



## **Food Systems Analysis in Rulindo District**

**By: EPRN CONSULT CO LTD**

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## Acronyms

BNR:	National Bank of Rwanda
CFSVA:	Comprehensive Food Security and Vulnerability Analysis
CIP:	Crop Intensification Program
DDS:	District Development Strategy
EDPRS:	Economic Development and Poverty Reduction Strategy
EPRN	Economic Policy Research Network
FAO:	Food and Agriculture Organization of the United Nations
FFS:	Farmer Field School
FLRM:	Forest and Landscape Restoration Mechanism
GAP:	Good Agricultural Practices
GDP:	Gross Domestic Product
GoR:	Government of Rwanda
MINAGRI:	Ministry of Agriculture and Animal Resources
MINALOC:	Ministry of Local Government
MINICOM:	Ministry of Trade and Industry
NAP:	National Agricultural Policy
NISR:	National Institute of Statistics of Rwanda
NST1:	National Strategy for Transformation 1
PRSP:	Poverty Reduction Strategy Paper
PSTA:	Rwanda's Strategic Plan for Agriculture Transformation phase
RAB:	Rwanda Agriculture and Animal Resources Development Board
SACCOs:	Savings and Credit Cooperatives

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## Executive Summary

By 2050, the world's population is estimated to have increased by another two billion people, totaling more than nine billion. The population in Rwanda will have doubled from the current 12 million people to 25 million in 2050, with 70 percent living in urban areas. With such an expected exponential urban population increase, the role of Urban Food Systems (UFS) transformation will be critical in achieving sustainable development in both relative and absolute terms. A sustainable food system needs to simultaneously integrate economic, social, and environmental dimensions. The overall goal is to increase agricultural productivity and improve nutrition while enhancing environmental sustainability.

Through a project entitled *"Feeding Urbanization: Building Prosperous Small Cities and Towns,"* The Food and Agriculture Organization of the United Nations (FAO) supports Rulindo district in its efforts to improve livelihoods through sustained food production and by establishing food system linkages of the district with the City of Kigali.

Early 2021, FAO commissioned a Diagnosis Study of the Rulindo's Food System with a specific focus on the rural-urban linkages with the City of Kigali. This study was carried out using the FAO's Rapid Urban Food System Assessment Tool (RUF SAT) as a reference.

As a starting point, a Food Liaison Advisory Group (FLAG) was established made of 20 members including of Government authorities at district level, farmers' cooperatives, processors, aggregators, retailing, restaurants, food services and CSOs. The consultants held two workshops with the FLAG. The FLAG identified urban centers (i.e., aggregations of tens to hundreds of households around weekly markets), making the first market linkages between Rulindo District and other cities, mainly the City of Kigali and Rubavu city. The identified five important urban centers are Base, Rusine, Gasiza, Remera-Mbogo and Shyorongi. The selection was based on economic importance (availability of roads, modern markets, electricity, etc.).

Moreover, the FLAG identified six major value chains of the district (maize, bean, Irish potato, tomato, egg and milk). The value chains were selected because the first three are in the crop intensification program (CIP), whereas the last three were identified as among the most nutritious food.



The study demonstrated the presence of a favorable environment and adequate policies to promote key agricultural commodities production. For example, The CIP has successfully improved high potential crop production, including maize, Irish potatoes and beans. Farmers grouped in cooperatives receive input and seed subsidies, and the Government fixes the minimum farm gate price for each harvest season to protect farmers' pricing interests. At harvest, farmers sell their produce at the farm gate or weekly urban center markets to aggregators who, in turn, supply to Kigali and Rubavu markets. For some commodities like eggs, Rubavu offers a better alternative competitive market because of their proximity to Goma City in the Democratic Republic of Congo. However, the COVID-19 pandemic slowed down various value chain commercial activities due to travel restrictions. Losses are still high in some value chains, particularly the maize value chain with inadequate post-harvest equipment and infrastructure; and the tomato chain with no cold storage facilities and unsatisfactory farm-to-market transport systems.

Another identified issue is that despite the availability of financial institutions and special financial products to enhance agro-business (e.g. micro-financial institutions including SACCOs are available from the Sector level). Farmers remain hesitant to contact financial institutions as they consider them high risky and/or that they will be unable to pay back a loan; instead, they rely on “*tontines*” which are lending and saving groups at the cooperative level.

*Summarized findings from the six value chains, in terms of production, linkage to Kigali market and sustainability issues:*

Maize is planted on hillsides and in marshland for the two-yearly agricultural seasons: Season A, (harvested during December and January), and Season B (harvested during May and June). The production is estimated at 5 – 6 tons/ha. Irrigation is minimal for maize production, and its availability largely depends on location. Maize naturally dries under the husks in drying shelters constructed by the government to support farmers, minimizing aflatoxin contamination-the ideal choice for off-takers and other buyers targeting grade 1 maize. After shelling, up to 70 percent is directly sold to buyers supplying Kigali; the remaining 30 percent is intended for household consumption and/or sold to the local market as whole grain or processed. The price of the 2020 harvest season was fixed at 220 RWF/kg, the minimum a farmer receives for Grade 1 maize. Aflatoxin contamination is a significant challenge for maize value chain farmers. Despite the availability of drying shelters using natural solar drying, farmers cannot achieve the required 13 percent moisture content to keep

maize safe from fungal contamination because of the Rulindo District's climatic characteristics (i.e. humid, and cooler ~19-25°C). During the interviews, farmers said they could only dry up to a 16-17 percent moisture content and are thus paid a low price.

Beans are the primary source of protein for Rwandans. They are consumed at almost every meal since animal protein is unaffordable to many. For farmers, the main reason for engaging in bean production is home consumption. The excess portion is sold to local markets as a source of household cash income. All farmers interviewed for this study said they keep 50-80 percent of their bean production and sell 20-50 percent to aggregators who channel them to Kigali markets. Improved seeds/ fortified bean varieties produce approximately 2 tons/ha. In contrast, unimproved varieties produce 800 kg/ha to 1.5 MT/ha. Fortified bean varieties are in high demand by Kigali market consumers. In 2020/2021, farmers receive 250-400 RWF/Kg during the peak harvest period and 600-1000 RWF/kg during the lean period.

Irish potatoes are planted depending on the season: during the dry season, they are planted in marshlands, and during the rainy season, they are planted on hillsides. The production for one hectare is estimated at 15-25 tons, depending on the season and the varieties are grown. Potatoes are cleaned and packaged in 100 kg polypropylene bags and stored in cooperative warehouses. Approximately 90 percent of the production is then sold to aggregators at the farm gate; the remaining 10 percent is consumed locally (homes, local bars and restaurants). Aggregators transport directly to Kigali markets on trucks. During the five years before the present study, prices changed from 100 RWF/Kg to the current 250 RWF/Kg and expected to increase in the coming years due to increased local and international demand.

Tomatoes are planted on hillsides and in marshland during three agricultural seasons: Seasons A and B with harvests during December and January, and again in May and June, respectively; and Season C during the dry season that spans June through August. Tomato farming produces an estimated 30 tons per hectare. Highly perishable, 25 percent of the harvested tomatoes are damaged or destroyed because of inappropriate transport (the tomatoes are stacked on top of each other in polypropylene bags or traditional baskets, damaging the tomatoes underneath), pests, and lack thereof of cold storage, etc. Sub-standard tomatoes are sold to cooperative members or weekly markets at a lower price. Approximately

60-70 percent of tomatoes are transported in trucks to Kigali and Rubavu markets, whereas bicycles are used to transport tomatoes to weekly markets. The balance is consumed at households and processed into ketchup at SG Enterprise Ltd located at Rulindo. The price of tomatoes at the farm gate varies between 200Rwf-600Rwf/Kg, depending on the season.

Farmers rear mostly crossbreeds (up to 70 percent) with improved milk production (5-12 L/day) compared to local breeds (i.e., Ankole produces 1-2 L/day), thanks to the cattle genetic improvement program for the past twenty years with the introduction of exotic breeds (e.g., Holstein Friesian breeds). The majority of farmers rely principally on a zero-grazing system (a system where the grass is harvested and fed fresh to housed cattle daily) that was introduced countrywide to limit the spread of cattle diseases such as Foot and Mouth Disease (FMD). To avoid milk spoilage where there is no refrigeration, milk is traditionally fermented (locally known as “ikivuguto”) and can last from three to four days. At the MCC, milk is tested for various quality parameters, and if it is not compliant, it is rejected and returned to the farmer, who may sell it at a low price to local food shops or it is consumed at home. MCC's milk in Rulindo is channeled to Burera Milk Processing Plant and Kigali. Mastitis and the presence of aflatoxin M1 (after feed contamination with aflatoxin B1) above the legal limit (0.5 ppb) are the major reasons milk is rejected at MCCs.

Farmers involved in egg production are business-oriented. A typical poultry farm has 1,000 to 5,000 layers per egg production cycle. The Rulindo district offers a competitive advantage in that it is located approximately halfway between the cities of Rubavu and Kigali, and there are ample feed ingredients (e.g., maize) available in the region. AGROTECH Ltd supplies one-day-old chicks, a local company located in Kigali City specializing in agriculture and livestock inputs. The interviewed farmers said they mostly prefer selling their eggs to Rubavu and Goma markets due to competitive prices. The current egg price in July 2021 at the farm gate was 80-85 RWF/egg. The average production cost of one egg is estimated at 75-83 RWF/egg, leaving a net income of 3-10 RWF/egg. Manure is sold directly to local farmers at 1,000 RWF for a 100-kg capacity bag. For a poultry farm of 1,000 hens, approximately 30 bags are removed every two weeks. At the end of the cycle, hens are sold to Rubavu markets at the end of the laying cycle for 2,000-2,500 RWF/hen.

*The consultants also conducted a situation analysis of food security, nutrition, and health in the Rulindo District to understand consumption patterns:*

The objective of the consumer's survey was to understand food security and nutrition patterns and be able to inform future interventions to eradicate stunting and malnutrition through the consumption of a balanced diet. The considered indicators were the consumption pattern (number of meals per day and diversity of plate composition), access to animal source food, type of cooking fuel and nutritional education. Five categories were considered: farmers, residents in urban centers, landless workers, manpowers/"abakarani" and vulnerable elderly persons. Focus Group Discussion approach was used to assess consumption patterns in the Rulindo district among the five categories. More than 16 percent of households in Rulindo District were food-insecure, and more than 19 percent were in extreme poverty and had the highest percentage of extreme-poor residents in the Northern Province correlated with malnutrition and stunting in children under five years (33.8 percent of children under five are stunted). Among the surveyed categories, four categories (farmers, landless workers, abakarani and vulnerable elderly people), have only two less diverse meals per day vs. the category of residents in urban centers. Firewood was the major cooking fuel among interviewed farmers, contributing to deforestation, and thus leading to environmental sustainability issues such as recurrent erosion, flood and landslides observed in Rulindo district and contributing to anthropogenic GHG emissions contribute to global warming.

Based on identified sustainability issues in Rulindo food systems, the following key recommendations should be considered: (1) strengthening the capacity of farmers in cooperatives in GAP, (2) facilitating access to improved seeds and postharvest facilities, (3) adopting climate-smart agricultural practices such as agroforestry, irrigation, organic farming, etc. (4) creating a multi-stakeholder platform for secondary cities to improve enabling environment and unlock more opportunities to sustainability support different food systems actors and (5) strengthen consumer awareness on nutrition aspects and balanced diet.

## 1. Introduction

In 2050, the World's population is estimated to increase by two billion people and reach more than nine billion people. The current population in Rwanda will have more doubled from 12 million citizens to 25 million in 2050, and 70 percent will be living in cities and towns on 1,754 square kilometers (KTpress, 2020). Feeding the world will require an increase in current food production and significantly reducing food losses and wastes (FLW). However, an increase in food production means more land dedicated to agriculture with associated adverse impacts on biodiversity and the environment (McCarthy et al., 2018).

To feed the world population in the next decades, it will be necessary and imperative to radically change the current food systems for a more sustainable and resilient food system. A sustainable food system needs to integrate economic, social, and environmental dimensions simultaneously. It also requires the integration of public and private actors in agriculture, trade, health, environment, gender norms, education, etc. The goal is to increase agricultural productivity, improve nutrition, and enhance environmental sustainability (FAO, 2018).

The Food Agriculture Organization of the United Nations (FAO) has launched the Urban Food Agenda Framework. The agenda is intended for "Leveraging the actions of sub-national and local governments to ensure sustainable food systems and improved nutrition" as a corporate strategy that responds to the demands of a multi-sectoral, multilevel and multi-stakeholder approach to promoting food security and nutrition across the rural-urban continuum. Through the Urban Food Agenda, FAO has recently started to foster prosperity in small cities and towns with an economy based on agriculture and help them cope with population growth even greater than biggest cities over the next few decades.

Rulindo district is one of the districts bordering the City of Kigali (CoK), located in the Northern Province with an area of 567 square kilometers and a population of more than 300,000 (which represents 2.7 percent of the total population of Rwanda). With the same projections mentioned above, in 2050, Rulindo district will double its population and 70 percent will live in small towns. The population growth and rapid urbanization will dictate radical changes and put

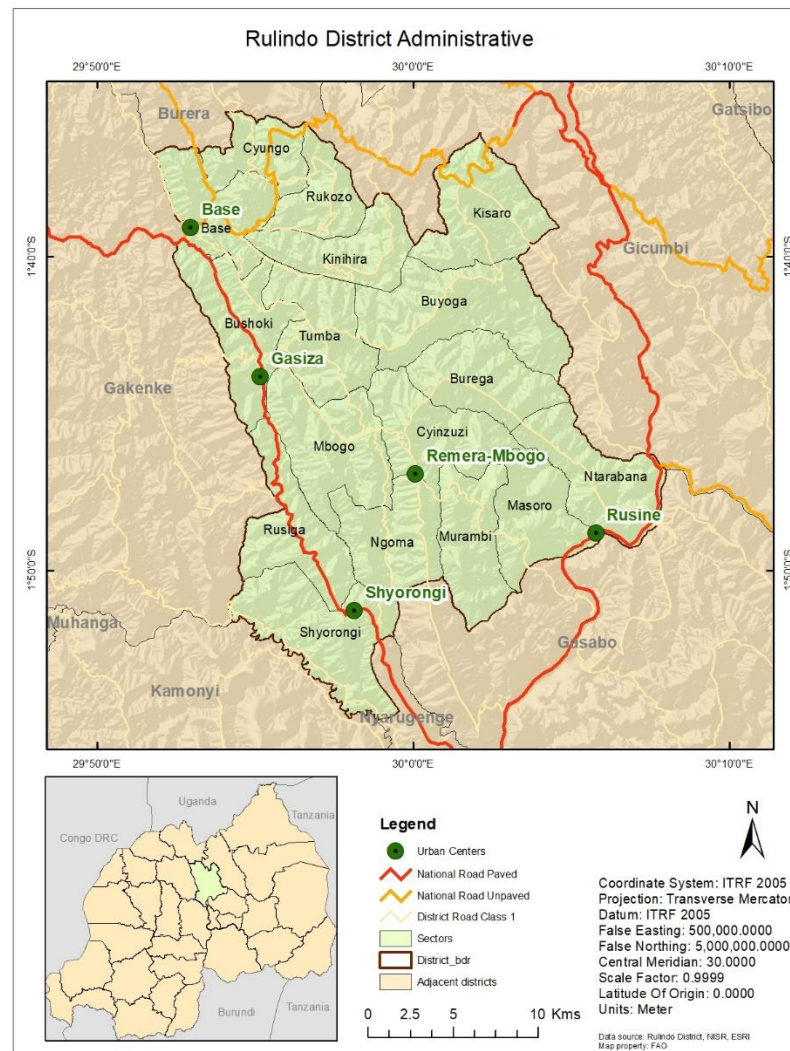
additional stress on food systems; for instance, what foods are grown by producers in the rural and peri-urban areas and how they are traded, processed, distributed and marketed.

FAO has developed a project entitled "Feeding Urbanization: Building Prosperous Small Cities and Towns" (FMM / GLO / 132 / MUL), intending to contribute to the improvement of livelihoods in small cities and towns through sustainable food production, off-farm value-adding operations and services, and well-targeted market linkages. The project will help small cities and towns in the Rulindo district achieve sustainable food systems for the next decades; specifically establishing linkages between the City of Kigali and the Rulindo district.

