.0	0.0	1218
Nyabihu (n=14)	100.0	0.0	0.0	444
Ruhango (n=12)	91.7	8.3	0.0	2144
Nyanza (n=12)	100.0	0.0	0.0	1957
Gasabo (n=18)	72.2	22.2	5.6	1019
Rusizi (n=14)	92.9	7.1	0.0	1467
Nyaruguru (n=19)	100.0	0.0	0.0	730
<b>Total (n=219)</b>	<b>79.5</b>	<b>18.3</b>	<b>2.3</b>	<b>1672</b>

- *Drying*

Sun drying is the method of drying products used at 98.5% while dryers are very rarely used 1.5%. The total cost of drying 100Kg of products is about 1,367 Frw which is equivalent to 14-15 Frw/kg.

- ✓ *Method of Drying and Average Cost of Drying 100kg*

Table 32 Methods of Drying and Average Cost per 100 kg

District	How Do You Dry Your Products? (%)		What is the Total Cost Drying 100-Kg Bag (FRW)?
	Sun Drying	Using Dryers	
Nyagatare (n=16)	87.5	12.5	884
Kirehe (n=22)	100.0	0.0	1157

Bugesera (n=14)	100.0	0.0	1194
Rwamagana (n=14)	100.0	0.0	629
Kayonza (n=17)	100.0	0.0	2667
Gicumbi (n=14)	100.0	0.0	1560
Musanze (n=7)	100.0	0.0	3000
Rulindo (n=13)	100.0	0.0	1100
Nyabihu (n=14)	100.0	0.0	500
Ruhango (n=11)	90.9	9.1	1944
Nyanza (n=14)	100.0	0.0	1400
Gasabo (n=17)	100.0	0.0	1740
Rusizi (n=10)	100.0	0.0	1250
Nyaruguru (n=16)	100.0	0.0	1543
<b>Total (n=199)</b>	<b>98.5</b>	<b>1.5</b>	<b>1367</b>

Casual labour is 43.9% against 42.0% for family labour. There is almost no hired permanent labour (1.1%). Average cost of post harvesting per is 15,502 Frw for 3.3 man-days.

- *Labour Used in Post Harvesting, Average Man Day per are and Average Cost of Post Harvesting per are.*

Table 33 Labour Used in Harvesting, Man-Days per are and Average Cost

District	Labour Used in Harvesting (%)				If Manual, Number of Man- Days per are	Average Cost of Post Harvesting per are (Frw)
	Casual Labour	Family	Contracted	Hired Permanent		
Nyagatare (n=13)	69.2	11.5	19.2	0.0	5.5	16857
Kirehe (n=21)	24.6	50.8	19.8	4.8	3.9	15863
Bugesera (n=15)	33.3	50.0	16.7	0.0	2.2	9889
Rwamagana (n=13)	42.3	50.0	7.7	0.0	2.7	21771
Kayonza (n=18)	52.8	44.4	2.8	0.0	2.6	15818
Gicumbi (n=13)	50.0	50.0	0.0	0.0	3.2	6413
Musanze (n=8)	18.8	81.3	0.0	0.0	3.0	8667
Rulindo (n=12)	58.3	37.5	4.2	0.0	2.8	20900
Nyabihu (n=12)	16.7	66.7	16.7	0.0	4.2	19167
Ruhango (n=10)	75.0	15.0	10.0	0.0	3.4	24857
Nyanza (n=11)	68.2	0.0	22.7	9.1	2.0	9900
Gasabo (n=16)	42.7	42.7	14.6	0.0	4.8	22300
Rusizi (n=12)	50.0	33.3	16.7	0.0	3.7	11625
Nyaruguru (n=13)	23.1	50.0	26.9	0.0	2.6	10640
<b>Total (n=187)</b>	<b>43.9</b>	<b>42.0</b>	<b>13.1</b>	<b>1.1</b>	<b>3.3</b>	<b>15502</b>

Results reveal that the use of mechanization in farm operations from 1<sup>st</sup> tillage to drying (<20%) is far below manually work (>80%). Only machinery is used at 32.3% for pesticides application, 20.6% for shelling maize or threshing beans, 18.8% at 1<sup>st</sup> tillage, and 12.9% at 1<sup>st</sup> weeding and 12.1% for harrowing.

• Summarized Results in Farming Operations

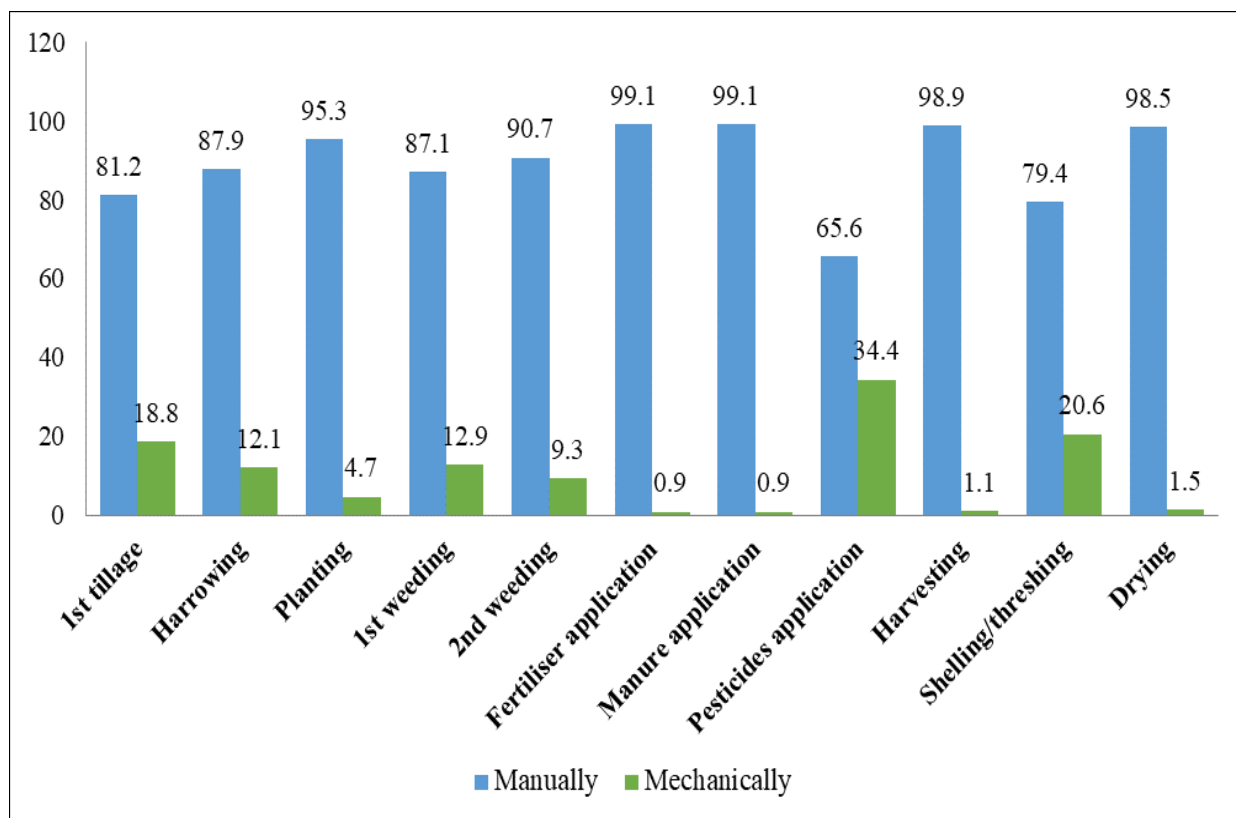


Fig 1 Summarized Results in Farming Operations

➤ Irrigation

Irrigation is practiced by 56.7% and farmers use surface water at 60.3% followed by sprinkler at 14.7% and centre pivot at 14.7%. This shows that their adoption to mechanization tools use should be applied to them as well, as long as they are familiar with using machines. Land preparation and planting should be associated to the irrigation system used. The other types of irrigation include

mainly the use of water can and water pump as well as the use of irrigation motor. Indeed, as surface irrigation is used by majority of the interviewed farmers (60.3%), this should be part of interest to favor surface irrigation from land preparation

• Types of Irrigation Practiced

Table 34 Types of Irrigation and Practice

District	Do You Carry Out Irrigation of Your Crop? (%)		What Type of Irrigation Do You Practice? (%)			
	Yes	No	Centre Pivot	Surface	Sprinkler	Other, Specify*
Nyagatare (n=19)	78.9	21.1	37.5	25.0	25.0	12.5
Kirehe (n=7)	85.7	14.3	0.0	50.0	33.3	16.7
Bugesera (n=14)	92.9	7.1	0.0	58.3	16.7	25.0
Rwamagana (n=6)	83.3	16.7	0.0	100.0	0.0	0.0
Kayonza (n=11)	63.6	36.4	0.0	66.7	16.7	16.7
Gicumbi (n=15)	46.7	53.3	0.0	71.4	0.0	28.6
Musanze (n=13)	7.7	92.3	100.0	0.0	0.0	0.0
Rulindo (n=19)	26.3	73.7	0.0	57.1	28.6	14.3
Nyabihu (n=18)	38.9	61.1	0.0	100.0	0.0	0.0
Ruhango (n=16)	75.0	25.0	0.0	16.7	33.3	50.0
Nyanza (n=17)	17.6	82.4	0.0	66.7	0.0	33.3
Gasabo (n=14)	71.4	28.6	0.0	66.7	22.2	11.1
Rusizi (n=17)	82.4	17.6	0.0	91.7	0.0	8.3
Nyaruguru (n=24)	58.3	41.7	0.0	76.9	0.0	23.1
<b>Total (n=210)</b>	<b>56.7</b>	<b>43.3</b>	<b>6.0</b>	<b>60.3</b>	<b>14.7</b>	<b>19.0</b>

\* The other types of irrigation include mainly the use of water can and water pump as well as the use of irrigation motor.