The present study was conducted to analyze the current situation of food systems in Rulindo district, particularly in its small cities and towns in the context of important commodities value chains highlighted by the Food Liaison Advisory Group (FLAG) – group of stakeholders engaged in the Rulindo food system – namely: maize, beans, Irish potato, vegetables (tomato), milk and eggs with an accent on sustainability issues (social, economic and environmental sustainability). The desk review encompasses available reports at the Rulindo district level, internal reports from different organizations that have carried out different commodities value chain analyses in Rwanda and other relevant information in the grey literature. The literature review serves as background information to assess the identified key value chains through social, economic, and environmental dimensions.

### **1.1. Geographic overview of Rulindo District**

Rulindo District is one of the five districts of the Northern Province and is divided into 17 Sectors, 71 Cells, and 494 Villages (Imidugudu), covering 567 square km surface area. Rulindo lies roughly halfway between the City of Kigali, the capital, and Musanze town (secondary city); and gives a strategic position to be one of the key districts supplying Kigali in different commodities. The district is connected to the City of Kigali (CoK) by a 75.51 km tarmac road and the existing 35 142 unpaved roads (DDS, 2018).



Map 1. Map of the Rulindo District with 17 sectors and 5 identified urban centers

### 1.1.1. Topography and land use

Mountains and hills predominate the Rulindo District relief, up to more than 2,400 m altitudes for Tare, Tumba, and Cyungo hills. Valleys and swamps are interspersed between hills and border rivers: Nyabarongo, Muyanzena, and Nyabugogo rivers. The valleys and swamps, such as Rugezi valley, feed Burera lake and Ntaruka Waterfall in Burera District, are a source of hydraulic energy for the Rulindo district and Rwanda, in general (DDS, 2018).

The agriculture sector dominates the landscape and the economy of the district. Approximately 79.3 percent of landfall is within the cropland category, 16 percent are dedicated to the proportion

of forested land and 4.3 percent for settlements, including houses, roads, infrastructures such as mining grounds and other urban elements (*Figure 1*). Thus, 16 percent of the forest resources are lower than the target set by the country, which aims at 30 percent of forested land (FLRM, 2018).

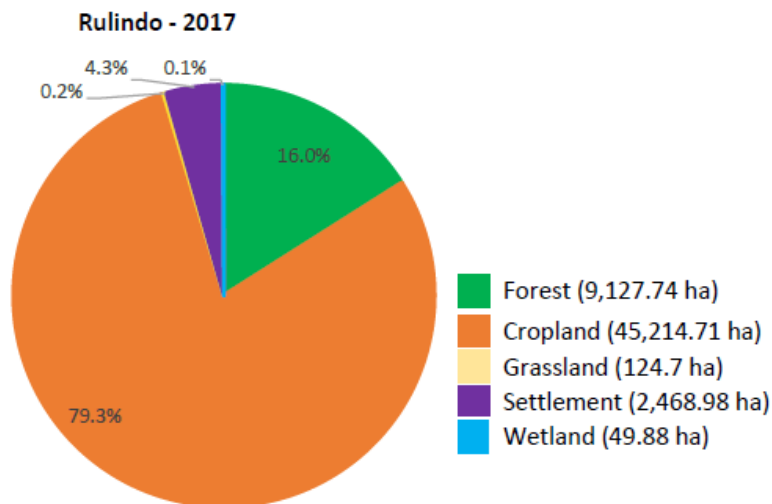


Figure 1. Land use composition of Rulindo District in 2017

### 1.1.2. Climate

Like the rest of the Country, the Rulindo district has a tropical climate characterized by a succession of rainy seasons and droughts. The dry season is from June to August, corresponding to the harvest seasons. There are two agricultural seasons: season A-from September to December; and season B-from February to June. The average annual temperature is 19° C; high temperatures are observed in August, reaching 28°C in the middle of the day. During the rainy seasons, the district encounters concentrations of mists in the valleys in the morning and on the hilltops in the late morning. Rainfall typically reaches 1,243.3 mm per year on average (DSS, 2018).

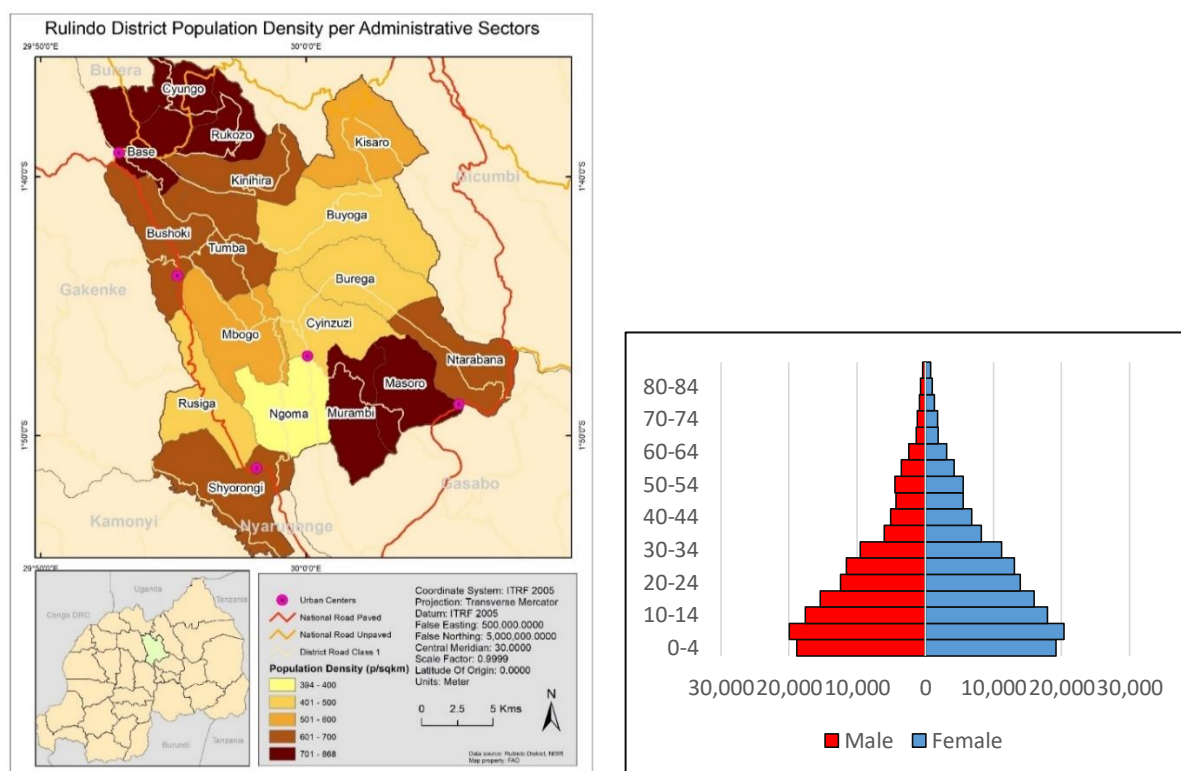
### 1.1.3. Hydrography

Rulindo District has significant water reservoirs from local sources, including rivers with a steady flow into valleys that enable the district to have water even during the dry seasons. The main rivers that flow into the district are Base, Bahimba, Mulindi, Cyonyonyo, Cyohoha, and Rukeri Muyanza (DSS, 2018).



## 1.2. Demographic overview of Rulindo District

According to the fourth population and housing census (2012), Rulindo district has a population of 287,681 with a density of 507 inhabitants per square km. Cyungo, Base, Rukozo, Masoro and Murambi administrative sectors have the highest population density. The population is dominated by females (152,056 population), representing 52.9 percent of the population and 47.1 percent (136 625 population). 97 percent live in rural areas vs. 3 percent in urban areas/commercial centers, known as “urban centers”. Youth dominates the Rulindo population; with 59.6 percent of residents are under 25 years and 60+ years representing 5.9 percent (**Error! Reference source not found.**) (DSS, 2018).



Map 2. Population density per administrative sectors in Rulindo.

Figure 2. Age pyramid of the resident population of Rulindo district in 2012

## 1.3. Overview of the agricultural policy framework in Rwanda

The Government of Rwanda (GoR) has reduced poverty and generated economic growth through various developmental programs over the last 27 years. The Poverty Reduction Strategy Paper (PRSP) was the first national poverty reduction program enacted and covered 2002-2006,

addressing six broad areas identified as *priorities for action* such as rural development and agricultural transformation, among others (MINECOFIN, 2002). Under the PRSP, some signs of progress were registered: extreme poverty was reduced from 40 percent to 35.8 percent from 2001 to 2005, and under-age five mortalities decreased by 30 percent.

A subsequent strategy, the Economic Development and Poverty Reduction Strategy (EDPRS I), followed the PRSP during 2008 through 2012 period to accelerate economic growth, create employment, and generate exports. As a result, economic growth accelerated and averaged 8.2 percent from <5 percent, and poverty was reduced from 56.7 percent to 44.9 percent, with more than 1 million Rwandans lifted out of poverty (GoR, 2013). EDPRS II was developed next. It covered the period of 2013-2018 and made agriculture more productive and sustainable, engaging the vast majority of the population and producing a sustainable poverty reduction.

Similarly, the National Agricultural Policy (NAP) was developed in 2018, aligning with Rwanda's Strategic Plan for Agriculture Transformation phase (PSTA 4). It was a strategic plan to transform the agricultural sector over a 7-year period (2018-2024) to generate a knowledge-based value agricultural sector that could contribute to the national economy and simultaneously ensure food and nutrition security through a food systems approach.

The combined efforts mentioned above yielded an agricultural sector that has become a backbone of Rwanda's economic activity, with 70 percent of the working population employed in agriculture and accounting for 33 percent of the national Gross Domestic Product (GDP) (FAO, 2021). Food crops represent the dominant sub-sector, accounting for 54 percent of the sector's GDP contribution, followed by Forestry (21 percent), Livestock (14 percent), Traditional Export Crops (7 percent), and Fishery (1 percent) (NISR, 2019).

In 2007, the Crop Intensification Program (CIP) policy boosted the agricultural production of high potential crops through improved productive input, irrigation coverage, and soil quality. Preliminary priority crops included maize, cassava, beans, and potatoes (Musabyimana and Tran, 2020). The CIP's success has resulted in increased agriculture production, especially cereals. According to World Bank data, cereal production increased three-fold during the 2007 to 2013 period, from 350,000 to 930,000 metric tons, respectively (World Bank, 2021).

The Government of Rwanda has enabled the environment for the private sector to work hand in hand with farmers, with the target to ensure food security for all Rwandans and transform the agricultural sector from a subsistent to a market-oriented sector.

The *Twigire Muhinzi* extension model is decentralized and implemented by Rwanda Agriculture Board (RAB) under the direct responsibility of the Ministry of Agriculture and Animal Resources (MINAGRI), in close collaboration with Districts and Sectors, which are under the supervision of the Ministry of Local Government (MINALOC). Through the *Twigire Muhinzi* extension model, farmers receive training on "Good Agricultural Practices" (GAP) directly used in the field. They are often used in combination with agricultural inputs to achieve a maximum increase in crop productivity (Wennink and Mur, 2016). "*Twigire Muhinzi*" is widely used and implemented in all districts.

The *Twigire Muhinzi* extension model brings together two agricultural extension approaches – the Farmer Promoters' and farmer field school (FFS) approaches. Farmer Promoters mobilize farmers and train them using demonstration plots in each village. Each village identifies one Farmer Promoter through a participatory exercise based on criteria which were developed in a participatory focus group where farmers are then organized into *Twigire* groups. In the same line, Farmer Promoters, in collaboration with extension agents at District and Sector level, also mobilize farmers to consolidate land, plant in time and receive government subsidies such as improved seeds, pesticides, and fertilizers. At least, farmers in *Twigire* groups in the village meet three times at demonstration plots under the farmer promoters' supervision who initially received GAP training.

To modernize the agricultural sector, farmers face challenges accessing financial services because of the risky nature of their activities. For the few that manage to secure funding, the interest rate is often high (Newtimes, 2019). For instance, from 2014 to 2018, 6.15 percent of the total loans were dedicated to the agricultural sector, while the sector contributes to a third of the national GDP and employs more than 70 percent. In Rwanda, there are different financial institutions encompassing 504 institutions, including 17 banks (i.e. 11 commercial banks, 4 microfinance banks, 1 cooperative bank and 1 development bank), 16 insurance companies, 470 microfinance

institutions (i.e. 19 limited liability companies, and 451 Savings and Credit Cooperatives (SACCOs); of which 416 are *Umurenge SACCOs*); and one pension fund (BNR, 2018).

To guarantee access to finance for smallholders because of the risky nature of agriculture, MINAGRI has launched the National Agriculture Insurance Scheme (NAIS) to mitigate risks and losses incurred by farmers due to unpredictable natural disasters, pests, and diseases. The scheme is also expected to enable farmers to easily access financial services and ensure the flow of credit to the agriculture sector. The Government of Rwanda subsidizes up to 40 percent of the insurance scheme. Rulindo district is part of the initial pilot phase. Three insurance companies (SONARWA, PRIME, and Radiant) are implementing the NAIS (MINAGRI, 2019).

In the Rulindo district, 100 ha maize was insured during the 2021-season A under the national agriculture insurance scheme. The scheme also insured Irish potatoes on 16 ha, chili on 258 ha, 721 cows, 15,300 poultry, and 421 pigs (Rulindo District report, 2020).

## **1.4. Context of food systems**

### **1.4.1. The situation of food security, nutrition and health**

Despite significant progress over the past two decades, Rwanda, in general, is still facing a high level of stunting among children under the age of five. According to the 2018 Comprehensive Food Security and Vulnerability Analysis (CFSVA), the stunting rate was estimated at 35 percent, while the wasting was 2 percent. Factors associated with higher rates of stunting included living in the lowest wealth quintile, having a mother with limited education, who did not take sufficient quantities of food during the pregnancy, or did not consume a diverse diet during pregnancy, not consuming animal proteins, or not drinking treated water, presence of a family garden or if they owned livestock among others (Nyiraneza et al., 2019; Weatherspoon et al., 2019; Binagwaho et al., 2020).

Previously, it was estimated that the effects of hunger and malnutrition cost Rwanda approximately US \$820 million (504 billion Rwanda francs) annually – the equivalent of 11.5 percent of its annual GDP (Umuseke, 2014).

The Comprehensive Food Security and Vulnerability and Nutrition Analysis Survey (CFSVA) report in 2018 showed that in the Rulindo district, 16.6 percent of households were food-insecure (Table 1). Compared with other districts in Northern Province, Rulindo district has the highest percentage of extreme-poor residents correlated with malnutrition and stunting in children under five years (Figure 3). The stunting rate was estimated at 33.8 percent in children under five years (CFSVA, 2018).

In the same observation, the United Nations Children's Fund (UNICEF) estimates that 57 percent of the population in Rwanda have access to safe drinking water that is within 30 minutes of their home, and the water is often not safe to drink, with direct consequences, especially for children suffering from water-borne diseases with the risk of severe illness (UNICEF, 2021).

In addition to the food insecurity challenge, food safety is one of the major concerns threatening fragile food security. The most highlighted example is the recurrent aflatoxins contamination in different commodities – especially grains such maize sorghum – countrywide and with ravaging consequences (Nishimwe et al., 2017, Niyibituronsa et al., 2020, Collins et al., 2021, Grosshagauer et al., 2020). Aflatoxins are secondary metabolites produced by fungi *Aspergillus* fungus and toxic to humans and animals. They are known to cause liver cancer and are associated with stunting, immunosuppression, etc. The lack of inadequate drying and post-harvest equipment and infrastructure at the farm level favors the development of *A. flavus* in grains, therefore the aflatoxin accumulation in grains, exposing consumers to their consequences.

Table 1. Percentage and number of food secure and food insecure households in Rulindo district (CFSVA 2018).

	<b>Food secure</b>	<b>Marginally food secure</b>	<b>Moderately food insecure</b>	<b>Severely food insecure</b>	<b>Total food insecure</b>
Percentage	40.5	42.9	16.0	0.5	16.6
Households	31,482	33,380	12,527	397	12,923

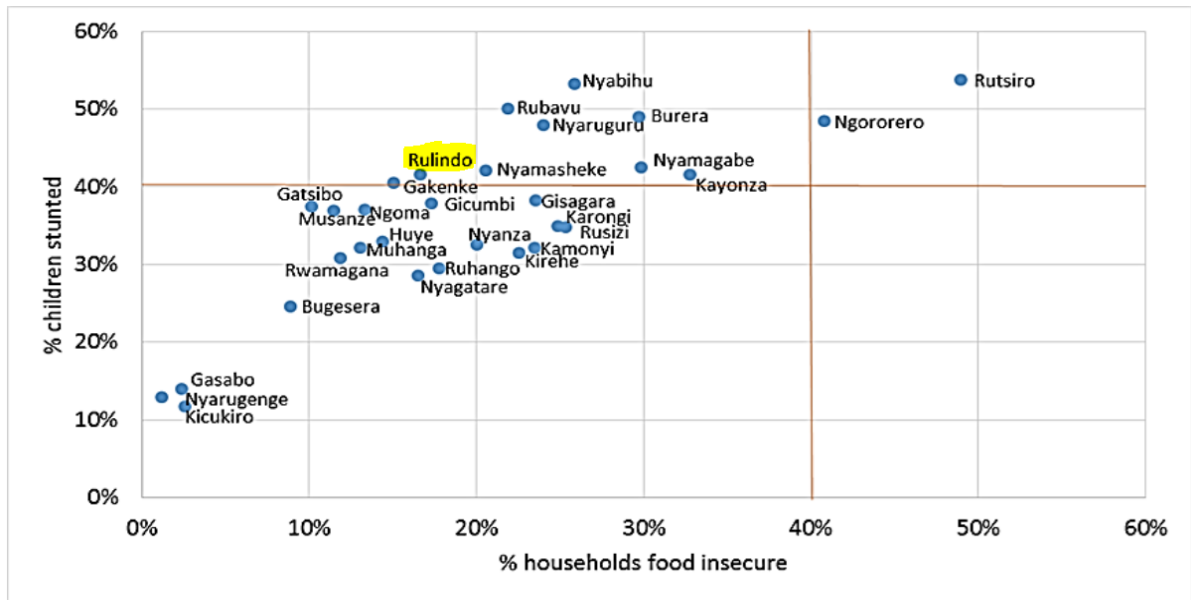


Figure 3. Convergence of food insecurity and malnutrition by district (CFSVA, 2018)

## 1.4.2. Sustainable land husbandry and crop production in Rulindo district

### 1.4.2.1. Land use consolidation

In line with the CIP policy discussed above, the land use consolidation policy has been introduced to cut the effects of land fragmentation by increasing the scale of agricultural yields and stimulating a transformation to a competitive and market-oriented agricultural sector. The policy also aims to promote more productive use of land resources by facilitating the implementation of soil and water conservation practices, increasing agriculture inputs use, and improving the opportunities for agriculture investments (MINAGRI, 2018).

In the Rulindo district, only the percentage under consolidation was 11.1 percent (vs. 15.9 percent national status). Maize, beans, and Irish potato were the three key priority crops produced in the Rulindo District during the 2020 – season A under the land use consideration with 26 492; 54 956, and 29 324 tons, respectively (*Table 2*) (District Report, 2020).

Table 2. Major crops cultivated in Rulindo district during the 2020 season A (Authors)

Crop	Planting area (ha)	Production in season A (MT)
Maize	6,271	26,492
Beans	18,559	54,956
Irish potato	1,128	29,324

#### 1.4.2.2. Soil preservation

The hilly aspect of the land in Rulindo District predominates and is a challenge to agricultural production. Around 22 percent of the land is located on a flat to the slight slope (0-5°), 68 percent on the moderate slope (6-15°) and 10 percent on a steep slope (16-30°). This directly affects agricultural production and food security because of recurrent erosion in the Rulindo District (FLRM, 2018). Terracing systems were introduced and used to grow crops on steep slopes while trying to preserve the soil from erosion. So far, the percentage of land protected against soil is 87.8 percent (vs. 68.5 percent) (DDS, 2018). It was estimated that 26.1 percent (11 821.17 ha) of croplands are under the terracing cultivation method. The majority (73 percent) is on a moderate slope, 20 percent on a flat to slight slope and 7 percent on a steep slope. The remaining cropland, 33 393.55 hectares, is not using terracing methods, though 67 percent are located on a moderate slope and 10 percent are on steep slopes (Table 3) (FLRM, 2018).

Soil preservation is a top Government priority to preserve soil fertility management and soil erosion control with a budget allocated for every fiscal year (FY). For instance, during the 2019-2020 FY, 5 147.5 ha of radical terraces and 14 088.6 ha of progressive terraces have been developed. This has resulted in 127 339.7 Ha under radical terraces and 958 777 hectares under advanced terraces (MINAGRI, 2020).

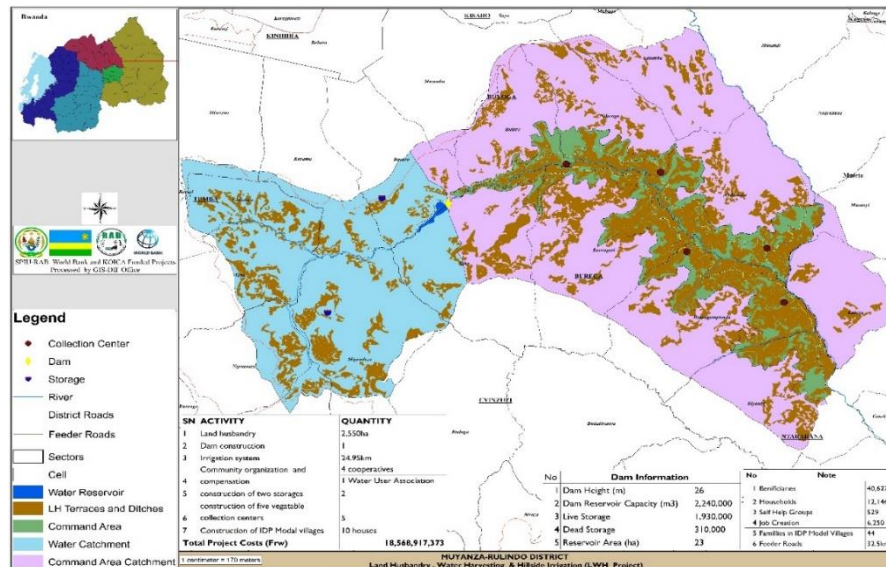
Table 3. Cropland utilization between terrace and non-terrace in Rulindo district (FLRM, 2018)

Total estimated cropland (ha) in Rulindo					
45,214.71					
Terrace (ha)			Non-Terrace (ha)		
11,821.17			33,393.55		
0-5 ° slope	6-15 °	16-30 °	0-5 °	6-15 °	16-30 °
2,394.16	8,579.07	847.93	7,506.69	22,495.13	3,391.73
% terraced cropland			% non-terraced cropland		
20%	73%	7%	22%	67%	10%
% total cropland			% total cropland		
5%	19%	2%	17%	50%	8%
Average number of trees per hectare					
24.72	29.8	41.04	26.16	33.36	38.32

### 1.4.2.3. Irrigation

The Government of Rwanda initiated marshlands, hillside, and small-scale irrigation projects to increase land under irrigation towards achieving NST1 discussed previously to increase agriculture production by reducing dependency on rain-fed agriculture.

The Rulindo District has achieved 3.1 percent of land under irrigation (vs. 6 percent national status) (DDS, 2018) and the percentage keeps increasing. In collaboration with FAO, the district has received its first solar-powered irrigation system through the project implementation: "Knowing water better: towards a fairer and more sustainable access to natural resources - KnoWat" with the financial support from the German Federal Ministry of Food and Agriculture. The project collaborates with the Rulindo district authorities and communities for better water allocation and use. Three ENOS/Sunlight solar pumps and accessories have been offered to farmers grouped under the Yanze Horticulture Production Cooperative (YAHOPROC) of vegetable growers in the Yanze catchment. The cooperative was formed in 2015, with 199 members – 131 women and 68 men and they sell most of their produce to Kigali city buyers (FAO,2020).



Map 2. Muyanza scheme map (Rainfed and Command area)

To increase agricultural production, Rulindo District - with partners - has invested in water harvesting infrastructure, including water reservoirs construction and water conveyance at the



Muyanza site to enhance irrigated agriculture (Map 2). Muyanza site involves six sectors, Burera, Mbogo, Tumba, Buyoga, Cyinzuzi, and Ntarabana, with total treated equivalent to a gross area of 2550 ha including 1450 ha of Rainfed area and 1100 ha for Command area.

The site is also equipped with irrigation infrastructures, including a Dam with 2 300 000 m<sup>3</sup> of Capacity and an Irrigation system of 24.95 km. The site also has post-harvest infrastructures composed of two medium storage and five collection centers with cooling rooms. The total net area is 1643 ha, including 988 ha on rainfed and 655 ha in the command area. More than 12 000 households grouped in four cooperatives directly benefit from the construction of the Muyanza site. Main crops cultivated in the site include horticultural crops and fruits for local and international markets, Maize, Beans and Irish potatoes (District internal report).

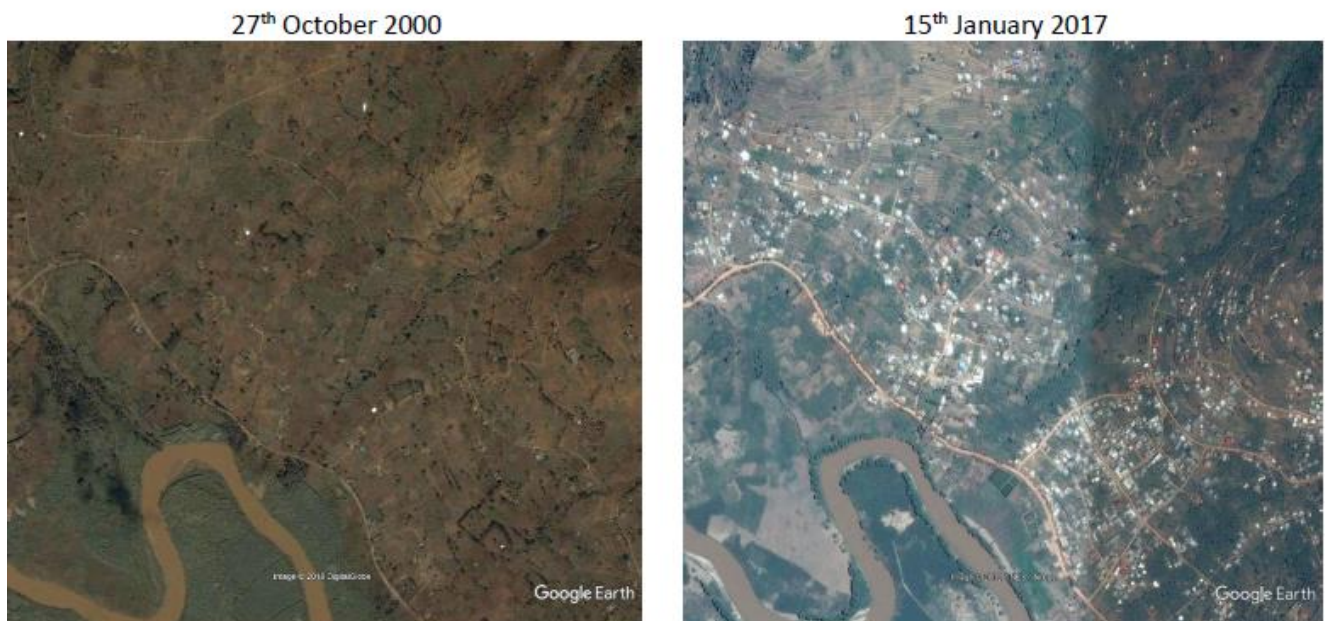
#### **1.4.2.4. Environment sustainability**

To sustainably manage forest resources and improve soil conservation, Rwanda has adopted a National Forestry Policy that ensures that present forest cover is well managed and will increase to 30 percent of the country's total area by 2020. This is to be contributed to by the districts through the implementation of robust measures aimed at planting more trees and maintaining the existing ones. In this line, Rulindo has identified the scaling up of tree planting in the district and the proper maintenance of the existing forests as strategies to be undertaken to fight soil erosion and climatic changes. In 2018, the forest area was estimated at 9 128 ha (i.e. 16 percent of Rulindo's area) – mainly composed of *Eucalyptus* - which still falls short of the 30 percent national target. Increasing trees in cropland is a way to directly lift farmers out of poverty and restore the land by improving yields, diversifying species, preventing soil erosion and land degradation. However, on average, one hectare of cropland in the Rulindo District comprises 31.9 trees. Settlement and the use of wood for cooking are the major challenges to the forest development in the Rulindo district (FLRM, 2018). However, *Eucalyptus* alone cannot guarantee environmental sustainability. There is a need to diversify tree species, including indigenous trees, and integrate the agroforestry concept. This concept uses tree species with minimal competition with crops and increases soil fertility and productivity in general.

#### **1.4.2.5. Key challenges to urban food system sustainability in Rulindo**

Key challenges to urban food system sustainability in the Rulindo district lie in settlement management. The settlement covers more than 4 percent of the land use in the Rulindo district. However, the settlement land has drastically increased in the last 20 years: in 2000, the settlement covered 673 ha, and the settlement land was 2 469 ha in 2017 (Picture 1). The main changes happened in cropland and the highest conversions from cropland to settlement (FLRM, 2018). With the 2050 horizon, it was estimated that the population in Rwanda would have more doubled from 12 million citizens to 25 million in 2050, and 70 percent will be living in cities and towns, which will have a significant impact on the Rulindo district (KTpress, 2020).

For this, Rulindo has an objective to accelerate sustainable urbanization from 18.4 percent of urbanization in 2017/18 to 35 percent by 2024 through promoting infrastructure development and enforcement of masterplans and servicing of settlement sites and construction of roads (DDS, 2018). The population growth and rapid urbanization will dictate radical changes and put additional stress on food systems; for instance, what foods are grown by producers in the rural and peri-urban areas and how they are traded, processed, distributed, and marketed.



Picture 1. Satellites imageries taken in the Shyorongi sector depicting conversion from cropland in 2000 to settlements in 2017 (FLRM, 2018)

## **2. Methodology**

### **2.1. Research approach**

Diagnosis of the Rulindo's Food System with a specific focus on the rural-urban linkages with the city of Kigali was carried out using the FAO's Rapid Urban Food System Assessment Tool (RUF SAT) as a reference. The TUF SAT was adjusted to match the realities on ground associated with COVID-19 preventive measures.

### **2.2. Preparatory work with the Rulindo district officials**

A number of meetings were held with the Rulindo district officials, including Vice-Mayor in charge of finance and economic development, Vice-mayor in charge of social affairs, Director of Agriculture and FAO officer and authorities of the administrative sectors of the district. The objective of these meetings was to inform the district officials and provide coordination support on activities to be undertaken, identification of FLAG members and Key Informant for interviews, obtaining relevant data, and other district publications related to food systems.

### **2.3. Establishment and collaboration with the FLAG**

The identification of Food Liaison Advisory Group (FLAG) members consisted of listing key stakeholders involved in food systems in Rulindo District. FLAG members included representatives from the private sector, Non-Government Organizations (NGOs) associated with food systems, representatives of different aspects of the food system – production (representatives of farmers' cooperatives), processing, distribution, retailing, restaurants, and food services. The consultants worked with FLAG to provide key information on situation of food systems in Rulindo, validate and enrich findings of the preliminary assessment of pressing issues and validation of field findings.

### **2.4. Data collection and analysis of identified key value chains in the Rulindo District with market linkage to City of Kigali**

Data on identified key value chains and their performance from the three sustainability dimensions were collected using RUF SAT qualitative research survey tools. The survey targeted different stakeholders involved in a different segment of value chains in the Rulindo district: farmers, aggregators and processors. Focus group discussion (FGD) was used for farmers in

different cooperatives identified upstream in collaboration with the Rulindo district. Farmers in cooperatives for each identified value chain were gathered and helped different answer questions of the survey tools. During the discussions, farmers provided insights into different sustainability issues along the identified value chains.

FGDs were conducted rigorously to ensure sufficient information that could be triangulated between cooperatives, aggregators, processors, and key informants at the District level to have a broad picture of food systems in the Rulindo district. Additional interviews were made individually to cooperative representatives to cross-check and complete data from FGDs.

## **2.5. Consumer's survey**

The objective of the consumer's survey was to understand food security and nutrition patterns and be able to inform future interventions in addition to current existing efforts to eradicate stunting and malnutrition through the consumption of a balanced diet. The considered indicators were the consumption pattern (number of meals per day and diversity of plate composition), access to animal source food, type of cooking fuel, and nutritional education. Five categories were considered: farmers, residents in urban centers, landless workers, "abakarani" and vulnerable elderly. FGD approach was used to assess consumption patterns in the Rulindo district among the five categories.

## **2.6. Limitations**

The study met some limitations linked with the current COVID-19 pandemic whereby some appointments with key targeted respondents (both farmers and some interviewees) were cancelled or postponed many times affecting the study timeline. Number of accessed respondents also was affected by the pandemic as few persons were allowed to meet at a time.