#### ✓ Sources of Water for Irrigation

The following table shows that respondent have water source to irrigate their crops where 74.4% get water from river stream. This shows that all irrigation water is pumped

(88.3%) from either river, lakes while 12% is from storage tanks/dams. The tanks may be used in gravitation way whereby mechanization should apply accordingly.

Table 35 Source of Water for Irrigation

District	Where Do you Get Water for Irrigation? (%)		
	River Stream	Lake	Storage Tank/Dam
Nyagatare (n=15)	60.0	26.7	13.3
Kirehe (n=6)	33.3	50.0	16.7
Bugesera (n=13)	46.2	53.8	0.0
Rwamagana (n=5)	100.0	0.0	0.0
Kayonza (n=7)	42.9	28.6	28.6
Gicumbi (n=7)	85.7	0.0	14.3
Musanze (n=1)	0.0	0.0	100.0
Rulindo (n=6)	83.3	0.0	16.7
Nyabihu (n=7)	85.7	0.0	14.3
Ruhango (n=12)	91.7	0.0	8.3
Nyanza (n=3)	66.7	0.0	33.3
Gasabo (n=9)	77.8	0.0	22.2
Rusizi (n=12)	100.0	0.0	0.0
Nyaruguru (n=14)	92.9	0.0	7.1
<b>Total (n=117)</b>	<b>74.4</b>	<b>13.7</b>	<b>12.0</b>

#### ✓ Methods of Acquiring Irrigation Equipment

People acquire irrigation equipment through their own purchase by cash (45.5%) followed by government subsidy (31.3%) and Government infrastructure (19.2%). For subsidy under irrigation machinery, the GoR provide 50%

and farmers pay also 50%. This shows that once mobilized, famers may purchase their own machineries whether through cooperatives or by their own means as family properties. However, it is recommended that the subsidy should also be initiated in agriculture mechanization.

Table 36 Methods of Acquiring Irrigation Equipment

District	How Did you Get the Equipment (%)			
	Government Subsidy	Government Infrastructure	Purchased by Cash	Donation
Nyagatare (n=13)	0.0	15.4	84.6	0.0
Kirehe (n=5)	0.0	40.0	60.0	0.0
Bugesera (n=11)	36.4	9.1	45.5	9.1
Rwamagana (n=4)	25.0	75.0	0.0	0.0
Kayonza (n=6)	33.3	50.0	16.7	0.0
Gicumbi (n=6)	50.0	0.0	50.0	0.0
Musanze (n=1)	0.0	0.0	100.0	0.0
Rulindo (n=8)	37.5	0.0	37.5	25.0
Nyabihu (n=4)	0.0	0.0	100.0	0.0
Ruhango (n=11)	81.8	0.0	18.2	0.0
Nyanza (n=2)	100.0	0.0	0.0	0.0
Gasabo (n=6)	33.3	33.3	33.3	0.0
Rusizi (n=11)	18.2	45.5	36.4	0.0
Nyaruguru (n=11)	27.3	9.1	54.5	9.1
<b>Total (n=99)</b>	<b>31.3</b>	<b>19.2</b>	<b>45.5</b>	<b>4.0</b>

#### ✓ Irrigation Water Payment

The majority of the farmers 68.6% do not pay for irrigation water. Those who pay fees, they give them to water user's association (78.4%) or WASAC (21.6%). This contributes to poor management of irrigation water sources as well as irrigation infrastructures. Compared to what is done in mechanization, where there are service providers

renting machineries, farmers could be mobilized for their own purchase and management of machineries if they own those machineries, the payment of maintenance fees could be possible as they do it in water user's associations. Unfortunately, their purchasing power is still very low and ownerships are as well at low level.

Table 37 Payment of Water Fees

District	Do You Pay for Irrigation Water? (%)		To Who? (%)	
	Yes	No	Water Users Association	WASAC
Nyagatare (n=16)	43.8	56.3	83.3	16.7
Kirehe (n=7)	57.1	42.9	75.0	25.0
Bugesera (n=12)	8.3	91.7	0.0	100.0
Rwamagana (n=5)	80.0	20.0	75.0	25.0
Kayonza (n=9)	33.3	66.7	66.7	33.3
Gicumbi (n=7)	14.3	85.7	100.0	0.0
Musanze (n=1)	100.0	0.0	100.0	0.0
Rulindo (n=7)	14.3	85.7	0.0	0.0
Nyabihu (n=7)	14.3	85.7	0.0	100.0
Ruhango (n=9)	0.0	100.0	0.0	0.0
Nyanza (n=5)	0.0	100.0	0.0	0.0
Gasabo (n=9)	33.3	66.7	66.7	33.3
Rusizi (n=12)	50.0	50.0	100.0	0.0
Nyaruguru (n=15)	40.0	60.0	83.3	16.7
<b>Total (n=121)</b>	<b>31.4</b>	<b>68.6</b>	<b>78.4</b>	<b>21.6</b>

➤ *Mechanization and Value Addition on Agricultural Products*

• *Equipment Used to Process Agricultural Produce*

The results show that farmers are still using hammer mill at 58.9% while using threshing machine was founded at 11.2%. Grain polisher and traditional store are also

remarkable with 11.2% and 10.3% respectively. Traditional stone (10.3%) and wet mill (5.6%) are less used by interviewed farmers. Other methods share the remaining percentage. We found that Nyagatare district have the most users of threshing machines.

Table 38 Processing Equipment

District	Processing Equipment (%)						
	Hammer Mill	Wet Mill	Traditional Stone	Hand Grinder	Motor and Pestle	Grain Polisher	Thresher
Nyagatare (n=9)	30.0	10.0	0.0	0.0	0.0	20.0	40.0
Kirehe (n=15)	81.3	0.0	0.0	0.0	6.3	0.0	12.5
Bugesera (n=7)	14.3	28.6	0.0	14.3	14.3	0.0	28.6
Rwamagana (n=10)	10.0	0.0	40.0	0.0	0.0	40.0	10.0
Kayonza (n=13)	86.7	0.0	0.0	0.0	0.0	6.7	6.7
Gicumbi (n=1)	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Musanze (n=3)	66.7	0.0	33.3	0.0	0.0	0.0	0.0
Rulindo (n=2)	50.0	50.0	0.0	0.0	0.0	0.0	0.0
Nyabihu (n=8)	62.5	25.0	0.0	0.0	0.0	0.0	12.5
Ruhango (n=5)	80.0	0.0	0.0	0.0	0.0	0.0	20.0
Nyanza (n=2)	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Gasabo (n=13)	43.8	0.0	25.0	0.0	0.0	31.3	0.0
Rusizi (n=6)	66.7	0.0	33.3	0.0	0.0	0.0	0.0
Nyaruguru (n=6)	100.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total (n=100)</b>	<b>58.9</b>	<b>5.6</b>	<b>10.3</b>	<b>0.9</b>	<b>1.9</b>	<b>11.2</b>	<b>11.2</b>

• *Equipment Used for Animal Feeding*

Referring on the below table, the results indicate that most of farmers use manual method (machete). It dominates with 93.5% compared to other methods. The level of using

shredders or choppers is at 2.2%; which is the lowest method; while manual chaff-cutter method is adopted at 4.3%. Farmers located in Bugesera district are the ones who use mostly machinery in animal feeding with 25%.

Table 39 Use of Machinery in Silage Process

District	How Do You Make the Silage? (%)		
	Using Machete	Shredders	Manual Chaff-Cutter
Nyagatare (n=3)	100.0	0.0	0.0
Kirehe (n=8)	100.0	0.0	0.0
Bugesera (n=4)	75.0	25.0	0.0
Kayonza (n=9)	100.0	0.0	0.0
Gicumbi (n=1)	100.0	0.0	0.0
Musanze (n=3)	100.0	0.0	0.0
Rulindo (n=1)	100.0	0.0	0.0
Nyabihu (n=2)	100.0	0.0	0.0
Ruhango (n=2)	100.0	0.0	0.0
Nyanza (n=2)	100.0	0.0	0.0
Gasabo (n=3)	33.3	0.0	66.7
Rusizi (n=4)	100.0	0.0	0.0
Nyaruguru (n=4)	100.0	0.0	0.0
<b>Total (n=46)</b>	<b>93.5</b>	<b>2.2</b>	<b>4.3</b>

➤ *Marketing of Agricultural Products (Sales)*

• *Sales at Harvesting Time*

Market prices are smoothly high (254.4Frw/Kg) compared to the farm gate price (178.6Frw/kg) because of the transport cost. Topography and transport method have a big impact on the price of the product on the market.