### **3. Situational Analysis of key value chains in Rulindo district**

#### **3.1. Selection of Value Chains and their importance for Rulindo district**

The Food Liaison Advisory Group (FLAG) platform identified six major value chains of the district: maize, bean, Irish potato, tomato, egg, and milk. The value chains were selected because the first three (maize, bean and Irish potato) are in the crop intensification program (CIP) for the Rulindo district. In contrast, the last three were identified as among the most nutritious food important for the Rulindo district.

District farmers are grouped into a cooperative, operating mainly on a size less than 1-hectare varying in size from 0.2 to 1 Ha and more than 95 percent of farmers are in cooperatives to benefit from the Government subsidies. According to the Rulindo district - Director of Agriculture, there are three major cooperatives in the Rulindo district, namely COMIXBU, KOYAKIRU, and COVAMABA, located in Kisaro, Cyungo, and Mukoto, respectively. The small land size for each small-scale farmer is a direct consequence of parceling land over time to accommodate offspring inheritance. Most Rulindo district farmers use multi- and intercropping systems, planting multiple crops in a given piece of land during a single growing season combined with livestock farming, including dairy cows, backyard poultry birds and goats.

Traditionally, farmers primarily grow crops for household consumption and sell the surplus to weekly local markets. However, the situation has changed with the new agricultural policies – such as CIP – aiming to boost the agricultural sector and transform it into a market-oriented sector since the sector contributes to a third of the national GDP and employs more than 70 percent.

#### **3.2. Characterization of value chains**

##### **3.2.1. Maize value chain**

Thanks to the CIP program, maize production in Rwanda has increased by 59 percent over 2013 to 2020, accompanied by an 83 percent increase of cultivated area for maize. However, the maize yield did not follow the same trend during the same period and oscillated in the range of 1,500 to 1,800 Kg/Ha. The cultivated area for maize during season A 2021 was estimated at

236,642 Ha. This is a seven percent increase when compared to 2020 season A. The total production was estimated at 378,641 MT, an increase of 7 percent compared to 2020 season A. The maize production in the Rulindo district was 4,164 Ha representing 1.76 percent of the national production, with an average of 1.5 MT/Ha (vs. 1.6 MT/Ha country status) (NISR, 2021).

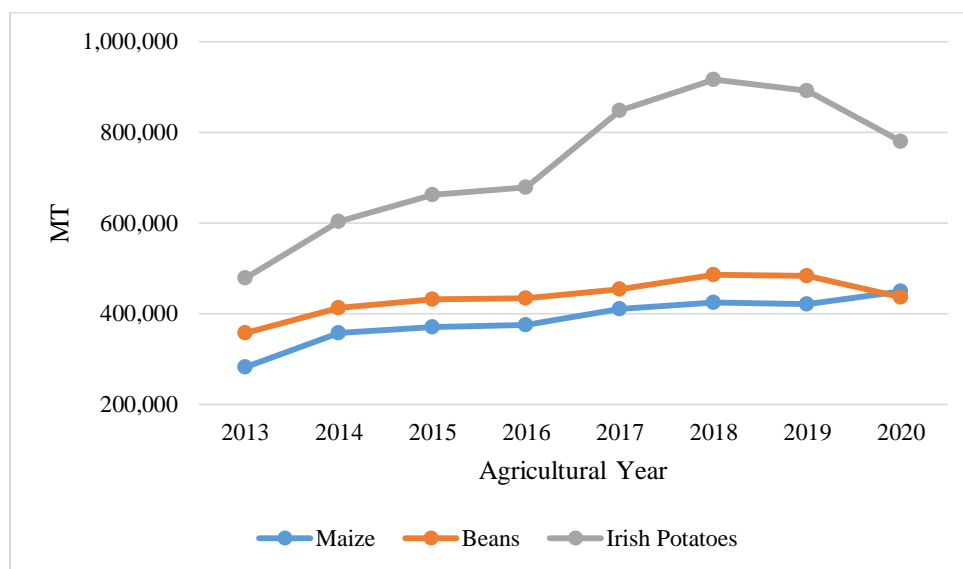


Figure 3. Production (in MT) for major crops in CIP throughout 2013 to 2020 (NISR reports)

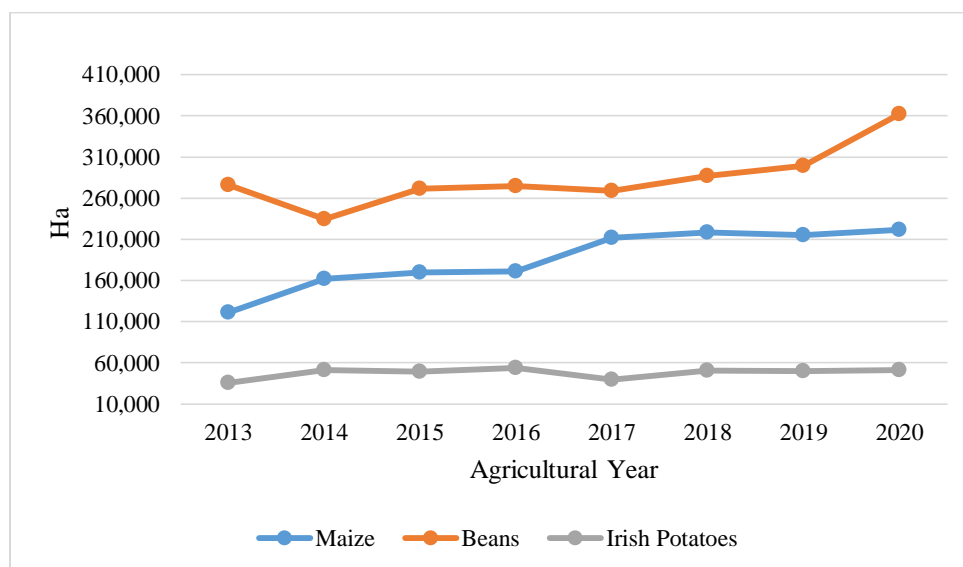


Figure 4. Cultivated area for major crops during the agricultural season A throughout 2013 to 2020 (NISR reports)

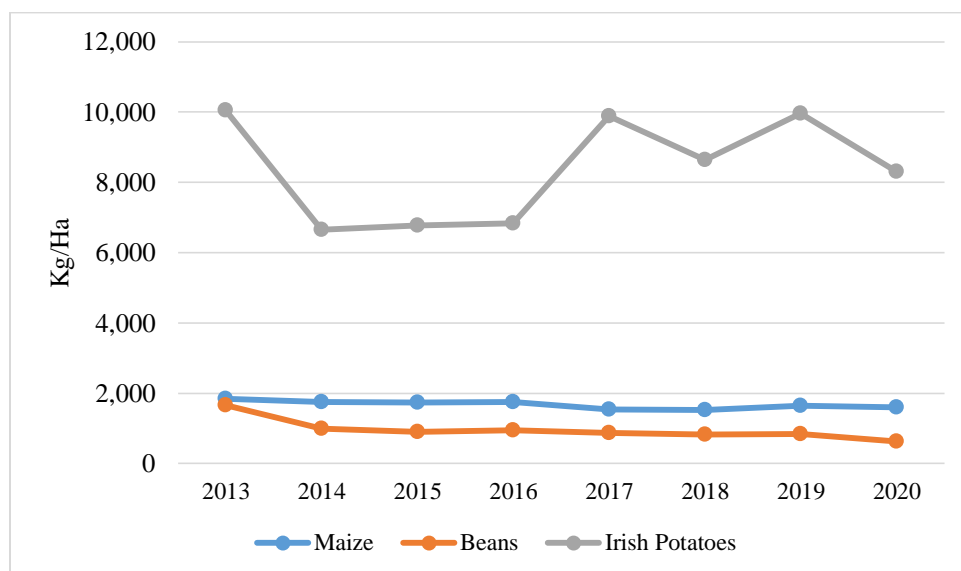


Figure 5. Yield for major crops (kg/Ha) throughout 2013 to 2020 (NISR reports)

The maize value chain has received massive public support at all levels with the implementation of the CIP program, which helped to increase the national maize production by over 59 percent from 2013 to 2020 (Figure ). However, the maize production increase was associated with unanticipated postharvest losses at the farm level because of a lack of (or inadequate) appropriate technology for drying and storage. Postharvest losses are characterized by insect infestations and mycotoxin contamination and result in high rejections during the sale, therefore high losses for farmers.

In addition to subsidized inputs that include fertilizers, seeds, and insurance programs, the government has constructed drying shelters to help farmers cope with drying challenges and recurrent aflatoxin contamination and provided postharvest handling training for farmers. These efforts have boosted maize production in general and have made it the farmers' preferred crop with more private sector involvement. For instance, African Improved Food (AIF) is a sixty-five-million-dollar public-private investment that has been operational since December 2016 to leverage and add value to small-scale farmer production, especially in the maize value chain.

In 2021, more than 61 percent of farmers were estimated to use improved seeds (NSIR,2021). **Farmers receive seeds from seed multipliers certified by RAB, agro-dealers**

**and NGOs operating in the district, and inputs (fertilizers and pesticides) from local agro-dealers located in the Rulindo district. However, farmers are still challenged by the unreliable and timely availability of seeds to farmers and the high cost of inputs.**

After harvest, maize naturally dries under the husks in drying shelters constructed by the government to support farmers, and sell their production immediately to main buyers, AIF and East Africa Exchange (EAX), to reduce aflatoxin contamination-the ideal choice for off-takers and other buyers targeting Grade 1 maize (clean and well-dried maize grains) vs. the storage at the farm causing high aflatoxin contamination. At the farm gate, maize is first analyzed for Grade 1 (i.e., aflatoxin levels, insects, foreign matters) and gets rejected if aflatoxin levels exceed the maximum limit of 10 mg/kg.

Cooperatives sign pre-harvest contracts with large buyers who purchase all the maize a cooperative produce. For each season, the minimum farm gate price is determined by RAB, MINICOM, Rwanda Cooperative Agency (RCA), and PSF. The two main buyers named by farmers in the discussion group are AIF which is one of the largest millers in the country, and EAX. After shelling, up to 70 percent is directly sold to buyers and channeled to Kigali for further processing; the remaining 30 percent is intended for household consumption and/or sold to local millers and other urban center aggregators and/or used for home consumption.

### **3.2.2. Irish potato value chain**

Irish potato is one of the most cultivated crops in Rwanda, mainly in the Northern province (i.e., Rubavu, Musanze, Nyabihu, Rulindo, and Burera districts) because of the rich and fertile volcanic soil. It is also one of the Government's six priority crops under the CIP program discussed previously, which resulted in the increase of Irish potato and made Rwanda the 6<sup>th</sup> largest producer in the Eastern region (FAO, 2021).

The Irish potato production increased over 300,000 tons from 2013 to 2020 (Figure ), with a slight increase of 45 percent of the cultivated area during the agricultural season A (Figure ). However, the yield did not increase and varied in the range of 8 to 10 tons over the same period (Figure ). The total cultivated area for Irish potatoes was estimated to be 52,196 ha, a slight increase of 1% compared to 2020 season A estimates. The production was estimated at 463,562



MT, an increase of 8% compared to 2020 season A. In the Rulindo district, during the 2020-harvest seasons, 29 324 MT was produced on the area of 1 983 ha (District Internal Report). Rwanda is a major net exporter of Irish potatoes, mainly to DR Congo and Burundi. The export production increased from 11 387 tons in 2012/13 (NISR, 2013) to 15 616 tons in 2018/2019 (NISR, 2019).

The seed supply chain is still facing ineffective seeds and the qualification of seed multipliers. For instance, the current production of Irish potato is estimated at 8 - 10 tons/ha vs. the expected 30 tons/ha attributed to ineffective seeds. RAB registers seed multipliers for operating, but they are still few to satisfy the growing demand. Rwanda needs about 35 000 tons of quality potato seeds to cover 25 percent of total cultivated land in each growing season (Newtimes, 2020).

Irish potato is predominantly cultivated in the Northern provinces (high altitude and fertile volcanic soils). The production in the Northern province accounts for 90 percent of the national production. Most Irish potato producers grow one crop per year in rotation with maize, beans, and peas, while the best practice is to grow one crop every two to three years to reduce disease pressure (BMC, 2014).

In the growing regions (mostly Northern and Western Provinces), farmers sell their produce through cooperatives to aggregators on an average farm gate price ranging from 80 RWF to 180 RWF per kilo depending on variety, season, seasonal yield, and demand-supply dynamics on the market. The farm gate price is negotiated for each harvest season between farmers' cooperatives, local governance, traders, and RAB. Aggregators and traders sell collected potatoes to wholesale/retail markets and finally to the end consumer across the country but mainly to Kigali markets with strong linkages for regional exports to neighboring countries. Fertilizers and pesticides are commonly used in fields to combat pests and plant diseases in fields.

The production depends on the season and the varieties grown, and agricultural practices. For the latter, low rainfall, and the absence of an adequate irrigation system to cope with the

drought, heavy rains associated with landslides, and in some areas, high acid levels are among causes of production loss and low yield.

At harvest, potatoes are cleaned and packaged in 100-kg polypropylene bags and stored in cooperative warehouses. **Approximately 90 percent of the production is then sold to aggregators at the farm gate; the remaining 10 percent is sold to neighbors in the same district (Rulindo) and/or used for home consumption.**



Picture 2. Track loading of Irish potato from Rulindo to Kigali

Aggregators in turn either sell the potatoes to big buyers associated with local markets in urban centers or transport them directly to Kigali markets on trucks. It is worth highlighting that the processing industry is still in its nascent form with a non-practical addition of value after harvest.

### 3.2.3. Bean value chain

Beans are the main staple food and a major protein, iron, and calories for Rwanda's population. They are consumed at each meal since animal protein is unavailable to many. For farmers, the main reason for engaging in bean production is for home consumption. The balance portion is sold to local markets as a source of household cash income. Farmers in three visited cooperatives interviewed for this study said they keep 50-80 percent of their bean production and sell 20-50 percent to aggregators at local markets. Common bean (*Phaseolus vulgaris*) is the most important pulse, with an increase of production of 22 percent (Figure ) and an increase of

the cultivated area of 31 percent (Figure ) during the period of 2013 to 2020. However, the increase in production and cultivated area was not associated with the yield increase capping in the 600 – 1,000 kg/Ha (Figure ).

In the Rulindo district, more than 54 000 MT cultivated on 34 780 ha were produced during the 2020-harvest seasons (District internal report). There are two different types of beans: climbing varieties and bush beans grown across the country in both cropping seasons (season A and season B), mainly in the Northern region of Rwanda (mainly Gicumbi, Burera, Gakenke and Rulindo districts) (DDS, 2018).



Picture 2. Climbing Bean farm at KOYAKIRU Cooperative, Rulindo District

Beans are mainly produced under the land-use consolidation schemes under the farmers' cooperatives, with many farmers operating individually. The main final and commercialized product is dry beans at the farm gate, even though green beans can be found at the local market in low quantities. Traders sell dry beans to local markets and also channel to Kigali and Rubavu markets. Processing in the Rwandan bean supply chain is nearly inexistent, with a meager contribution to the beans' value chains (Bucagu et al., 2018).

**Farmers commonly use traditional bean seeds that have been retained from a previous harvest for the upcoming one. One visited cooperative, COMIXBU, uses improved seeds, thanks to their collaboration with HarvestPlus – a program dedicated to ending hunger through providing nutrient-rich foods - that uses iron-biofortified bean varieties. Bush and climbing bean varieties are the two common varieties used by farmers involved in the bean value chain. Improved seeds produce approximately 2 tons/ha for a cooperative, in contrast**

**with others who use unimproved varieties that produce 500-800 kg/ha. Fortified bean varieties are in high demand by Kigali market consumers.**

After harvest, beans are immediately dried. Sun-drying is the only method used to dry beans. Traditionally, beans are shelled mechanically after drying by hitting them with a large stick. Manual labor requiring force is relegated to males, while the separation of grains from unwanted matter through sieves is reserved for female workers. After pesticide treatment, beans are then stored in polypropylene bags to avoid insect infestations.

Aggregators in urban centers usually channel purchased beans to Rubavu and Kigali markets. During the lean period, some farmers buy beans from aggregators in urban centers if they are not able to keep enough for an upcoming season.

#### **3.2.4. Tomato value chain**

Tomatoes are an important horticultural crop in Rwanda, with consumption on the rise. The production is primarily in the open field and therefore bound by seasonality. Typically, tomatoes are produced during three seasons each year, while four production seasons are possible with irrigation. The three growing seasons are Season A and Season B (with harvests in May/June and December/January respectively) and Season C, which refers to marshland production (minor in comparison to Seasons A & B) (EU 2015). Tomatoes are badly stored and not cooled, which causes a significant decrease in the quality and high post-harvest losses in the supply chain. Quantitative losses from farm to market were estimated at 56 percent, with 21 percent discarded and 13.6 percent at the retail market (Horticulture Innovation Lab, 2017).

The EU Baseline report on horticulture (2015) indicates two main challenges which may affect the sustainability of the tomato value chain in Rwanda: (a) despite support programs, irrigation is underutilized: only 13 percent of small-scale vegetable growers (not only tomatoes) practice irrigation, versus 42 percent of larger-scale farmers, equipment is costly and has low availability and/or awareness (sprays, hoses, pumps and generators), and (b) tomatoes can generate an “Imitation Mindset”: in recent years, many farmers jumped into production without

fully considering supply and demand, leading to overproduction. Moreover, little production information or market information about supply and demand (before harvesting).

In Rulindo district, one cooperative, Terimbere Mukoto, is involved in the tomato value chain and uses different varieties such as Adventure, Nuru, and Star varieties depending on the season (dry or rainy)), and their resistance to diseases. Seeds and other inputs are purchased from local agro-dealers. Cooperative has benefited from irrigation systems funded by the district, which offers a considerable advantage to farmers in that it makes it possible to produce tomatoes during the lean season. Fungal diseases that attack leaves are the primary pests mentioned by farmers, and insect larvae that attack immature tomato fruits are also a major concern.

Because of the massive use of pesticides to control crop insect pests including thrips, leaf miners, beetles, fruit flyers, whiteflies, jassids, aphids, and mites in tomatoes, farmers interviewed said they had received training on pesticide applications offered by the FAO and were aware of how deleterious pesticides could be to the ecosystem. They were planning to start organic farming with minimal pesticide use in response to the high consumer demand for non-treated tomatoes.

**Highly perishable, 25 percent of the harvested tomatoes are damaged or destroyed because of inappropriate transport (the tomatoes are stacked on top of each other in polypropylene bags or in traditional baskets, damaging the tomatoes underneath), pests, and lack thereof of cold storage, etc. Male and female cooperative members are equally involved during all steps of the tomato production process.**



Picture 4. Illustration of packing tomatoes in 50-100 kg polypropylene bags

Farmers harvest tomatoes in traditional baskets ("*ibitebo*") or in 50-100 kgs polypropylene bags when the tomatoes are red-ripe and soft; therefore, harvesting takes place on the day they are to be sold to minimize loss through spoilage. After sorting for defects, tomatoes are sold directly to aggregators at the farmer's cooperative and to local food shops, or they are channeled via bicycle to weekly markets in neighboring urban centers such as the Base and Gasiza urban centers. The cooperative also supplies tomatoes to one of the largest agro-processing companies in Rwanda located in the Rulindo district for an estimated 50-100 Kg per week during the harvest season. Aggregators transport tomatoes to Kigali and Rubavu markets on overloaded trucks using poor packing practices. Approximately 60-70 percent goes to the most competitive markets in Rubavu City. Farmers prefer the Rubavu market because of its proximity to Goma City in the DRC and the market offers more competitive prices than those in Kigali City.

### 3.2.5. Egg value chain

According to the PSTA4 – a strategic plan for the agricultural sector over the period 2018 – 2024 - eggs production is expected to increase from 7 000 to 17 000 tons (142.8 percent). Exotic breeds of layer predominate the egg production with an average annual production rate of 240 eggs per hen (PSDAG, 2018).

Eggs are produced by small, medium and large poultry farmers, with the majority of output purchased by small traders for delivery to city outlets (wholesalers, exporters and

retailers). In addition to domestically produced poultry products, wholesalers also supply retailers with imported eggs and/or broilers. Retailers supply eggs and broilers to hotels, bakeries, fast food chains, restaurants, and households. The end consumer price of an exotic-breed egg is FRw 80-100 in Kigali and FRw 60-70 in other urban and rural areas (Mikhail Miklyaev et al. 2017).

Farmers in the Rulindo district involved in egg production are business-oriented. They have had to invest in necessary housing for their poultry and appropriate equipment. A typical poultry farm has 1,000 to 5,000 layers per egg production cycle. The Rulindo district offers a competitive advantage. It is located approximately halfway between Rubavu and Kigali, and there are ample feed ingredients (e.g., maize) available in the region. The interviewed poultry farmers were located in the Bishoki sector, close to the main road that facilitates transport.

**Feeds are homemade. Farmers prefer to make their own feed instead of purchasing them from feed millers. During discussions, they confessed to not trusting the feed millers' formulation; they assume that animal feed manufacturers intentionally reduce the proportion of some feed ingredients to increase their profit margins, resulting in low egg production. Instead, farmers mix feed ingredients themselves.** The ingredients, essentially maize, are grown locally and purchased from neighboring farmers. Feed was priced at 380 RWF/Kg at the study time.

AGROTECH Ltd supplies one-day-old chicks, a local company located in Kigali City specializing in agriculture and livestock inputs. Farmers prefer ISA Browns breeds; they begin laying much earlier (around 20-22 weeks of age) and are prolific egg layers, providing more than 300 eggs annually. Eggs are produced for one to one and a half years, and the productivity is estimated at 70-75%. During their laying period, hens are vaccinated against Marek's disease, Newcastle, and infectious bursal disease.

Three products are sold at a poultry farm: Eggs, hens at the end of the laying \cycle, and manure.

- **Eggs:** Sold to aggregators who transport them to Rubavu markets. Rubavu markets offer competitive prices because of their proximity and exchanges with Goma markets in the DRC.

The current egg price at the farm gate is 80--85 RWF/egg. The average production cost of one egg is estimated at 75--83 RWF/egg, leaving a net income of 3--10 RWF/egg.

- **Manure:** Sold directly to local farmers at 1,000 RWF for a 100-kg capacity bag. For a poultry farm of 1,000 hens, approximately 30 bags are removed every two weeks.
- **Hens:** Sold to Rubavu markets at the end of the laying cycle for 2,000--2,500 RWF/hen.

### 3.2.6. Milk value chain

For centuries in the Rwandan tradition, cows have been considered sacred and symbols of wealth and social status as well as an economic asset—consequently, Rwandan dairy farmers number in the thousands. The 2016 National Institute of Statistics of Rwanda report estimated that more than 50% of Rwandan households keep at least one cow. Such a possession has been encouraged by the Rwandan government as it helps combat persistent malnutrition among children. The “Girinka” (which literally translates “one cow per poor family”) program was initiated to help vulnerable families gain access to milk and dairy products by providing them with cows.

Low-income families are identified at the village level and receive a pregnant cow. To be selected, beneficiaries must not own a cow, have at least 0.2-0.75 ha of land to plant fodder, and an available cowshed. After birth, the calf is reared until it is about ten months old, and then it is passed on to the next vulnerable family awaiting a cow. The program is still active and will remain so until all vulnerable families have a cow in their possession countrywide. Local authorities supervise the program’s implementation.

To fill gaps in insufficient milk production of local breeds (i.e., Ankole produces 1-2 L/day), RAB initiated and has been running a cattle genetic improvement program for the past twenty years. Artificial insemination was used to introduce exotic breeds (e.g., Holstein Friesian breeds) and resulted in crossbreeds (up to 70%) with improved milk production (5-7 L/day). Most often, farmers keep the evening milk (1-2 L/day/cow) and give it to their children; the morning milk (4-5 L/day/cow) is sold to milk collection centers (MCC) or neighbors. To avoid milk spoilage where there is no refrigeration, kept milk is traditionally fermented (locally known as “ikivuguto”) and can last from three to four days; otherwise, it will spoil in one day.



At the MCC, milk is tested for various quality parameters, and if it is not compliant, it is rejected and returned to the farmer, who may sell it at a low price to local food shops or consume it at home. Mastitis and the presence of aflatoxin M1 (subsequent to feed contamination with aflatoxin B1) above the legal limit (0.5 ppb) are the major reasons milk is rejected at MCCs.

Farmers prefer to take their milk to MCCs because of their competitive price. MCCs, pay 200 RWF/L while others pay 150--170 RWF/L. Despite 200 RWF/L, farmers feel the price is not fair because of the lack of forage and grasses, especially during the dry season, which is the hottest period of the year with a shortage of natural pasture availability. They have to work many hours to have enough forage and grass for their dairy cows. Children are also involved in finding grass on hills, forests, etc.; otherwise, they have to buy it from neighbors. Napier grass is grown on contours and terraces or intercropped with other crops to cope with forage shortage.

### 3.2.7. Sustainability issues per value chain

Table 4. Common key sustainability issues in the selected value chains

Value chains	Social sustainability	Economic sustainability	Environmental sustainability
Maize, Irish potato, beans, tomato	<ul style="list-style-type: none"> <li>• Inclusion of youth employment</li> <li>• Inefficient circular economy</li> <li>• Aflatoxin contamination in maize value chain</li> </ul>	<ul style="list-style-type: none"> <li>• Inadequate and lack of financial record keeping and reporting</li> <li>• Inadequate access to finance</li> <li>• Inadequate access to improved seeds</li> </ul>	<ul style="list-style-type: none"> <li>• Massive use of pesticides</li> <li>• Drought, landslide, erosion</li> </ul>
Egg	<ul style="list-style-type: none"> <li>• Antimicrobial resistance</li> <li>• Competition between humans and livestock for the same</li> </ul>	<ul style="list-style-type: none"> <li>• High price volatility at markets</li> </ul>	

	ingredients		
Milk	<ul style="list-style-type: none"> <li>• Cultural context</li> <li>• Competition between humans and livestock for the same ingredients:</li> </ul>	<ul style="list-style-type: none"> <li>• Rejection due to milk-borne pathogens and antibiotic residues</li> <li>• Competition between humans and livestock for the same ingredients</li> </ul>	<ul style="list-style-type: none"> <li>• GHG emissions</li> </ul>

### 3.2.7.1. Economic sustainability

- **Inadequate and lack of financial record keeping and reporting:** During interviews, there were gaps in financial literacy among the farmers (i.e., lack of financial report copies and record-keeping). Also noted were inadequate contract literacy skills at the cooperative level, manifested in the fact that some buyers do not honor their buying contracts and vice-versa some farmers also do not honor their contracts by side-selling or adhering to quality standards required by buyers. There is a need to train farmers in contract literacy skills so they will understand contract terms, obligations, and responsibilities of involved parties and learn how to negotiate appropriate prices.
- **Access to finance:** Farmers favor the “tontine financial model” - a financial scheme by which cooperative members contribute periodically and can access credit without interest anytime needed - and hesitate to accept loans from formal financial institutions because of what they consider high-interest rates and exposure to high risks in the ag sector such as floods, erosion and long drought periods that might negatively impact their production and ability to repay a loan.
- **Access to improved seeds:** in the Irish potato value chain, farmers interviewed declared that they were satisfied with the current farm gate price. However, access to improved seed was still limited for some farmers and it impacted their production. Unfortunately, the farmers had been swindled by individuals claiming to be professional seed multipliers who

distributed “fake improved seeds,” that produced low yields. Seed supply chain regulations with local certified seed multipliers would help farmers overcome seed provision challenges.

- **Egg value chain**

- Farmers face high price volatility in markets. For instance, with restricted travel during the COVID-19 pandemic, farmers could not sell their eggs, so the Government purchased them for vulnerable communities. Eggs were sold under the normal price at 50 RWF/egg. Farmers were also challenged with high prices and feed ingredient availability, and thus they were hindered from being competitive in Kigali markets.

- **Milk value chain**

- **Cultural context:** Farmers primarily rear cows for traditional reasons discussed above and for milk to be consumed by household members. Economic sustainability is not considered a priority given what they invest and what they receive from milk sales.
- **Competition between humans and livestock for the same ingredients:** Rwanda is a small country with the highest population density in Africa. As such, land needed to raise livestock feed is in competition with land needed to raise food for human consumption. Additionally, humans and livestock compete for the same common feed ingredients used to increase milk production such as maize.
- **Animal diseases:**
  - **Mastitis** is an infectious condition resulting in an inflammatory reaction in the mammary gland of a cow. Studies have estimated the prevalence of subclinical mastitis at the farm level to be as high as 52% (Ndahetuye et al. 2020). Coliforms are the main causative agents, resulting from poor hygiene and management systems. It can reduce the lactation period considerably, from 305 to 245 days, and increase preventive veterinary services which can be expensive.
  - **East Coast Fever (ECF):** ECF is a cattle tick-borne disease caused by *Theileridae parva*. Infected animals develop enlarged lymph glands, become listless, stop feeding, and cough frequently. Fever occurs a few days after the onset of symptoms, followed by diarrhea and mucous discharges from the eyes and nose. Mortality may exceed 90% in

adult animals. ECF is an endemic tick-borne cattle disease in Rwanda and causes considerable cattle production loss.

- **Milk-borne pathogens:** Informal markets still prevail in the milk value chain, and most dairy and milk products passing through them are likely to have safety and quality problems. Kamana et al. (2014) showed that milk samples collected from farms, MCCs, milk processing plants, and milk shops have *Staphylococcus aureus* and *Salmonella* from 175 (53.0%) and 25 (7.6%) samples, respectively, with the highest isolation rate from cheese samples originating in milk shops. The absence of refrigeration and lack of temperature monitoring were found to be prevailing safety issues in Rwanda's milk chain.
- The MCCs cannot handle all daily production, especially during peak seasons, resulting in poor quality milk. In addition, the lack of adequate transport infrastructures such as good roads and equipment to keep the milk safe from farm to the MCC adds to the problem. For instance, milk transported in jerricans easily spoils due to inadequate jerrican hygiene and is often rejected by the MCCs. Insufficient and costly electricity needed to power milk cooling equipment constitutes other challenges highlighted by those interviewed at the MCCs.

#### **3.2.7.2. Social sustainability**

Aflatoxin contamination is a major challenge for maize value chain farmers. Despite the availability of drying shelters using natural solar drying, farmers cannot achieve the required 13 percent moisture content to keep maize safe from fungal contamination because of the Rulindo District's climatic characteristics (i.e., humid, and cooler ~19-25°C). During the interviews, farmers said they could only dry up to a 16-17 percent moisture content and are thus paid a low price because they cannot meet the required 13 percent moisture content for Grade 1 maize. Cooperatives need to make dryers and associated postharvest equipment available to dry the maize to an acceptable level. Exposure to aflatoxins, particularly aflatoxin B1, is associated with an increased risk of developing liver cancer and impaired immune functions in humans, stunting children's growth.

Traditionally, women, farmers play key roles in all farming activities since they are involved in what qualified as ‘soft’ activities from seed selection, planting, harvesting and storage in addition to backyard livestock and cooking activities, while men are more mainly involved in “hard” farming activities and dairy production. The women support in the selection of nutritious crops which can grow in the kitchen garden, and the consumption of animal source food (i.e., eggs) completing the traditionally grown crops (i.e., maize, Irish potatoes) can positively impact the food and nutritional security of their families, therefore reducing the recurrent malnutrition and stunting.

The agriculture sector remains an essential part of youth employment, especially in Rulindo district, through a circular economy and preventing the rural exodus. For instance, if the maize was processed locally into maize flour and sold to local schools, by-products could be used as inputs for livestock (e.g., maize bran in the poultry farms) and then generated manure used for cropping and selling eggs, etc.

- **Antibiotic resistances:** Farmers treat hens when they get sick, and that in itself invites two major concerns: drug residue in consumed eggs and antimicrobial resistance. With increased antibiotic resistance, the drugs become inefficient in treating diseases and increase the risk of spreading to other livestock and humans.

### **3.2.7.3. Environmental sustainability**

Maize production is also impacted by climate change that has caused unusually long rainy and dry seasons and, thus, low yields. As with other promoted crops under the CIP policy, farmers massively use pesticides to combat diseases and pests. However, discussions with farmers suggest they are unaware of pesticides’ dangers, especially on ecosystems. Surprisingly, they did understand the decrease in bee population to be a direct consequence of pesticide use. Pesticides do not only have negative impacts to farmers, but also, they contaminate soil and water with long term impact on the ecosystem and on public health.

A more sustainable approach to combat diseases and pests is needed to minimize and limit the excessive use of pesticides, both for farmers’ own protection and the environment’s.

While the primary goal of intensive agriculture using improved seeds – and sometimes in monoculture practices – is to increase productivity, there is a need to improve not only the quantity of food produced but also take into consideration high nutrient values such as vitamins, minerals and micronutrients, through agricultural biodiversity necessary to sustain rural livelihoods.