Table 40 Prices of Agricultural Product at Harvesting Time

District	Quantity Sold at Harvesting (kg)	Distance to the Market (km)	Farm Gate Price per kg (Frw)	Market Price per kg (Frw)
Nyagatare (n=7)	7257.7	5.7	145.0	208.3
Kirehe (n=7)	2928.6	2.6	332.5	299.8
Bugesera (n=6)	1650.0	4.0	171.3	450.0
Rwamagana (n=1)	830.0	0.0	130.0	-
Kayonza (n=1)	4000.0	5.1	165.0	188.0
Gicumbi (n=4)	2575.0	1.0	115.0	165.0
Musanze (n=3)	2066.7	2.5	150.0	140.0
Rulindo (n=3)	2133.3	0.0	155.0	157.5
Nyabihu (n=3)	5366.7	0.0	132.5	202.5
Ruhango (n=2)	7500.0	0.0	160.0	-
Nyanza (n=10)	8769.0	1.1	138.5	153.8
Gasabo (n=3)	243.3	1.6	180.0	520.0
Rusizi (n=3)	1566.7	0.0	300.0	-
Nyaruguru (n=3)	750.0	0.0	130.0	175.0
<b>Total (n=55)</b>	<b>4266.4</b>	<b>2.2</b>	<b>178.6</b>	<b>254.2</b>

• *Sales After Harvesting Time*

Some of farmers prefer to keep their produce in the store or farms and sell them after a certain period. The both prices are always higher compared to the ones during the

harvesting period. During this period, the average of farm gate price is 197.5Frw/Kg and 302.6 at the market.

Table 41 Prices of Agricultural Product at After Harvesting Time

District	Quantity Sold at After Harvesting (kg)	Distance to the Market in km	Farm Gate Price per kg (Frw)	Market Price per kg (Frw)
Nyagatare (n=16)	15127.1	59.4	176.7	230.8
Kirehe (n=18)	1672.7	1.0	223.3	357.4
Bugesera (n=14)	2895.9	1.9	318.0	205.0
Rwamagana (n=18)	1119.4	0.9	256.6	258.7
Kayonza (n=17)	3897.1	13.9	220.0	925.6
Gicumbi (n=15)	2890.0	4.1	90.0	319.0
Musanze (n=18)	4750.0	0.9	131.7	166.1
Rulindo (n=16)	918.8	1.8	147.0	244.5

Nyabihu (n=18)	3888.9	2.5	217.5	266.2
Ruhango (n=15)	28013.3	8.5	100.0	133.4
Nyanza (n=9)	16122.2	2.8	200.0	154.6
Gasabo (n=17)	4446.8	2.1	207.5	269.1
Rusizi (n=13)	1407.7	1.8	270.0	221.7
Nyaruguru (n=19)	1247.4	1.2	-	259.4
<b>Total (n=223)</b>	<b>5809.6</b>	<b>6.5</b>	<b>197.5</b>	<b>302.6</b>

• *Comparison on Quantity Sold During Harvesting and After Harvesting Periods*

Considering the results, it is clear that the most of farmers prefer to sell their products after harvesting. Some of farmers have stores and others prefer to keep the crops in the farm. Nyabihu and Rulindo districts which located in the northern province are the only district where farmers prefer

to sell their products during harvesting period due to the climate condition of this area. It is the area which most of the time it is cold and no enough sun. Therefore, farmers prefer to sell immediately after harvesting. Also, it is the area where farmers can cultivate three or four seasons. So, this makes them to sell their produce immediately after harvesting in order to proceed with the next season.

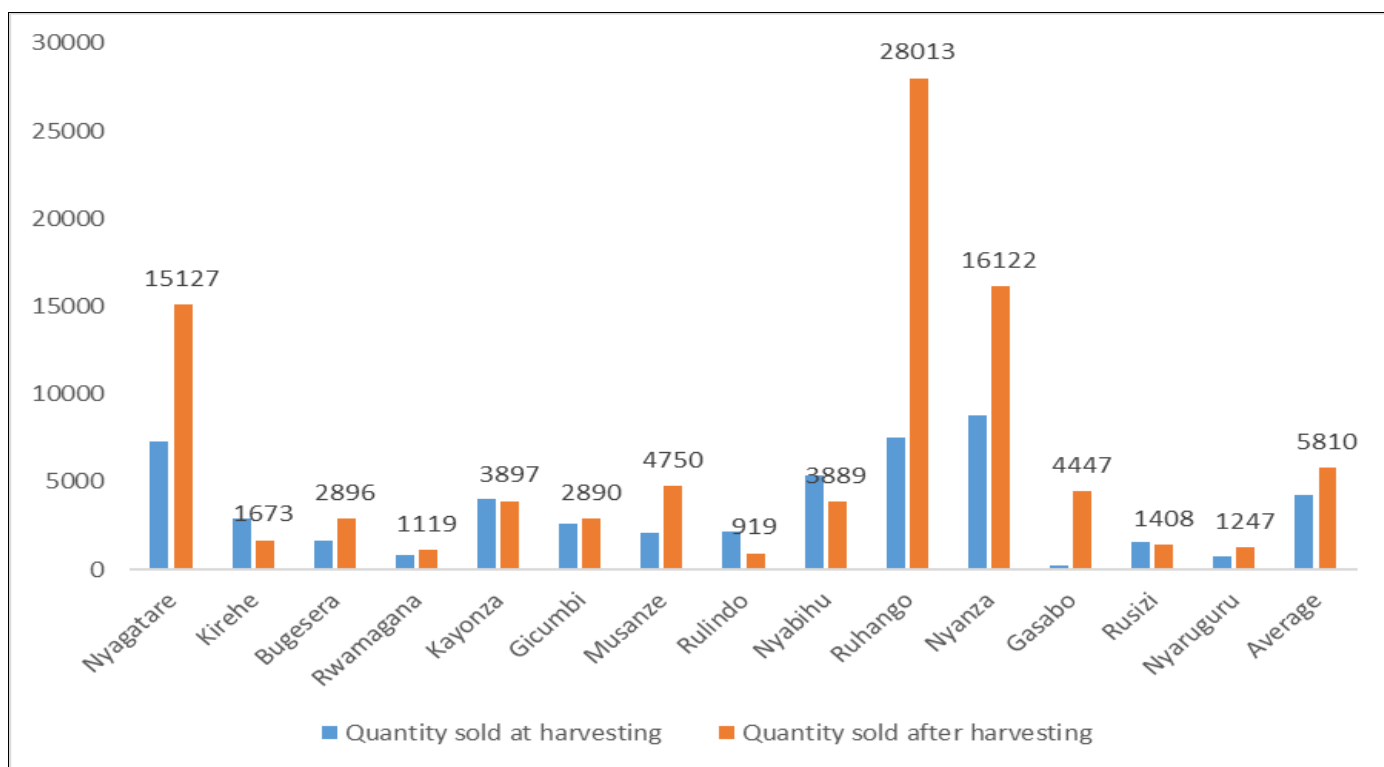


Fig 2 Quantity Sold at Harvesting and After Harvesting

➤ *Livestock Inventory and Marketing*

Results show that cattle, sheep, pigs, poultry, and goats are the most kept with 52.9%, 17.2%, 9.5%, 8.1% and 8.1% respectively. Oxen keeping is very low (3.2%) as well as rabbit (0.9%).