## 4. Situation of food security, nutrition, and health in the Rulindo District

### 4.1. Introduction

Like all districts in the Northern province, the Rulindo district is rural and is characterized by scattered urban centers containing hundreds of households aggregated around weekly markets. It is also the first market linkage between other cities, mainly the City of Kigali and Rubavu City. The situational analysis of the Rulindo district's food security and consumption patterns discussed herein; was based on district and national level data, and it was completed using a five-category qualitative survey to provide a broad and complete picture of food consumption patterns and food security within the district. Various approaches have been used to understand the Rulindo population's food and nutrition patterns, including key informant interviews with district-level officials working on food security and nutrition and focus group discussions.

Discussions and interviews focused on household dietary diversity, number of meals per day, food sources and purchases, household food expenditures, food security coping mechanisms, nutrition and food safety knowledge. In addition to key informants' interviews, the focus groups discussions were conducted with the following five categories of respondents:

- a. **Category of farmers:** Three focus group discussions (FGD) were organized with farmers from different cooperatives identified upstream in collaboration with the Rulindo district, namely COMIXBU, KOYAKIRU, and COVAMABA, located in Kisaro, Cyungo, and Mukoto Sectors, respectively. FGD were conducted during July 15 – 23 July 2021. For this category, discussions were conducted during the COVID-19 pandemic associated with movement restrictions. Therefore, only nine members (six males and three females) per cooperative attended each meeting. In total, 27 farmers (nine members for each of three sessions aged from 25 to 57 years old) were interviewed to gain an understanding of how they view specific issues within the value chains at the farm level.
- b. **Category of residents in urban centers:** These are generally non-farmers respondents residing in urban centers which are either involved in urban area business activities or employed by the district and sector administrations, NGOs, etc. For this category, a door-to-door survey was conducted as this group's availability was limited for FGD due to the

COVID-19 restrictions during the survey period. A total of 25 participants (21 males and four females, all of them, were married) living in Base and Gasiza as main centers; constituted the group. Household size ranged from three to seven members (including parents, 2 – 4 children and home maid). The age of respondents ranged from 39 to 51 years old. The survey was conducted during the period of August 12 – 14, 2021.

- c. **Category of landless workers:** Also known as “abapagasi”, the persons in this category live in rural areas and work for other farmers doing cultivation to get food. They are paid daily in either food or cash, the monetary value varying between 700 to 1,000 RWF. The workers are poor and vulnerable to food insecurity, often receiving government support through programs such as the Vision Umurenge Program (VUP), which provides additional support for the extremely poor and public work jobs for those who are labor-constrained. Three FGDs were organized (10 -15 participants – aged from 18 to 47 years old - for each FGD; a third are women) from Shyorongi, Bushoki, Base areas. The survey for this category was conducted on January 21, 2022.
- d. **Category of ‘abakarani’:** They are primarily young men who operate within urban areas and are informally known as “abakarani.” They transport purchased food products on their head, in wheelbarrows or bicycles, clean markets, etc., and live near urban areas. Most of them also cultivate their small piece of land or leased farms. Three FGD were organized (10 -15 participants for each FGD) from Base, Shyorongi, Gasiza urban centers. The survey for this category was conducted on January 22, 2022.
- e. **Category of vulnerable elderly:** they are poor and vulnerable elders, mostly living alone or with grandchildren and supported by the government, the district, NGOs, and churches. For this category, three FGD were organized (7-12 participants for each FGD, a third are female) from Shyorongi, Bushoki and Base areas. The survey for this category was conducted on January 20, 2022.

#### **4.2. Household dietary diversity**

According to the 2018 Comprehensive Food Security and Vulnerability Analysis (CFSVA) report, 40.5 percent of all households in the Rulindo district (about 77,791 households) are food secure. They can meet essential food and non-food needs without engaging in atypical coping



strategies such as buying less preferred or less expensive food, borrowing food, or relying on help from friends/relatives. They have an acceptable diet, using only a small share of their budget to cover food essentials. A total of 42.9% percent of all households in the Rulindo district are considered marginally food secure; they are at high risk of becoming food insecure. Although they have minimally adequate food consumption, they cannot afford some non-food essentials. A calculated 16.6 percent of Rulindo district households are food insecure. They have significant food consumption gaps and can only meet minimum food needs using irreversible coping strategies.

Of the five categories, the plate composition of residents in urban areas is diverse. Their food intake consists of cereals, roots and tubers, vegetables, and fruits that are consumed during three meals a day, including breakfast, lunch and dinner. They can afford to buy processed foods in supermarkets such as processed meat, mayonnaise, margarine, etc.

Those in the other four categories often have one to two meals a day. Small farmers' plate composition is less diverse and varies according to the growing season, mainly consisting of potatoes, beans, and maize. Although most adults do not eat breakfast, children eat day-old leftovers in the morning. It is worth noting that, for these four categories, beans are served with almost each meal as a protein source; access to animal protein is very limited.

There is marked contrast between residents in urban centers and other categories in their ability to access animal source food (ASF) such as milk, eggs and fish. Residents in urban centers have regular access to ASF and other diverse commodities, while other four categories have little access to ASF and consume a diet heavily based on starchy farm-grown foods including Irish potatoes or maize. Paradoxically, farmers can raise various small animals, for example, in restricted backyards spaces such as rabbits and goats for meat, and poultry that provide both eggs and meat--all of which can easily provide ASF. However, for most of poor people, they prefer selling the produce instead of eating (they see those produce as source of income/money rather than source of vitamins!). For many residents in rural areas of Rulindo district, meat is expensive (3,000+ RWF/kg) and it is only consumed during festivities such as wedding ceremonies and child baptisms, and at Christmas and New Year's celebrations. In order

to serve meat during festivities, especially Christmas and New Year's, some farm-holds communally contribute a given amount for a specified period (i.e., six months) to buy a cow that is slaughtered and shared.

Those in other categories (i.e., categories of farmers, landless workers, 'abakarani'<sup>1</sup>, and vulnerable elderly) are food insecurity vulnerable and are likely to eat only once or twice a day. What landless workers consume largely depends on what they earn daily in either food or cash; most often it is potatoes, maize or beans because they are cheap commodities and are widely grown in the Rulindo district. These individuals are classified as Category E of the *Ubudehe Program*, a social stratification program based on household income. Five categories are represented by the letters "A," through "E," with "A" indicating households with the highest income and "E" indicating society's most vulnerable. The government assists an individual in E category by providing a fortified porridge mix, commonly known as "Shisha Kibondo," to alleviate the high risk of children and pregnant mothers becoming malnourished.

Similarly, to protect the elderly who are 65 years of age without a pension and living in or near the poverty level, the government established a grant scheme wherein each elderly person identified in the community as needy receives a monthly stipend (~5,200 RWF) to purchase needed commodities for food security. Those in the "abakarani" category are mainly young men working informally. Depending on their daily income, they eat once or twice a day and mostly eat in urban area food shops selling pastry such as "chapatti or andazi"<sup>2</sup>, fermented milk, and cooked food.

#### **4.3. Household food sources, purchases and expenditures**

Rulindo District residents primarily consume locally grown commodities. Urban area supermarkets sell processed food products that are mainly purchased by residents living in high-income urban areas. Non-farmers living in urban centers with relatively higher incomes reported that they spend more than 70,000 RWF/month on food items, while farmers reported that they

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<sup>1</sup> *Abakarani* means manpower mainly boys who help buyers on the markets to transport the produce like on wheelbarrow or by head.

<sup>2</sup> *Andazi/capati* means doughnut

spend approximately 20,000 RWF/month on food. Those in vulnerable categories (i.e., landless workers, ‘abakarani’, and vulnerable elderly) reported that they are spending less than 5,000 RWF/month on food purchases, as a big part of the food is not purchased rather grown by themselves or paid for labor-work. Farmers in Rulindo reported they eat what they grow and only purchase a few commodities not grown or produced in their region, such as rice, cooking oil, sugar and salt, while non-farmers purchase all food commodities. Restaurants, Bars, and other food shops are primarily located in urban centers because residents with high incomes can afford their services. Restaurants sell buffet-style food such as potatoes, rice, maize and meat. In addition to alcoholic and non-alcoholic drinks (beers and soda, respectively), bars commonly sell roasted meat known as “brochette or zingalo” with side dishes of roasted potatoes and roasted bananas.

#### **4.4. Nutrition and food safety knowledge**

Women from each village in Rulindo district meet once a week for what is called “akagoroba k’ababyeyi” (literally translated as “mothers’ evening”) to discuss nutrition and food safety, and how to mitigate malnutrition. An extension agent or health advisor (locally known as *umujyanama w’ubuzima*) trained in nutrition and food safety is present to help with discussions. They are commonly referred to as “*abafashamyumvire*,” the word literally translates as “helpers in mind changing.” This is a government educational initiative mainly designed for the Rulindo district to combat malnutrition in the region.

#### **4.5. Household-level role in decision making**

Women play a major role in food purchasing and cooking. They assume activities related to cooking such as selecting food items for each meal, monitoring children’s nutrition, watering, handling and storing harvested crops, purchasing food, cooking, distributing food to household members, and preserving leftover food. Cooking requires one-two hours per meal. Although women are in charge of selecting food at the market, men usually decide and buy meat for family consumption. Children are in charge of collecting firewood for cooking. After cooking, food is distributed equally to all household members; if leftovers are kept for the children.

Firewood is the most common energy used for cooking by farm families, while natural gas is commonly used in urban areas. In place of firewood, charcoal is commonly used in urban centers and sold for a higher price than firewood. Because of its cost, few farmers use it. Charcoal usage is expected to grow. The percentage of population living in urban centers is expected to expand due to the establishment of villages/agglomeration centers through a government policy called ‘*gutura mu mudugudu*’. Farmers have easy access to wood that is collected in their fields/farms or cut from their trees (a chore reserved to men), and they do not need to buy it. Using both firewood and charcoal as cooking fuel is unsustainable and causes two main sustainability issues: social and environmental.

Poorly dried wood burns inefficiently in cook stoves and thus becomes a *social* issue. Additionally, poorly ventilated environments generate smoke that causes respiratory illnesses and distress such as coughing, sneezing, headaches, and long-term illnesses related to bronchitis, lung cancer, asthma, etc. It is important to highlight that women are more involved in cooking activities than men, predisposing them to the aforementioned respiratory illnesses caused by firewood smoke. Environmentally, wood and charcoal burning contribute to anthropogenic GHG emissions and, therefore, global warming. Moreover, wood and charcoal use destroys forests and in turn, leads to increased erosion. Thus, soil fertility is lost and harvests are significantly reduced.

#### **4.6. Factors that drive household food insecurity and inadequate nutrition**

During this study, factors driving households to food insecurity and inadequate nutrition were discussed with participants and key informants. The common factor was the lack of or inadequate access to nutritious foods. Moreover, recurrent droughts and erosion, acidic soil in some parts of the district, and food price volatility did not favor increased production and negatively impacted household resources needed to purchase nutritious foods.

Another important factor driving household insecurity in some households, especially child malnutrition, involved social behaviors. Farmers who raised animals such as poultry that could provide nutritious eggs for their family and mitigate malnutrition, thereby easily providing ASF,

often preferred to sell the eggs instead. *‘You may find a farmer with chickens, but children have malnutrition because they don’t eat eggs which are all sold’* Vice Mayor Social Affairs of Rulindo District. As discussed previously, the government has initiated nutrition training at the village level through extension agents. With the help of an extension agent or a person from the community trained in nutrition and food safety with practical suggestions (i.e., cooking nutritious foods available in the village), women meet once a week and discuss nutrition and food safety and how to avoid malnutrition. They are encouraged to plant kitchen gardens with legumes and fruits.

#### **4.7. Coping mechanisms to feed the family**

Farmers keep a significant part of what they grow for family food security, depending on the growing season. It has been estimated that the proportion of beans farmers keep for personal use ranges from 50 to 80 percent of the total household’s production, while maize is estimated at 30 percent. Another popular alternative for addressing family food security is the “tontine financial model,” a financial scheme in which farmers monetarily contribute to a fund during good planting seasons periodically. This allows them to access credit without interest whenever they need cash to buy food or make other necessary purchases. However, there are few opportunities for those in vulnerable categories to cope with food insecurity; they primarily rely on district and government support.

## **5. Linkages and food flow between Rulindo and Kigali, Rubavu and Goma Cities**

### **5.1. Infrastructure**

#### **5.1.1. Roads**

Rulindo District is one of the five districts of the Northern Province and is divided into 17 Sectors, 71 Cells, and 494 Villages (Imidugudu), covering 567 square km surface area. Rulindo lies roughly halfway between the City of Kigali, the capital, and Musanze town (secondary city); and gives a strategic position to be one of the key districts supplying Kigali and secondary cities in different commodities. The district is connected to the City of Kigali (CoK) by a 56 km tarmac road and the existing 35 142 unpaved feeder roads connecting different sectors and cells. The same tarmac road goes through the whole district and links Musanze and Rubavu cities for a distance of 51 Km and 111 Km, respectively.

In major urban centers, the district has initiated the construction of modern markets (i.e., markets with roof) to facilitate business. Every fiscal year, a specific budget is devoted to constructing and rehabilitating rural feeder roads connecting various sectors, cells, and principal district roads. New road infrastructure provides for agricultural input supplies and facilitates the delivery of farm output to markets.

#### **5.1.2. Linkages of farmers to the markets and transport**

In Rulindo district, there are 14 markets (8 open-air markets; and six modern markets). Most modern markets are located in the five identified urban centers near the tarmac road. Urban centers are the main connection centers between Rulindo district and Kigali and secondary cities (i.e. Rubavu).

At harvest, farmers sell their produce at the farm gate or at weekly urban center markets to aggregators who in turn supply Kigali and Rubavu markets. Farmers and aggregators use unpaved roads from farm gate villages to weekly markets in cells or urban centers. Bicycles remain the major transport means for farmers to supply markets. However, the transport using unpaved roads becomes arduous during the rainy period, thus complicating the delivery of food

products from farm to the market. After purchase, aggregators channel products directly to Kigali and Rubavu markets on the truck using the tarmac road.

Table 5. Modern markets in Rulindo District

Market name	Modern market	Sector
BASE	Modern market	BASE
SHYORONGI	Modern market	BUGARAGARA
RUSINE (Rusine center)	Modern market	MASORO
REMERA	Modern market	NGOMA
KIYANZA	Modern market	NTARABANA
BUYOGA (Buyoga center)	Modern market	BUYOGA

Table 6 Open markets in Rulindo District

Market name	Modern	Sector
RWAHI (Rwahi center)	Air market	Shyorongi
KIRAMBO (Kirambo center)	Air market	Ngoma
KABARORE (Kabarore center)	Air market	Ngoma
GATARE (Gatare center)	Air market	Buyoga
GITUMBA (Gitumba center)	Air market	Buyoga
MUYANZA (Ndarage center)	Air market	Buyoga
MUGAMBAZI (Mugambazi center)	Air market	Murambi
KIRENGE (Kirenge center)	Air market	Rusiga

## 5.2. Food flows between Rulindo and Kigali

Findings showed that Rulindo supplies Kigali with five different food commodities, namely maize, bean, Irish potato, milk and tomatoes (to a less extent). Up to 70 percent of harvested maize is directly sold to the two big buyers in the country, AIF and EAX. Twenty to 50 percent of bean production is sold to aggregators at local markets and then channeled to Kigali markets such as Nyabugogo, Kimironko and Nyarugenge markets. Approximately 90 percent of the Irish potato production is sold to aggregators who channel them directly to Kigali at the farm gate. Similar patterns are observed for milk and tomato value chains. The remaining quantities for both commodities are sold to neighbors and/or used for home consumption.

In return, Kigali supplies Rulindo with processed food products, such as processed milk, tomatoes, sugar, cooking oil, salt, etc. Vendors located in urban centers which operate food businesses are supplied with processed food products from Kigali city and sell them to farmers and other residents in Rulindo district.

### **5.3. Food flows between Rulindo and Rubavu/Goma**

Findings showed that Rulindo supplies Goma (in DRC) through Rubavu in eggs and tomatoes. Rubavu markets offer competitive prices because of their proximity to Goma markets in the DRC, relatively high prices.

### **5.4. Agro and financial services**

In Rwanda, there are different financial institutions encompassing 504 institutions, including 17 banks (i.e. 11 commercial banks, four microfinance banks, one cooperative bank and one development bank), 16 insurance companies, 470 microfinance institutions (i.e. 19 limited liability companies, and 451 Savings and Credit Cooperatives (SACCOs); of which 416 are Umurenge SACCOs); and one pension fund. Most of them have their branches in the Rulindo district have developed special loan packages for the agriculture sector. For instance, the IKOFI package is a Bank of Kigali's digital financial product dedicated to the agriculture sector in Rwanda and facilitates farmers to have access to loans at a low-interest rate.

Agro-dealers are in all sectors of the Rulindo district and supply farmers with inputs (fertilizers and pesticides) and certified seeds, as discussed in the previous chapters. Agro-dealers are supplied by agro companies located in Kigali city.

### **5.5. Linkages of the surveyed consumers to the identified markets**

Survey consumers were in two categories: farmers and non-farmers. Surveyed farmers are those who supply weekly markets and were located in different sectors to capture the big picture of market linkages between farmers, markets, urban centers and Kigali cities, and secondary cities. In the same line, surveyed non-farmers were residents of the urban centers who actively participate in the economic activities of urban centers (e.g., buying their food commodities directly from urban centers).



## **6. Recommendations and Way-Forward**

Identified challenges and opportunities facing the urban food systems in Rulindo District were shared at a consultative workshop with the Food Liaison Advisory Group (FLAG) – a group of stakeholders engaged in the Rulindo food system – held in September 2021 with an emphasis on sustainability issues (social, economic and environmental sustainability). The main objective of the consultative workshop was to refine the findings and build a consensus on key challenges among invited key stakeholders. FLAG participants added some inputs to the preliminary findings. They came up with a consensus on the food system's overall functioning and the challenges of developing a sustainable Food System in Rulindo and its connectivity to Kigali. In addition, with participants in the workshop, discussions were heard on the potential solutions for sustainable food systems in the Rulindo district.

### **6.1. Action point 1 – Strengthening the capacity of farmers’ cooperatives**

- i. Farmers use the same methods; although they are in cooperatives, nothing has changed over years and generations. For instance, none of the interviewed farmers kept records necessary to set the selling price. The business plan is one of the areas in that farmers need the training to see their activities as business-oriented activities instead of relying on external actors, such as big buyers who have to buy their products. Instead, farmers should consider diversifying their activities, such as adding value to production, for example, grinding maize grains and selling maize flour instead of selling only maize kernels.
- ii. However, the proposed approach requires enough investments from financial institutions. Paradoxically, farmers are still reluctant to contract financial loans, fearing not to pay back the loans. There is a need for collaboration between the Rulindo District and financial institutions operating in the district and which are involved in the agricultural sector to approach farmers’ cooperatives and explain in-depth different financial packages intended for farmers, but more importantly, support them in their business plan to avoid falling into bankruptcy.
- iii. Another area of training is how to sensitize farmers on how to use field pesticides wisely and responsibly to avoid the farmers’ exposure to pesticides and preserve the ecosystems, especially insects that are very sensitive to pesticides. The use of organic pesticides should be encouraged along with other pest control farming practices.

## **6.2. Action point 2 – Facilitate access to improved seeds**

- i. The study showed that assessed value chains (tomato, Irish potato, and beans) suffer from poor quality of seeds. Farmers either use open phenotype seeds saved from the previous year's harvest or non-certified seed multipliers, with low yield for farmers. There is a need to support the private sector to get more involved in the seed multiplication and RAB to efficiently supervise the certification of seed multipliers in the Rulindo District. With adequate and responsible use of pesticides and fertilizers, large productivity increases and therefore increase farmers' livelihood.

## **6.3. Action point 3 – Facilitate access to postharvest facilities**

- ii. Both perishable food crops (e.g., tomatoes) and grains suffer from inadequate facilities and cause huge losses. For instance, there is no cold room in the Rulindo district to help farmers keep their perishable food crops (such as vegetables and tomatoes). Farmers are forced to harvest the same selling day and bring them to markets with inadequate transport causing losses. If not sold, farmers either sell them for low prices or throw them as losses and wastes. Different cold rooms across the district are necessary to help farmers reduce food losses from perishable food crops.
- iii. Secondly, as discussed earlier, the available drying shelters using natural solar drying are inadequate to achieve the required 13 percent moisture content to keep maize grains safe from fungal contamination. They are forced to sell their produce as Grade 2 at a low price instead of Grade 1 at a premium price. Mobile dryers can be the best alternative for farmers to cope with the weather conditions in the Rulindo district on the one hand and the required 13 percent moisture content on the other hand.

## **6.4. Action point 4 - Adopt Climate-smart agricultural practices**

- i. Rulindo district suffers from climate change because of its relief (steep hills and mountains) associated with long drought periods and erosions and the deforestation caused by the increase in the use of firewood which still predominates, especially among people living in rural areas. Agroforestry (defined as a land use management system in which trees or shrubs are grown around or among crops or pastureland) is one of the solutions for climate

resilience, which can help farmers respond to hazardous climate events as erosion – and also offer solutions for firewood availability.

#### **6.5. Action point 5 - Creation of a multistakeholder platform for secondary cities**

- i. Findings showed exchanges between secondary cities, such as exchanges between Rulindo and Rubavu city. However, there is no interaction between different actors involved in the food systems of both cities. Exchanges between actors – farmers, aggregators and policymakers – will improve enabling environment and unlock more opportunities to sustainability support different food systems actors.

#### **6.6. Action 6 - Consumer awareness on nutrition aspects and balanced diet**

- i. There is a need to strengthen the existing efforts in raising nutrition aspects and balanced diet among rural population, such as “akagoroba k’ababyeyi” (literally translated mothers evening) on how to use the farmer’s basket efficiently to feed the most vulnerable population, and eradicate the recurrent malnutrition.

## 7. Conclusion

The present study was conducted to analyze the current situation of food systems in Rulindo district to understand better linkages between Rulindo district and the City of Kigali and secondary cities (Musanze and Rubavu cities), identify health and sustainability issues, so that findings will inform future interventions to sustainability cope with the climate resilience. The study was conducted using RUF SAT approach, a stepwise approach to technically assess the urban food system developed by FAO. A workshop was organized with key representatives of food systems known as FLAG to validate and enrich the findings of the preliminary assessment in the literature, including pressing issues, the identification of key urban centers, and the characterization of major commodity value chains within the Rulindo District.

FLAG identified six major value chains (tomatoes, maize, bean, Irish potato, eggs and milk), the most economically important crop value chains for farmers in Rulindo District, and five important urban centers in Rulindo District (Base, Rusine, Gasiza, Remera-Mbogo and Shyorongi), linking Rulindo District to Kigali and secondary cities (i.e. Musanze, and Rubavu).

The study demonstrated the presence of a favorable environment and adequate policies to promote key agricultural commodities production. For example, the CIP policy has successfully improved high potential crop production, including maize, Irish potatoes and beans. Farmers grouped in cooperatives receive input and seed subsidies, and the Government fixes the minimum farmgate price for each harvest season to protect farmers' pricing interests. At harvest, farmers sell their produce at the farm gate or at weekly urban center markets to aggregators who supply Kigali and Rubavu markets. Despite a favorable environment that helps farmers cope with agricultural production risks (e.g. introduction of agricultural insurance and financial programs available to farmers), farmers hesitate to contact financial institutions for assistance. Many feel such programs themselves are high risk and/or will be unable to pay back a loan; instead, they rely on "tontines" at the cooperative level. Additionally, cooperatives maintain inadequate financial records of previous activity, causing problems during pricing and negotiations. Thus, farmers cannot effectively estimate what they have invested in their enterprise.

Surveyed farmers were grouped in cooperatives like 95 percent of farmers in the Rulindo district. Farmers use multi- and intercropping systems, planting multiple crops in a given piece of

land during a single growing season. They primarily grow vegetables such as beans, potatoes, and grains (maize) for household consumption. What they do not personally need, they sell to weekly local markets. The average farm size is less than 1 hectare and varies from 0.2 to 0.8 ha.

In addition to cropping activities, most farmers have one to two cows that produce between five to seven liters per cow, a backyard poultry pen housing three to five birds per household, and from two to five goats. Interviewed farmers said that the family usually consumes one or two liters of milk produced in the evening. The four to six liters produced during the morning are sold to neighbors, urban center food shops, or Milk Collection Centers (MCCs). Backyard poultry produces about 12–20 eggs per cycle. Fresh eggs produced locally are in high demand among customers who like their intensely yellow egg yolks, which are considered a sign of quality. Farmers reported during interviews that their income from animal-sourced products (i.e. milk and eggs) is used to purchase needed food commodities they cannot produce themselves, such as cooking oil, sugar, and salt.

Maize is planted on hillsides and in marshland for the two-yearly agricultural seasons: season A, (harvested during December and January), and Season B (harvested during May and June), and the production is estimated at 5 – 6 tons/ha. After harvest, maize naturally dries under the husks in drying shelters constructed by the government to support farmers, minimizing aflatoxin contamination-the ideal choice for off-takers and other buyers targeting Grade 1 maize (clean and well-dried maize grains). After shelling, up to 70 percent is directly sold to buyers (i.e., AIF and EAX) and supply Kigali markets; the remaining 30 percent is intended for household consumption and/or sold to the local market. Despite the availability of drying shelters using natural solar drying, farmers cannot achieve the required 13 percent moisture content to keep maize safe from fungal contamination because of the Rulindo District's climatic characteristics (i.e. humid and cooler ~19-25°C). During the interviews, farmers said they could only dry up to a 16-17 percent moisture content and are thus paid a low price because they cannot meet the required 13 percent moisture content for Grade 1 maize.

Beans are their primary protein source; thus, beans are a major commodity. They are consumed at each meal since animal protein is unavailable to many. For farmers, the main reason for engaging in bean production is home consumption. The unneeded portion is sold to

aggregators in local markets as a source of household cash income and then channeled to Kigali markets. All farmers interviewed for this study said they keep 50-80 percent of their bean production and sell 20-50 percent to aggregators at local markets. Improved seeds produce approximately 2 tons/ha for a cooperative, in contrast with others who use unimproved varieties that produce 800 kg/ha to 1.5 MT/ha. Access to improved seeds is one of the major challenges faced by farmers in the bean value chain.

Irish potatoes are planted depending on the season: during the dry season, they are planted in marshlands and during the rainy season, they are planted on hillsides. The production for one hectare is estimated at 15-25 tons, depending on the season and the varieties are grown. Approximately 90 percent of the production is then sold to aggregators at the farmgate; the remaining 10 percent is sold to neighbors and/or used for home consumption. Aggregators, in turn, either sell the potatoes to big buyers associated with local markets in urban centers or transport them directly to Kigali markets on trucks. Inadequate access to improved seeds is one of the major challenges farmers face in the Irish potato value chain.

Tomatoes are planted on hillsides and in marshland during three agricultural seasons: Seasons A and B with harvests during December and January, and again in May and June, respectively; and Season C during the dry season that spans June through August. Tomato farming produces an estimated 30 tons per hectare. The tomato value chain experiences high losses; approximately 25 percent of the harvested tomatoes were estimated to be damaged or destroyed because of inappropriate transport (the tomatoes are stacked on top of each other in polypropylene bags or in traditional baskets, damaging the tomatoes underneath), pests, lack of cold storage, etc. Sub-standard tomatoes are sold to cooperative members or weekly markets at a lower price. Farmers sell their produce to aggregators from Kigali and Rubavu markets and to local food shops in nearby urban centers during weekly markets. Tomatoes are transported in trucks to Kigali and Rubavu markets; bicycles are used to transport tomatoes to weekly markets. Approximately 60-70 percent goes to the most competitive markets in Rubavu City.

Farmers involved in egg production are business-oriented. They have had to invest in necessary housing for their poultry and appropriate equipment. A typical poultry farm has 1,000 to 5,000 layers per egg production cycle. The Rulindo district offers a competitive advantage. It

is located approximately halfway between the cities of Rubavu and Kigali, and there are ample feed ingredients (e.g., maize) available in the region. Eggs are sold to aggregators who transport them to Rubavu markets. Rubavu markets offer competitive prices because of their proximity and exchanges with Goma markets in the DRC. The high cost of inputs, especially for feed ingredients (such as soybean, fish meals, etc.), is still a key challenge to the egg value chain in Rulindo district particularly, and in Rwanda in general, which hampers their competitiveness compared to other eggs produced in the Eastern African (e.g., with more affordable and available feed ingredients).

Regarding the milk value chain, farmers rear mostly crossbreeds (up to 70 percent) with improved milk production (5-7 L/day) compared to local breeds (i.e., Ankole produces 1-2 L/day), thanks to the cattle genetic improvement program for the past twenty years with the introduction of exotic breeds (e.g., Holstein Friesian breeds). The majority of farmers rely principally on a zero-grazing system (a system where the grass is harvested and fed fresh to housed cattle daily) introduced countrywide to limit the spread of cattle diseases such as Foot and Mouth Disease (FMD). Farmers keep the evening milk (1-2 L/day/cow) and give it to their children; the morning milk (4-5 L/day/cow) is sold to milk collection centers (MCC) or neighbors. At the MCC, milk is tested for various quality parameters, and if it is not compliant, it is rejected and returned to the farmer, who may sell it at a low price to local food shops or consume it at home. From MCCs, milk is stored and channeled to Kigali in a refrigerated milk truck and sold to milk processing companies. Rwanda is a small country with the highest density in Africa with limited lands for livestock activities competing with other crops grown on the same lands, thus limiting the forage availability therefore, limiting milk production.

Previous reports showed that more than 16 percent of households in Rulindo District were food-insecure, and more than 19 percent were in extreme poverty and had the highest percentage of extreme-poor residents in the Northern Province correlated with malnutrition and stunting in children under five years (33.8 percent of children under five are stunted). Among the surveyed categories, four categories (farmers, landless workers, abakarani and vulnerable elderly people), have only two less diverse meals per day vs. the category of residents in urban centers. Firewood was the major cooking fuel among interviewed farmers, contributing to the deforestation, and

thus leading to environmental sustainability issues such as recurrent erosion, flood and landslides observed in Rulindo district, and contributing to anthropogenic GHG emissions therefore, contribute to global warming, in general.

Regarding the sustainability issues, food systems in the Rulindo district suffer from climate change effects. There are recurrent floods, erosion, landslides, and a long period of drought. One of the causes of environmental can be attributed to deforestation. Natural forests in the district have significantly decreased over the last decades. Settlement and its related impacts (such as wood for cooking) are at the origin of the forest declination in the Rulindo district. Currently, forest resources cover 16 percent vs. the national target of 30 percent.

Pesticides are used on a massive scale. Unfortunately, the farmers who use them do so without protection and/or training about the dangers of pesticides and how to apply them safely. Pesticides can also negatively affect ecosystems, especially the killing of non-targeted insects such as bees that play an important role in pollination.

Despite a favorable environment that helps farmers cope with agricultural production risks (e.g. introduction of agricultural insurance and financial programs available to farmers), farmers hesitate to contact financial institutions for assistance. Many feel such programs themselves are high risk and/or will be unable to pay back a loan; instead, they rely on “tontines” at the cooperative level. Additionally, cooperatives maintain inadequate financial records of previous activity, causing problems during pricing and negotiations. Thus, farmers cannot effectively estimate what they have invested in their enterprise.

Food systems in the Rulindo districts are mainly linked to Kigali city and Rubavu town. The first linkages are urban centers. Farmers or middlemen sell their products to aggregators during weekly markets and then channel them to Kigali and Rubavu city. The study linked four value chains to Kigali: maize, beans, Irish potato, and milk. Eggs and tomatoes are channeled to Rubavu markets despite the long distance between Rulindo and Rubavu. Rubavu markets offer a better alternative competitive market because of their proximity to Goma City in the Democratic Republic of Congo (DRC), and engage in commercial exchanges with Rubavu markets. Kigali is



the center of economic activities and receives national and export products. Sometimes, the competition on the market can be challenging for some products. Because of the geographic location of Rulindo, halfway between Kigali and Rubavu, farmers have the opportunity to supply the more competitive market, and for this case, Rubavu markets and channeled to Goma in DRC. Despite the competitive market in Rubavu and Goma cities for eggs and tomato, market infrastructures in surveyed urban centers are still lacking (such as cold rooms), and limit farmers having the premium price. In addition, findings showed no discussions between secondary cities (Rulindo and Rubavu) on mutual benefits to support their agricultural activities. Multistakeholder exchanges between secondary cities between Rulindo and Rubavu to discuss the infrastructures improvement and governance mechanisms to improve their respective agricultural activities can be a key to unlock potential markets in DRC beyond the Goma city.

It is worth highlighting that the COVID-19 pandemic slowed various value chain commercial activities due to travel restrictions. Losses are still high in some value chains, particularly the maize value chain with inadequate or absent post-harvest equipment. The tomato chain has inadequate or no cold storage facilities and unsatisfactory farm-to-market transport systems that collectively account for significant losses.