• *Types of Livestock Kept*

Table 42 Types of Livestock Kept

District	Livestock Kept (%)						
	Cattle	Oxen	Goat	Sheep	Poultry	Pig	Rabbit
Nyagatare (n=14)	55.0	15.0	10.0	15.0	0.0	0.0	5.0
Kirehe (n=14)	44.0	0.0	4.0	20.0	16.0	12.0	4.0
Bugesera (n=14)	63.2	5.3	0.0	26.3	0.0	5.3	0.0
Rwamagana (n=8)	45.5	0.0	18.2	18.2	9.1	9.1	0.0
Kayonza (n=15)	43.5	0.0	4.3	30.4	17.4	4.3	0.0
Gicumbi (n=11)	52.9	0.0	17.6	11.8	11.8	5.9	0.0
Musanze (n=13)	52.9	5.9	29.4	11.8	0.0	0.0	0.0
Rulindo (n=4)	42.9	0.0	14.3	0.0	28.6	14.3	0.0

Nyabihu (n=7)	60.0	10.0	20.0	10.0	0.0	0.0	0.0
Ruhango (n=9)	90.0	0.0	0.0	0.0	0.0	10.0	0.0
Nyanza (n=7)	66.7	0.0	0.0	22.2	11.1	0.0	0.0
Gasabo (n=8)	88.9	0.0	0.0	0.0	11.1	0.0	0.0
Rusizi (n=10)	33.3	6.7	6.7	20.0	13.3	20.0	0.0
Nyaruguru (n=18)	44.8	0.0	0.0	20.7	3.4	31.0	0.0
<b>Total (n=152)</b>	<b>52.9</b>	<b>3.2</b>	<b>8.1</b>	<b>17.2</b>	<b>8.1</b>	<b>9.5</b>	<b>0.9</b>

- *Average Number of Cattle Owned and the Average Value by Breed*

Table 43 Average Cattle Owned and Average Selling Price

District	Average Cattle Owned (%)		Average Selling Price (Frw)	
	Improved	Local	Improved	Local
Nyagatare (n=9)	11.1	2.8	402500	150000
Kirehe (n=7)	1.3	0.6	312222	300000
Bugesera (n=9)	27.3	1.0	374444	143333
Rwamagana (n=4)	2.0	0.3	344000	250000
Kayonza (n=10)	12.7	0.4	992589	150000
Gicumbi (n=6)	1.6	0.2	282050	290000
Musanze (n=6)	1.3	0.4	664286	175000
Rulindo (n=3)	1.3	0.0	350000	
Nyabihu (n=6)	3.7	0.0	421333	
Ruhango (n=9)	2.7	0.0	366667	
Nyanza (n=6)	2.8	1.0	325000	150000
Gasabo (n=6)	19.3	0.3	400000	220000
Rusizi (n=5)	2.0	0.3	712500	275000
Nyaruguru (n=9)	1.4	0.6	386667	224000
<b>Total (n=95)</b>	<b>7.0</b>	<b>0.7</b>	<b>461038</b>	<b>207391</b>

The main purpose of keeping cattle is principally manure (29.4%) and milk production (23.0%). Insurance (18.8%) and financing future expenditures 16.1% are also significant. Other purposes combine the prestige, replacing stock, animal draft and store of wealth (12.7%).

- *Reasons for Keeping Cattle*

Table 44 Purpose of Keeping Cattle (%)

District	Purpose of Keeping Cattle (%)				
	Manure Production	Milk Production	Insurance	Finance Future Expenditure	Other*
Nyagatare (n=9)	24.4	24.4	17.1	17.1	17.1
Kirehe (n=7)	32.4	20.6	17.6	11.8	17.6
Bugesera (n=9)	29.7	18.9	16.2	18.9	16.2
Rwamagana (n=4)	31.6	21.1	10.5	26.3	10.5
Kayonza (n=10)	24.4	14.6	29.3	14.6	17.1
Gicumbi (n=6)	37.5	25.0	12.5	12.5	12.5
Musanze (n=6)	25.0	25.0	15.0	20.0	15.0
Rulindo (n=3)	25.0	25.0	12.5	25.0	12.5
Nyabihu (n=6)	38.9	27.8	22.2	5.6	5.6
Ruhango (n=9)	36.8	36.8	10.5	10.5	5.3
Nyanza (n=6)	27.8	33.3	16.7	16.7	5.6
Gasabo (n=6)	31.0	20.7	17.2	10.3	20.7
Rusizi (n=5)	31.6	26.3	21.1	15.8	5.3
Nyaruguru (n=9)	26.2	21.4	26.2	21.4	4.8
<b>Total (n=95)</b>	<b>29.4</b>	<b>23.0</b>	<b>18.8</b>	<b>16.1</b>	<b>12.7</b>

\*Other include: Prestige, replacing stock, animal draft and store of wealth

- *Machinery in Livestock Production*

Except chaff-cutting used by 6.0% of farmers interviewed, machinery in livestock production is found extremely low (with 1% for forage and 0% for milking and milk transportation, manure handling, etc.

Table 45 Use of Machinery in Livestock Production ( in %)

District	Use Machinery in Milking	Use Machinery in Manure Handling	Use Machinery in Hay Production	Use Machinery in Forage Harvesting	Use Machinery in Chaff Cutting	Use Machinery in Milk Transportation
Nyagatare (n=18)	0.0	0.0	5.6	0.0	27.8	0.0
Kirehe (n=17)	0.0	0.0	0.0	5.9	0.0	0.0
Bugesera (n=19)	0.0	0.0	5.3	0.0	5.3	0.0
Rwamagana (n=14)	0.0	0.0	0.0	0.0	0.0	0.0
Kayonza (n=18)	0.0	0.0	0.0	0.0	5.6	0.0
Gicumbi (n=14)	0.0	0.0	0.0	0.0	0.0	0.0
Musanze (n=14)	0.0	0.0	0.0	0.0	0.0	0.0
Rulindo (n=15)	0.0	0.0	0.0	0.0	0.0	0.0
Nyabihu (n=11)	0.0	0.0	0.0	8.3	0.0	0.0
Ruhango (n=11)	0.0	0.0	0.0	0.0	9.1	0.0
Nyanza (n=14)	0.0	0.0	0.0	0.0	0.0	0.0
Gasabo (n=11)	0.0	0.0	0.0	0.0	27.3	0.0
Rusizi (n=7)	0.0	0.0	0.0	0.0	14.3	0.0
Nyaruguru (n=18)	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total (n=201)</b>	<b>0.0</b>	<b>0.0</b>	<b>1.0</b>	<b>1.0</b>	<b>6.0</b>	<b>0.0</b>

- *Machinery in Livestock Products Processing*

Machinery in livestock products processing shows 0% users.

Table 46 Use of Machinery in Livestock Processing (in %)

District	Use Machinery in Milking Processing	Use Machinery in Slaughtering	Use Machinery in Meat Processing	Use Machinery in Skin Processing
Nyagatare (n=18)	0.0	0.0	0.0	0.0
Kirehe (n=17)	0.0	0.0	0.0	0.0
Bugesera (n=19)	0.0	0.0	0.0	0.0
Rwamagana (n=14)	0.0	0.0	0.0	0.0
Kayonza (n=18)	0.0	0.0	0.0	0.0
Gicumbi (n=14)	0.0	0.0	0.0	0.0
Musanze (n=14)	0.0	0.0	0.0	0.0
Rulindo (n=15)	0.0	0.0	0.0	0.0
Nyabihu (n=11)	0.0	0.0	0.0	0.0
Ruhango (n=11)	0.0	0.0	0.0	0.0
Nyanza (n=14)	0.0	0.0	0.0	0.0
Gasabo (n=11)	0.0	0.0	0.0	0.0
Rusizi (n=7)	0.0	0.0	0.0	0.0
Nyaruguru (n=18)	0.0	0.0	0.0	0.0
<b>Total (n=201)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

- *Marketing of Livestock and related products*

Only 30.3% of farmers have sold livestock in 2017/2018 and the sales are mainly related to cattle (71.6%) and goats (13.4%). Other sales combined have 14.9% for pig, sheep and chicken

Table 47 Livestock Sold in 2017/2018 and Types Sold

District	Selling Livestock in 2017/18 (%)		Type of Livestock Sold (%)		
	Yes	No	Cattle	Goat	Other
Nyagatare (n=20)	35.0	65.0	85.7	14.3	0.0
Kirehe (n=20)	20.0	80.0	75.0	0.0	25.0
Bugesera (n=20)	20.0	80.0	100.0	0.0	0.0
Rwamagana (n=15)	13.3	86.7	50.0	50.0	0.0
Kayonza (n=18)	44.4	55.6	62.5	25.0	12.5
Gicumbi (n=16)	37.5	62.5	83.3	0.0	16.7
Musanze (n=16)	31.3	68.8	60.0	20.0	20.0
Rulindo (n=17)	17.6	82.4	66.7	0.0	33.3
Nyabihu (n=15)	40.0	60.0	66.7	16.7	16.7
Ruhango (n=12)	50.0	50.0	83.3	0.0	16.7

Nyanza (n=13)	30.8	69.2	75.0	25.0	0.0
Gasabo (n=11)	36.4	63.6	100.0	0.0	0.0
Rusizi (n=9)	33.3	66.7	33.3	33.3	33.3
Nyaruguru (n=19)	26.3	73.7	40.0	20.0	40.0
<b>Total (n=221)</b>	<b>30.3</b>	<b>69.7</b>	<b>71.6</b>	<b>13.4</b>	<b>14.9</b>

Other include: Pig, sheep and chicken

63.5% sell their livestock at local market using trekking mode (73.0%). Own transport is low with 23.8% and hired transport extremely low (3.2%).

Table 48 Livestock Main Market and Mode of Transport

District	Main Market (%)			Mode of Transport to the Market (%)		
	Farm Gate	Local Market	Urban Market	Trekking	Own transport	Hired transport
Nyagatare (n=20)	0.0	85.7	14.3	42.9	42.9	14.3
Kirehe (n=20)	50.0	50.0	0.0	60.0	40.0	0.0
Bugesera (n=20)	0.0	100.0	0.0	75.0	25.0	0.0
Rwamagana (n=15)	50.0	50.0	0.0	100.0	0.0	0.0
Kayonza (n=18)	25.0	75.0	0.0	80.0	10.0	10.0
Gicumbi (n=16)	40.0	60.0	0.0	100.0	0.0	0.0
Musanze (n=16)	60.0	40.0	0.0	100.0	0.0	0.0
Rulindo (n=17)	33.3	66.7	0.0	25.0	75.0	0.0
Nyabihu (n=15)	33.3	66.7	0.0	100.0	0.0	0.0
Ruhango (n=12)	40.0	40.0	20.0	100.0	0.0	0.0
Nyanza (n=13)	66.7	33.3	0.0	25.0	75.0	0.0
Gasabo (n=11)	0.0	100.0	0.0	75.0	25.0	0.0
Rusizi (n=9)	66.7	33.3	0.0	100.0	0.0	0.0
Nyaruguru (n=19)	40.0	60.0	0.0	75.0	25.0	0.0
<b>Total (n=221)</b>	<b>33.3</b>	<b>63.5</b>	<b>3.2</b>	<b>73.0</b>	<b>23.8</b>	<b>3.2</b>

• *Livestock Products Sold and Mode of Transport*

Livestock products sold include respectively milk (58.2%), manure (36.7%), meat (3.8%) and eggs (1.3%). Trekking (54.5%) is the main mode of transport to market

followed by own transport (34.1%). Other mode of transport combines hired and public transport for 10.4%.

Table 49 Livestock Products Sold and Mode of Transport

District	Livestock Products Sold (%)				Mode of Transport to the Market? (%)		
	Milk	Manure	Eggs	Meat	Trekking	Own Transport	Other
Nyagatare (n=6)	83.3	16.7	0.0	0.0	40.0	60.0	0.0
Kirehe (n=5)	42.9	57.1	0.0	0.0	66.7	33.3	0.0
Bugesera (n=4)	80.0	20.0	0.0	0.0	66.7	0.0	33.3
Kayonza (n=9)	54.5	27.3	9.1	9.1	83.3	16.7	0.0
Gicumbi (n=4)	66.7	33.3	0.0	0.0	20.0	60.0	20.0
Musanze (n=7)	44.4	55.6	0.0	0.0	40.0	20.0	40.0
Rulindo (n=1)	33.3	33.3	0.0	33.3	0.0	100.0	0.0
Nyabihu (n=5)	62.5	37.5	0.0	0.0	100.0	0.0	0.0
Ruhango (n=5)	71.4	28.6	0.0	0.0	60.0	40.0	0.0
Nyanza (n=4)	50.0	33.3	0.0	16.7	66.7	33.3	0.0
Gasabo (n=4)	57.1	42.9	0.0	0.0	0.0	66.7	33.3
Rusizi (n=2)	50.0	50.0	0.0	0.0	100.0	0.0	0.0
Nyaruguru (n=1)	50.0	50.0	0.0	0.0	0.0	0.0	0.0
<b>Total (n=57)</b>	<b>58.2</b>	<b>36.7</b>	<b>1.3</b>	<b>3.8</b>	<b>54.5</b>	<b>34.1</b>	<b>10.4</b>

Other mode of transport includes: hired and public transport

➤ *Access to credit and rural finance*

Results below show that farmers have very limited access to credit and rural finance (only 28.7% of interviewed farmers). Those who used credits, it was either

to improve agriculture (41.3%), speed up farming operation (20.0%) and acquire farm inputs (20.0%). Other credits were used for buying machinery, livelihood improvement, land and/or livestock acquisition livestock.

- *Credit Access and Purpose*

Table 50 Credit Access and Purpose

District	Ever Used Credit	Purpose of Using Credit (%)			
		Improving Agriculture	Speed Up Farming Operation	Inputs Acquisition	Others
Nyagatare (n=22)	31.8	42.9	14.3	28.6	14.3
Kirehe (n=22)	40.9	25.0	25.0	12.5	37.5
Bugesera (n=21)	23.8	28.6	42.9	14.3	14.3
Rwamagana (n=16)	31.3	40.0	20.0	20.0	20.0
Kayonza (n=19)	31.6	16.7	33.3	16.7	33.3
Gicumbi (n=19)	36.8	50.0	0.0	33.3	16.7
Musanze (n=19)	26.3	33.3	16.7	50.0	0.0
Rulindo (n=19)	10.5	100.0	0.0	0.0	0.0
Nyabihu (n=21)	23.8	0.0	33.3	33.3	33.3
Ruhango (n=16)	75.0	58.3	8.3	16.7	16.7
Nyanza (n=17)	17.6	33.3	66.7	0.0	0.0
Gasabo (n=19)	21.1	66.7	0.0	0.0	33.3
Rusizi (n=17)	29.4	60.0	20.0	0.0	20.0
Nyaruguru (n=21)	9.5	50.0	0.0	50.0	0.0
<b>Total (n=268)</b>	<b>28.7</b>	<b>41.3</b>	<b>20.0</b>	<b>20.0</b>	<b>18.7</b>

*Others include: Buying machinery, Livelihood improvement, Land acquisition, Livestock acquisition*

- *Reasons for Not Using Credits*

For many revealed reasons, farmers never used credits (71.3%). These are respectively no need (45.7%), lack of guarantee (15.2%), do not like (12.0%), difficult to get

(10.9%), difficult to reimburse (8.7%) and others (7.6%). Other reasons include fear, lack of profitability in farming and climate change

Table 51 Reasons for Not Using Credits

District	Never Used Credit	Reasons for Not Using Credit (%)					
		No Need	Lack of Guarantee	Do Not Like	Difficult to Get It	Difficult to Reimburse	Other
Nyagatare (n=22)	68.2	60.0	0.0	20.0	20.0	0.0	0.0
Kirehe (n=22)	59.1	50.0	0.0	16.7	16.7	0.0	16.7
Bugesera (n=21)	76.2	44.4	0.0	22.2	0.0	22.2	11.1
Rwamagana (n=16)	68.8	40.0	0.0	20.0	20.0	20.0	0.0
Kayonza (n=19)	68.4	66.7	0.0	0.0	0.0	16.7	16.7
Gicumbi (n=19)	63.2	62.5	25.0	0.0	0.0	0.0	12.5
Musanze (n=19)	73.7	28.6	0.0	28.6	28.6	0.0	14.3
Rulindo (n=19)	89.5	37.5	25.0	25.0	0.0	0.0	12.5
Nyabihu (n=21)	76.2	30.0	30.0	10.0	10.0	10.0	10.0
Ruhango (n=16)	25.0	0.0	0.0	0.0	100.0	0.0	0.0
Nyanza (n=17)	82.4	50.0	0.0	0.0	25.0	25.0	0.0
Gasabo (n=19)	78.9	75.0	0.0	25.0	0.0	0.0	0.0
Rusizi (n=17)	70.6	60.0	20.0	0.0	20.0	0.0	0.0
Nyaruguru (n=21)	90.5	30.0	60.0	0.0	0.0	10.0	0.0
<b>Total (n=268)</b>	<b>71.3</b>	<b>45.7</b>	<b>15.2</b>	<b>12.0</b>	<b>10.9</b>	<b>8.7</b>	<b>7.6</b>

*Other include: Fear, farming is not profitable and climate change,*

- *Different Source of Credits*

Different sources of credits include respectively banks (40.2%), SACCOs (34.2%), farmer groups/coops (16.2%) and other (9.4%)

Table 52 Different Sources of Credit

District	Source of Credit (%)				Frequency of Use (%)	
	Bank	SACCO	Farmer Group/Coop	Other	Rarely	Frequently
Nyagatare (n=10)	70.0	20.0		10.0	50.0	50.0
Kirehe (n=11)	36.4	54.5	9.1	0.0	81.8	18.2
Bugesera (n=8)	0.0	75.0	25.0	0.0	50.0	50.0
Rwamagana (n=8)	50.0	0.0	37.5	12.5	37.5	62.5
Kayonza (n=9)	22.2	66.7	0.0	11.1	100.0	0.0
Gicumbi (n=10)	20.0	50.0	30.0	0.0	70.0	30.0
Musanze (n=8)	50.0	12.5	37.5	0.0	62.5	37.5
Rulindo (n=7)	14.3	57.1	0.0	28.6	28.6	71.4
Nyabihu (n=7)	28.6	28.6	42.9	0.0	60.0	40.0
Ruhango (n=15)	73.3	13.3	0.0	13.3	66.7	33.3
Nyanza (n=6)	100.0	0.0	0.0	0.0	33.3	66.7
Gasabo (n=6)	33.3	0.0	33.3	33.3	80.0	20.0
Rusizi (n=8)	12.5	37.5	25.0	25.0	50.0	50.0
Nyaruguru (n=4)	25.0	75.0	0.0	0.0	75.0	25.0
<b>Total (n=117)</b>	<b>40.2</b>	<b>34.2</b>	<b>16.2</b>	<b>9.4</b>	<b>61.6</b>	<b>38.4</b>

➤ *Access to Knowledge/Information*

More than 80% of farmers interviewed accessed agricultural information in the last 12 months with high access in Nyanza and Nyabihu districts (>90%) and less access in Bugesera district (66.7%)

Table 53 Received Agricultural Information in the Last 12 Months

District	In the last 12 Months, Did You Receive Any Agriculture Related Information? (%)	
	Yes	No
Nyagatare (n=22)	77.3	22.7
Kirehe (n=22)	86.4	13.6
Bugesera (n=21)	66.7	33.3
Rwamagana (n=18)	83.3	16.7
Kayonza (n=20)	75.0	25.0
Gicumbi (n=19)	84.2	15.8
Musanze (n=19)	68.4	31.6
Rulindo (n=19)	73.7	26.3
Nyabihu (n=21)	90.5	9.5
Ruhango (n=16)	87.5	12.5
Nyanza (n=20)	95.0	5.0
Gasabo (n=22)	81.8	18.2
Rusizi (n=18)	83.3	16.7
Nyaruguru (n=24)	75.0	25.0
<b>Total (n=281)</b>	<b>80.4</b>	<b>19.6</b>

The access to knowledge is dominated by Government extension services which reach 29.3% of farmers, radios (22.0%), TV (5.3%) and FFS (4.3%). Other knowledge is got from civil Society Organizations (NGOs, Faith-Based),

Field days/ demonstrations, Seed traders/Agro-dealers, Research organizations, Agricultural shows, Cell phone, Web-based sources (Internet), Road shows and Adverts, Printed materials (Posters, bulletins), etc.

Table 54 Sources of Agricultural Information

District	The sources of Agricultural information (%)						
	Government Extension Service	Radio	Farmer Coops / Groups	Neighbor/ Other Farmers	Television	Farmer Field Schools	Other*
Nyagatare (n=17)	20.0	18.3	15.0	8.3	10.0	1.7	26.7
Kirehe (n=19)	22.6	12.9	16.1	1.6	1.6	11.3	33.9
Bugesera (n=14)	35.3	14.7	14.7	5.9	5.9	8.8	14.7
Rwamagana (n=15)	29.6	25.9	11.1	7.4	3.7	3.7	18.5
Kayonza (n=15)	21.1	23.7	10.5	5.3	5.3	5.3	28.9
Gicumbi (n=16)	44.1	23.5	8.8	11.8	2.9	2.9	5.9

Musanze (n=13)	36.7	33.3	6.7	6.7	3.3	0.0	13.3
Rulindo (n=14)	20.6	32.4	11.8	20.6	2.9	2.9	8.8
Nyabihu (n=19)	35.7	26.2	7.1	14.3	4.8	9.5	2.4
Ruhango (n=14)	46.7	20.0	10.0	6.7	3.3	6.7	6.7
Nyanza (n=19)	25.0	21.9	9.4	12.5	15.6	0.0	15.6
Gasabo (n=18)	26.2	24.6	13.1	4.9	4.9	1.6	24.6
Rusizi (n=15)	30.8	17.9	15.4	12.8	2.6	5.1	15.4
Nyaruguru (n=18)	34.0	22.6	15.1	17.0	0.0	1.9	9.4
<b>Total (n=226)</b>	<b>29.3</b>	<b>22.0</b>	<b>12.2</b>	<b>9.5</b>	<b>5.3</b>	<b>4.3</b>	<b>17.4</b>

*\*Other include: Civil Society Organizations (NGOs, faith-Based), Field days/ demonstrations, Seed traders/Agro-dealers, Research organizations, Agricultural shows, Cell phone, Web-based sources (Internet), Road shows and Adverts, Printed materials (Posters, bulletins), etc.*

Field pest and disease control is adopted by 31.0% against 22.4% for soil and water management, 15.9% for seedling propagation, 11.4% for crop storage and 9.7% for

post-harvest processing. These results reveal where mechanization emphasis should be put: essentially in pest and disease control, in storage and processing.

Table 55 Agricultural Technologies Used

District	Agricultural technologies (%)					
	Field Pest and Disease Control	Soil and Water Management	Seedling Propagation	Crop Storage	Post-Harvest Processing	Other
Nyagatare (n=17)	25.9	25.3	16.9	16.9	7.2	7.8
Kirehe (n=19)	33.3	15.6	20.7	11.1	11.9	7.4
Bugesera (n=14)	14.8	27.8	18.5	5.6	9.3	24.1
Rwamagana (n=15)	25.0	15.4	25.0	7.7	11.5	15.4
Kayonza (n=15)	30.0	7.1	1.4	17.1	11.4	32.9
Gicumbi (n=16)	32.9	31.8	23.5	7.1	2.4	2.4
Musanze (n=13)	38.5	21.5	9.2	12.3	10.8	7.7
Rulindo (n=14)	26.4	27.6	16.1	10.3	6.9	12.6
Nyabihu (n=19)	35.3	23.5	22.4	1.2	7.1	10.6
Ruhango (n=14)	35.3	22.1	14.7	16.2	7.4	4.4
Nyanza (n=19)	37.6	24.2	11.5	13.3	8.5	4.8
Gasabo (n=18)	31.8	17.6	13.5	6.1	18.9	12.2
Rusizi (n=15)	36.1	18.1	20.5	14.5	8.4	2.4
Nyaruguru (n=18)	26.2	29.7	13.1	14.5	9.7	6.9
<b>Total (n=226)</b>	<b>31.0</b>	<b>22.4</b>	<b>15.9</b>	<b>11.4</b>	<b>9.7</b>	<b>9.6</b>

88.7% of farmers are quite satisfied while 10.1% are neutral and 1.2% only dissatisfied. Satisfaction is justified by useful (56.5%), reliable (25.2%), accessible (14.3%) information, etc. Hence, access to information remains very low. Other reasons include not accessible, unreliable information, low cost, etc.

Table 56 Farmers Perception on the Quality of Information Received

District	The farmers' Perception on Quality of Information (%)			Reasons for Farmers' Perception on Quality of Information (%)			
	Satisfied	Neutral	Dissatisfied	Information is Useful	Reliable Information	Accessible	Other*
Nyagatare (n=17)	88.1	11.9	0.0	62.1	19.0	17.2	1.7
Kirehe (n=19)	92.6	7.4	0.0	46.3	22.2	22.2	9.3
Bugesera (n=14)	100.0	0.0	0.0	80.0	20.0	0.0	0.0
Rwamagana (n=15)	100.0	0.0	0.0	70.8	20.8	4.2	4.2
Kayonza (n=15)	82.4	17.6	0.0	38.2	50.0	11.8	0.0
Gicumbi (n=16)	100.0	0.0	0.0	58.8	32.4	5.9	2.9
Musanze (n=13)	88.5	11.5	0.0	50.0	30.8	19.2	0.0
Rulindo (n=14)	69.7	30.3	0.0	45.2	51.6	3.2	0.0
Nyabihu (n=19)	85.7	14.3	0.0	63.4	14.6	9.8	12.2
Ruhango (n=14)	96.6	0.0	3.4	75.9	24.1	0.0	0.0
Nyanza (n=19)	82.5	14.3	3.2	28.6	34.9	33.3	3.2
Gasabo (n=18)	96.4	1.8	1.8	66.1	16.1	5.4	12.5
Rusizi (n=15)	81.8	18.2	0.0	69.7	12.1	18.2	0.0

Nyaruguru (n=18)	83.7	10.2	6.1	60.9	15.2	23.9	0.0
<b>Total (n=226)</b>	<b>88.7</b>	<b>10.1</b>	<b>1.2</b>	<b>56.5</b>	<b>25.2</b>	<b>14.3</b>	<b>3.9</b>

*\*Other reasons include: Not accessible, Unreliable information, Low cost, etc. Some reasons were provided by interviewees.*

• *Reasons for Farmers' Perception on Quality of Information*

Farmers find the information useful (56.5%), reliable (25.2%) and accessible (14.3%).

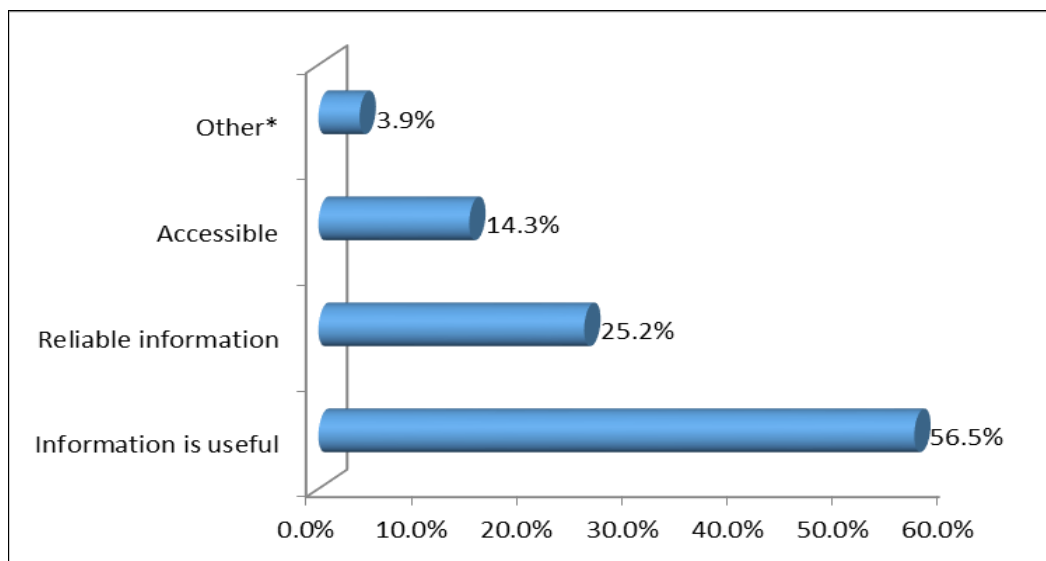


Fig 3 Reasons for Quality Information Received.

➤ *Social Networking*

A social network can be said to exist wherever distinct social actors are connected by more or less persistent relationships (Mark T. et al., 2010). In this study, the connectivity analyzed relates to memberships in any association. Around 70.0% of interviewees belong to a self-help group or to a farmer cooperative group. However, the self-groups are informal with only 33.5% while the cooperative groups are formal with high number of memberships (64.8%).

Table 57 Social Networking

	Community/ Group Association Membership (%)		Type of Community Group (%)		
	Yes	No	Self-Help Farmer Group	Farmer Coop Group	Other
Nyagatare (n=14)	63.6	36.4	23.1	76.9	0.0
Kirehe (n=14)	76.2	23.8	37.5	62.5	0.0
Bugesera (n=14)	55.0	45.0	36.4	63.6	0.0
Rwamagana (n=8)	87.5	12.5	23.1	76.9	0.0
Kayonza (n=15)	57.9	42.1	27.3	63.6	9.1
Gicumbi (n=11)	77.8	22.2	28.6	71.4	0.0
Musanze (n=13)	68.4	31.6	46.2	46.2	7.7
Rulindo (n=4)	73.7	26.3	63.6	36.4	0.0
Nyabihu (n=7)	65.0	35.0	38.5	53.8	7.7
Ruhango (n=9)	81.3	18.8	0.0	100.0	0.0
Nyanza (n=7)	66.7	33.3	33.3	66.7	0.0
Gasabo (n=8)	70.0	30.0	33.3	66.7	0.0
Rusizi (n=10)	68.8	31.3	45.5	54.5	0.0
Nyaruguru (n=18)	73.9	26.1	35.3	64.7	0.0
<b>Total (n=152)</b>	<b>70.0</b>	<b>30.0</b>	<b>33.5</b>	<b>64.8</b>	<b>1.7</b>

*Other include: health based association, association for children care, etc...*

➤ *Household assets and basic facilities*• *Farm Tools*

Only 32.9% have bicycles, 18.4% have motorized water pumps, 8.0% have sprayer, 6.8% have Motorcycle while 3.3% have vehicle and 3.0% have threshers

Table 58 Farm Tools

District	The Farm Tools (%)							
	Bicycle	Motorised Water Pump	Wheel Barrow	Sprayer	Motorcycle	Vehicle	Thresher	Other
Nyagatare (n=20)	19.7	15.2	10.6	10.6	10.6	6.1	4.5	22.7
Kirehe (n=18)	41.9	9.7	3.2	3.2	9.7	0.0	6.5	25.8
Bugesera (n=18)	45.5	30.3	3.0	12.1	3.0	3.0	0.0	3.0
Rwamagana (n=11)	56.3	0.0	12.5	6.3	6.3	6.3	6.3	6.3
Kayonza (n=15)	26.5	8.8	11.8	5.9	5.9	5.9	5.9	29.4
Gicumbi (n=9)	43.8	12.5	12.5	12.5	6.3	0.0	6.3	6.3
Musanze (n=10)	53.3	6.7	20.0	13.3	0.0	6.7	0.0	0.0
Rulindo (n=11)	31.3	31.3	6.3	0.0	12.5	0.0	0.0	18.8
Nyabihu (n=4)	20.0	20.0	20.0	20.0	0.0	0.0	0.0	20.0
Ruhango (n=14)	28.6	42.9	7.1	3.6	10.7	0.0	0.0	7.1
Nyanza (n=14)	26.3	21.1	21.1	15.8	10.5	0.0	0.0	5.3
Gasabo (n=11)	29.2	12.5	20.8	0.0	0.0	8.3	0.0	29.2
Rusizi (n=9)	21.1	36.8	5.3	15.8	5.3	0.0	5.3	10.5
Nyaruguru (n=11)	46.7	6.7	40.0	0.0	0.0	0.0	0.0	6.7
<b>Total (n=175)</b>	<b>32.9</b>	<b>18.4</b>	<b>11.9</b>	<b>8.0</b>	<b>6.8</b>	<b>3.3</b>	<b>3.0</b>	<b>15.7</b>

*Other includes: Tractor, Chaff cutter, Pedal pump (Manual), Tractor plough / Harrow, Generator, Grain mill, Seeder / Weeder, etc*

• *Structures*

Apart of the main house, the results show that the agriculture and livestock infrastructures are still low where livestock shade is dominating with 27.8%. Infrastructures for agriculture produce, water harvesting, etc... are still at low level.

Table 59 Farm House Structures

District	Farm House Structures (%)						
	Main House	Livestock Shade	Grain Store	Water Harvesting Pond	Feed Trough	Water Trough	Other
Nyagatare (n=17)	25.0	22.2	16.7	5.6	2.8	8.3	19.4
Kirehe (n=17)	26.3	26.3	21.1	5.3	2.6	0.0	18.4
Bugesera (n=7)	40.0	26.7	6.7	0.0	0.0	20.0	6.7
Rwamagana (n=8)	46.2	15.4	23.1	7.7	0.0	0.0	7.7
Kayonza (n=14)	13.3	30.0	6.7	0.0	13.3	10.0	26.7
Gicumbi (n=11)	47.4	21.1	10.5	10.5	0.0	0.0	10.5
Musanze (n=9)	33.3	33.3	20.0	13.3	0.0	0.0	0.0
Rulindo (n=8)	33.3	33.3	8.3	8.3	0.0	0.0	16.7
Nyabihu (n=12)	45.0	20.0	5.0	20.0	0.0	5.0	5.0
Ruhango (n=11)	28.6	28.6	23.8	9.5	0.0	0.0	9.5
Nyanza (n=6)	28.6	57.1	0.0	0.0	14.3	0.0	0.0
Gasabo (n=8)	31.3	31.3	6.3	0.0	18.8	12.5	0.0
Rusizi (n=4)	33.3	33.3	0.0	0.0	22.2	0.0	11.1
Nyaruguru (n=11)	53.3	40.0	0.0	0.0	6.7	0.0	0.0
<b>Total (n=144)</b>	<b>32.3</b>	<b>27.8</b>	<b>12.4</b>	<b>6.0</b>	<b>4.9</b>	<b>4.5</b>	<b>12.0</b>

*Other includes: Solar panel, Biogas Digester, Feed stores and Water tank*

➤ *Main Constraints and Opportunity to the Mechanization of the Activities in the Crop and Livestock Value Chains*• *Main Constraints to the Mechanization of the Activities in the Crop Value Chains*

In general, the survey results show that high cost of machines is the main challenge (constraint) followed their availability. Some of farmers said that they even do not know the machine. This survey proves that more efforts should be emphasized on technology awareness such as field demonstration, workshops, etc... in order to increase the level of awareness.

Table 60 Farm Operations in the Crop Value Chains (in %)

Farming Operations	Expensive Machines	Machines are Not Available	Do Not Know the Machinery	Low Purchasing Power	Land Steepness	Other*
Seedling propagation (n=137)	39.1	17.3	15.5	15.5	4.5	8.2
Land preparation (n=235)	25.9	21.2	8.5	13.2	27.8	3.3
Planting (n=157)	23.8	23.8	25.9	16.1	7.7	2.8
Manure application (n=133)	27.1	24.6	28.0	11.0	2.5	6.8
Fertilizer application (n=128)	20.7	31.0	30.2	11.2	2.6	4.3
Weed control (n=130)	24.3	25.2	30.6	13.5	0.9	5.4
Field pesticide application (n=125)	32.1	24.5	20.8	16.0	0.0	6.6
Harvesting (n=149)	19.4	36.6	25.4	13.4	0.7	4.5
Pruning (n=114)	26.3	22.2	34.3	12.1	0.0	5.1
Bagging (n=110)	27.4	22.1	32.6	10.5	0.0	7.4

\*Other constraints include mainly the lack of knowledge and skills, lack of information, lack of spare parts as well as the durability of the machinery.

- *Main Constraints to the Mechanization of the Activities in the Livestock Value Chains*

Mechanization in livestock activities is still a big challenge as shown by results in the table 57. Most of farmers do know that livestock activities can be mechanized. It is clear that more effort should be put on sensitization and mobilization of mechanization in livestock.

Table 61 Main Constraints to Mechanization to Improve Livestock Value Chains (in %)

Livestock activities	Do not know	Not available	Lack of knowledge	Lack of information	Expensive	Low purchasing power
Cattle feeding (n=114)	62.3	9.6	12.3	9.6	4.4	0.9
cattle deworming (n=83)	90.4	6.0	0.0	2.4	0.0	1.2
Cattle tick control (n=91)	79.1	5.5	2.2	0.0	13.2	0.0
Dairy cattle feeding (n=93)	88.2	8.6	1.1	0.0	1.1	1.1
Dairy cattle milking (n=89)	88.8	4.5	0.0	0.0	3.4	3.4
Sheep and goats feeding (n=92)	91.3	5.4	1.1	0.0	1.1	1.1
Sheep and goats deworming (n=86)	90.7	4.7	0.0	1.2	1.2	2.3
Sheep and goats tick control (n=83)	92.8	4.8	0.0	0.0	0.0	2.4
Poultry feeding (n=90)	91.1	4.4	0.0	1.1	2.2	1.1
Poultry Hatchery/ Brooding (n=84)	91.7	4.8	0.0	0.0	2.4	1.2
Poultry Slaughtering (n=84)	92.9	4.8	1.2	0.0	0.0	1.2
Poultry Vaccination (n=84)	91.7	4.8	0.0	0.0	0.0	3.6
Poultry deworming (n=82)	93.9	4.9	0.0	0.0	0.0	1.2
Poultry watering (n=84)	92.9	4.8	1.2	0.0	0.0	1.2
Pig feeding (n=86)	93.0	4.7	0.0	0.0	1.2	1.2
Pig vaccination (n=83)	92.8	4.8	0.0	0.0	1.2	1.2
Pig deworming (n=82)	93.9	4.9	0.0	0.0	0.0	1.2
Pig watering (n=82)	93.9	4.9	0.0	0.0	0.0	1.2

- *Main Proposed Solutions to the Mechanization Constraints in the Crop Value Chains*

For main solutions to mechanization in the crop value chains, availability of machine is most solicited followed by subsidy. The low price of machine is also requested by farmers as well as their capacity building in terms of training on the use of those machines.

Table 62 Main Solutions to Mechanization Constraints in Crop Value Chains (in %)

Farming operations	Subsidy	Availing machinery	Machinery price decrease	Awareness and training on the use of machinery	Other*
Seedling propagation (n=137)	22.0	30.9	17.9	17.9	11.4
Land preparation (n=235)	24.7	31.2	14.0	20.9	9.3
Planting (n=157)	20.5	27.4	13.7	30.1	8.2
Manure application (n=133)	14.0	26.4	14.7	41.1	3.9
Fertilizer application (n=128)	13.1	31.5	18.5	35.4	1.5
Weed control (n=130)	14.3	41.3	23.8	16.7	4.0
Field pesticide application (n=125)	14.0	37.2	24.0	19.8	5.0

Harvesting (n=149)	12.1	42.1	17.9	21.4	6.4
Pruning (n=114)	15.8	33.3	23.3	25.8	1.7
Bagging (n=110)	16.4	30.0	20.9	28.2	4.5

\*Other proposed solutions include mainly the advocacy for credit acquisition, providing support to farmers, availing skilled technicians

• *Main Proposed Solutions to the Mechanization Constraints in the Livestock Value Chains*

Considering the proposed solution from the survey, availing machinery is dominant compare to other solutions, training and demonstration is the second solution. This means that at least farmers have a good level of understanding the importance of mechanizing their activities.

Table 63 Main Solutions to Mechanization Constraints in Livestock Value Chains (in %)

Livestock Activities	Availing Machinery	Sensitization	Training and Demonstration	Subsidy	Price Reduction
Cattle feeding (n=114)	41.8	11.8	33.3	6.5	6.5
cattle deworming (n=83)	51.8	9.8	23.2	7.1	8.0
Cattle tick control (n=91)	48.4	12.1	12.9	6.5	20.2
Dairy cattle feeding (n=93)	63.0	3.9	10.2	15.0	7.9
Dairy cattle milking (n=89)	66.4	0.0	8.8	13.6	11.2
Sheep and goats feeding (n=92)	69.3	0.8	10.2	12.6	7.1
Sheep and goats deworming (n=86)	57.0	0.0	20.7	14.0	8.3
Sheep and goats tick control (n=83)	57.6	1.7	18.6	14.4	7.6
Poultry feeding (n=90)	65.6	3.3	9.0	14.8	7.4
Poultry Hatchery/ Brooding (n=84)	57.6	1.7	18.6	14.4	7.6
Poultry Slaughtering (n=84)	56.7	3.3	18.3	14.2	7.5
Poultry Vaccination (n=84)	56.7	1.7	18.3	14.2	9.2
Poultry deworming (n=82)	57.6	1.7	18.6	14.4	7.6
Poultry watering (n=84)	56.7	2.5	19.2	14.2	7.5
Pig feeding (n=86)	63.3	1.8	11.0	15.6	8.3
Pig vaccination (n=83)	57.1	1.7	18.5	14.3	8.4
Pig deworming (n=82)	57.6	1.7	18.6	14.4	7.6
Pig watering (n=82)	57.6	1.7	18.6	14.4	7.6

#### IV. CONCLUSION AND RECOMMENDATIONS

##### ➤ Conclusion

Considering the challenges and solutions proposed by farmers during this survey, it provided an important opportunity for self-evaluation and for revealing the real picture of agricultural mechanization in Rwanda.

Key constraints identified include:

- High cost of machinery and equipment
- Limited availability of machines on the market
- Lack of information on agricultural machinery
- Low purchasing power among farmers
- Land steepness and difficult terrain
- Limited technical skills and inadequate sensitization
- Weak advocacy for credit acquisition and absence of subsidies
- Unavailability of spare parts
- Limited participation of women and youth in agricultural mechanization

Most of these challenges are already highlighted in Rwanda's existing agricultural mechanization policy, particularly in Chapter 1.3: Challenges, Policy Priorities, and Interventions.

It appears that the main issue is not the absence of policies but rather their effective implementation. Strengthening enforcement and ensuring practical application of the existing strategies remain the critical steps needed to advance agricultural mechanization in Rwanda.

##### ➤ Recommendations

Referring to the existing agricultural mechanization policy, and based on the constraints and solutions identified by farmers, the following actions should be considered to boost the level of agricultural mechanization in Rwanda:

- *Policy Implementation Incentives:*

The Government of Rwanda (GoR) should emphasize effective implementation of the policy by creating incentives to support smallholder farmers.

- *Mechanization Service Provision:*

Strong support should be given to mechanization service providers to ensure smallholder farmers can access these services affordably and reliably.

- *Tax Exemptions and Subsidies:*

Exemptions and subsidies on agricultural machinery should be introduced to increase the number of machines available, both imported and locally purchased.

- *Capacity Building:*

Training and capacity building in agricultural mechanization should be prioritized to develop the skills necessary for sustainable mechanization.

- *Women and Youth Involvement:*

Greater support should be provided to encourage women and youth participation in mechanization service provision, ensuring wider adoption and dissemination of technology across the population.

- Advocacy on credit acquisition is more solicited by farmers in

This survey proved also that more efforts should be emphasized on technology transfer (awareness) such as field demonstration, workshops, etc... in order to increase the level of farmers' awareness on agricultural mechanization.

Collaboration of all stakeholders involved in agriculture sector is most solicited in order to achieve the target and increase the level of agriculture mechanization in Rwanda as well as agriculture productivity in general.

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#### ACRONYMS AND ABBREVIATIONS

- MINAGRI: Ministry of Agriculture and Animal Resources
- MINALOC: Ministry of Local Government
- MINECOFIN: Ministry of Finance and Economic Planning
- RAB: Rwanda Agricultural and Animal Resources Development Board
- RADA: Rwandan Agriculture Development Authority
- VMSC: Village Mechanization Service Centers
- MOU: Memorandum of Understanding
- NISR: National Institute of Statistics of Rwanda
- CIP: Crop Intensification Program

- EDPRS: Economic Development and Poverty Reduction Strategy
- FAO: Food and Agriculture Organization
- FGDs: Focus Group Discussions
- GoR: Government of Rwanda
- KAFACI: Korea-Africa Food and Agriculture Cooperation Initiative
- LUC: Land Use Consolidation
- MDGs: Millennium Development Goals
- NISR: National Institute of Statistics of Rwanda
- PSTA: Strategic Plan for the Transformation of Agriculture
- SPSS: Statistical Package for Social Sciences
- SACCO: Savings and Credit Co-operative
- RCoEAM: Rwanda Centre of Excellence in Agricultural Mechanization

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