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# ANNEXES

## Annex 1 – Summary of actors, their role, and challenges in the maize value chain

Activity	Agents	Role in the Value Chain	Challenges
<b>Input suppliers</b>			
<b>Seeds</b>	<ul style="list-style-type: none"> <li>- Certified seed multipliers</li> <li>- RAB</li> <li>- Shops of improved seeds</li> </ul>	<ul style="list-style-type: none"> <li>- Distribution of improved seeds to farmers</li> </ul>	<ul style="list-style-type: none"> <li>- unreliable and timely availability of seeds to farmers</li> </ul>
<b>Fertilizers</b>	<ul style="list-style-type: none"> <li>- Local agro-dealers and farmers selling organic manure from livestock</li> </ul>	<ul style="list-style-type: none"> <li>- Distribution of fertilizers to farmers</li> </ul>	<ul style="list-style-type: none"> <li>- Lack and inadequate awareness on the use of chemical fertilizers</li> <li>- High cost of inputs</li> <li>- Long-distance between farmers and local agro-dealers</li> </ul>
<b>Extension</b>	<ul style="list-style-type: none"> <li>- Rulindo District extension agents</li> </ul>	<ul style="list-style-type: none"> <li>- Training of farmers on Good Agricultural Practices (GAPs)</li> </ul>	<ul style="list-style-type: none"> <li>- Few extension agents</li> </ul>
<b>Production</b>			
<b>Farmers Small/medium and Large</b>	<ul style="list-style-type: none"> <li>- More than 95% are small farmers</li> </ul>	<ul style="list-style-type: none"> <li>- Maize production</li> </ul>	<ul style="list-style-type: none"> <li>- Fall Armyworm</li> <li>- Lack of irrigation capacity</li> <li>- Prolonged periods of drought</li> <li>- Landslides</li> <li>- Erosion</li> </ul>
<b>Harvest, Marketing Processing and Retailing</b>			
<b>Harvest and postharvest handling</b>	<ul style="list-style-type: none"> <li>- Farmers</li> </ul>	<ul style="list-style-type: none"> <li>- Drying under the husks in drying shelters</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of adapted drying equipment and farmers rely on intermittent solar drying</li> <li>- Aflatoxin contamination and insect infestation</li> </ul>
<b>Processing activities</b>	<ul style="list-style-type: none"> <li>- Maize processing plants based in Rulindo</li> <li>- EAX and AIF based in Kigali</li> </ul>	<ul style="list-style-type: none"> <li>- Purchase the maize production gathered at the cooperative and transport for processing</li> </ul>	<ul style="list-style-type: none"> <li>- Maize of poor quality</li> <li>- Inadequate dried maize</li> <li>- Aflatoxin contamination</li> </ul>
<b>Retailing</b>	<ul style="list-style-type: none"> <li>- Food shops in urban centres</li> </ul>	<ul style="list-style-type: none"> <li>- Selling maize flour known as “Kawunga”</li> </ul>	<ul style="list-style-type: none"> <li>- Flour of poor quality potentially contaminated with mycotoxins.</li> </ul>

## Annex 2 – Summary of actors, their role, and challenges in the Irish potato value chain

Activity	Agents	Role in the Value Chain	Challenges
<b>Input suppliers</b>			
<b>Seeds</b>	- Certified seed multipliers	- Distribution of improved seeds to farmers	- Poor quality of seeds
<b>Fertilizers</b>	- Local agro-dealers and farmers selling organic manure from livestock	- Distribution of fertilizers to farmers	- Lack and inadequate awareness on the use of chemical fertilizers - High cost of inputs - Long-distance between farmers and local agro-dealers
<b>Extension</b>	- Rulindo District extension agents	- Training of farmers on Good Agricultural Practices (GAPs)	- Few extension agents
<b>Production</b>			
<b>Farmers Small/medium and Large</b>	- More than 95% are small farmers	- production	- Lack of irrigation capacity - Prolonged periods of drought - Landslides - Erosion
<b>Harvest, Marketing Processing and Retailing</b>			
<b>Harvest and postharvest handling</b>	- Farmers	- Packing in 25-kg PP bags	- -
<b>Processing activities</b>	- Processing is in nascent form		
<b>Retailing</b>	- Food shops in urban centres	- Selling Irish potatoes	

### Annex 3 – Summary of actors, their role, and challenges in the bean potato value chain

Activity	Agents	Role in the Value Chain	Challenges
<b>Input suppliers</b>			
<b>Seeds</b>	<ul style="list-style-type: none"> <li>- Improved seeds from HarvestPlus</li> <li>- Seed retained from a previous harvest</li> </ul>	<ul style="list-style-type: none"> <li>- Farmers</li> </ul>	<ul style="list-style-type: none"> <li>- Poor quality of seeds</li> </ul>
<b>Fertilizers</b>	<ul style="list-style-type: none"> <li>- Local agro-dealers and farmers selling organic manure from livestock</li> </ul>	<ul style="list-style-type: none"> <li>- Distribution of fertilizers to farmers</li> </ul>	<ul style="list-style-type: none"> <li>- Lack and inadequate awareness on the use of chemical fertilizers</li> <li>- High cost of inputs</li> <li>- Long-distance between farmers and local agro-dealers</li> </ul>
<b>Extension</b>	<ul style="list-style-type: none"> <li>- Rulindo District extension agents</li> </ul>	<ul style="list-style-type: none"> <li>- Training of farmers on Good Agricultural Practices (GAPs)</li> </ul>	<ul style="list-style-type: none"> <li>- Few extension agents</li> </ul>
<b>Production</b>			
<b>Farmers Small/medium and Large</b>	<ul style="list-style-type: none"> <li>- More than 95% are small farmers</li> </ul>	<ul style="list-style-type: none"> <li>- production</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of irrigation capacity</li> <li>- Prolonged periods of drought</li> <li>- Landslides</li> <li>- Erosion</li> </ul>
<b>Harvest, Marketing Processing and Retailing</b>			
<b>Harvest and postharvest handling</b>	<ul style="list-style-type: none"> <li>- Farmers</li> </ul>	<ul style="list-style-type: none"> <li>- Packing in 25-kg PP bags</li> </ul>	<ul style="list-style-type: none"> <li>-</li> <li>-</li> </ul>
<b>Processing activities</b>	<ul style="list-style-type: none"> <li>- Processing is in inexistent form</li> </ul>		
<b>Retailing</b>	<ul style="list-style-type: none"> <li>- Food shops in urban centres</li> </ul>	<ul style="list-style-type: none"> <li>- Selling beans</li> </ul>	



#### Annex 4 – Summary of actors, their role, and challenges in the tomato value chain

Activity	Agents	Role in the Value Chain	Challenges
<b>Input suppliers</b>			
<b>Seeds</b>	- Local agro-dealers	- Distribution of improved seeds to farmers	- High cost of seeds
<b>Fertilizers</b>	- Local agro-dealers and farmers selling organic manure from livestock	- Distribution of fertilizers to farmers	- High cost of inputs - Long-distance between farmers and local agro-dealers
<b>Extension</b>	- Rulindo District extension agents	- Training of farmers on Good Agricultural Practices (GAPs)	- Few extension agents
<b>Production</b>			
<b>Farmers Small/medium and Large</b>	- Farmers	- production	- High harvest and post-harvest losses
<b>Harvest, Marketing Processing and Retailing</b>			
<b>Harvest and postharvest handling</b>	- Farmers	- Packing in 25-kg PP bags	- High harvest and post-harvest losses - Lack greenhouse tomatoes - Inadequate packaging - Absence of cold chain
<b>Processing activities</b>	- One company involved in processing activities		
<b>Retailing</b>	- Food shops and markets in urban centres	- Selling tomatoes	- Absence of cold rooms

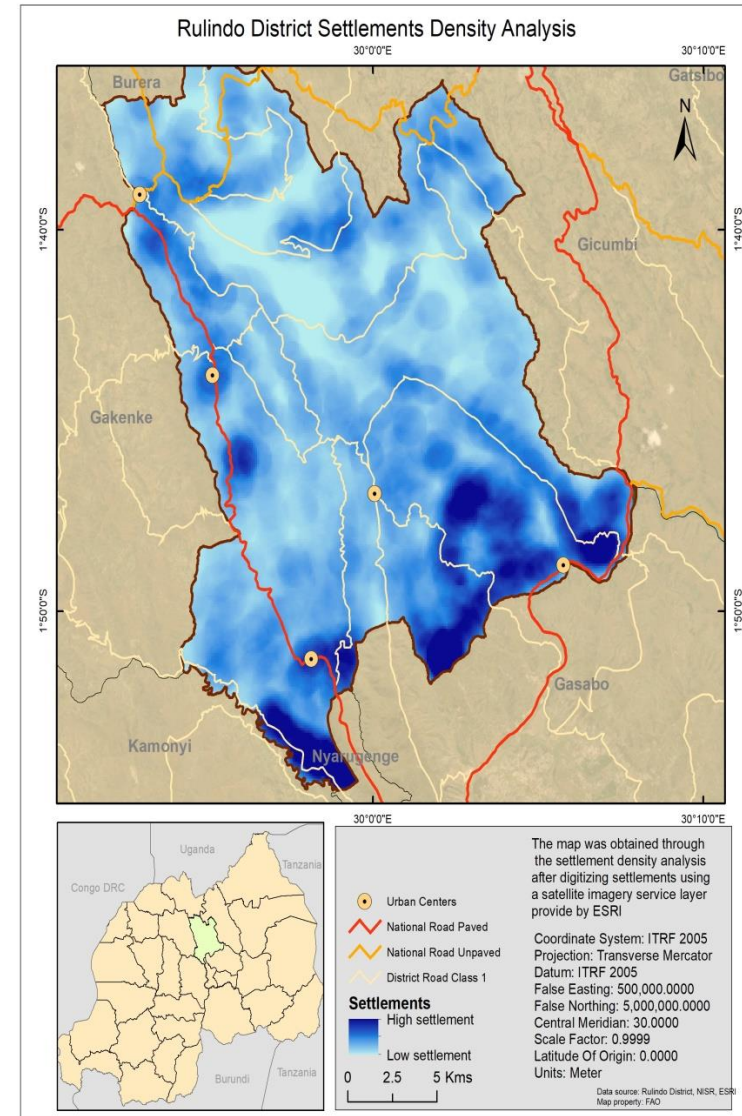
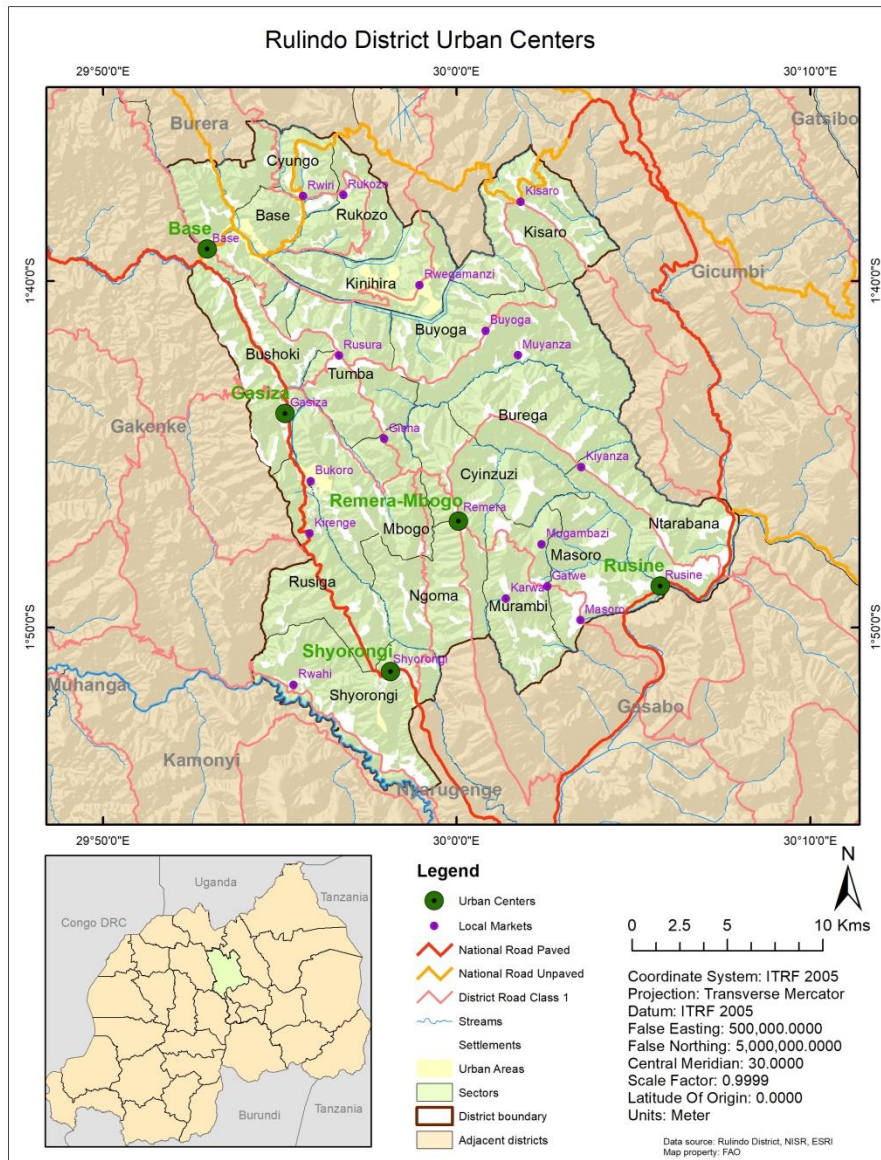
## Annex 5 – Summary of actors, their role, and challenges in the egg value chain

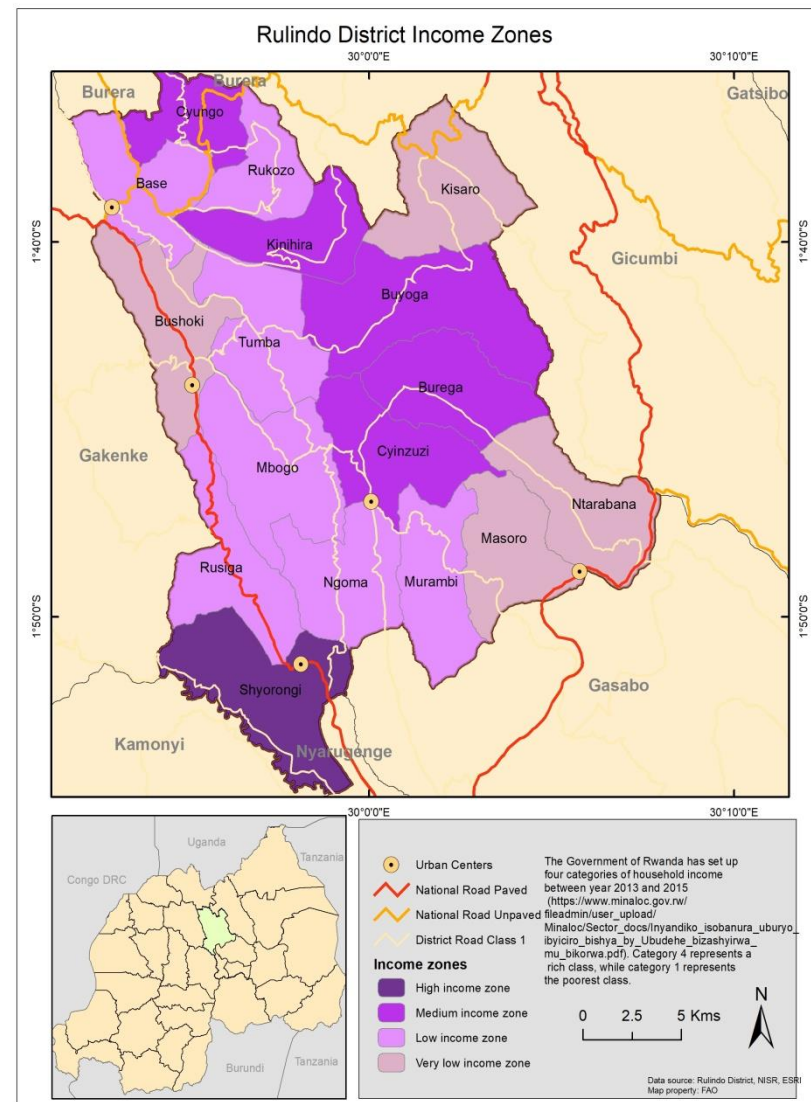
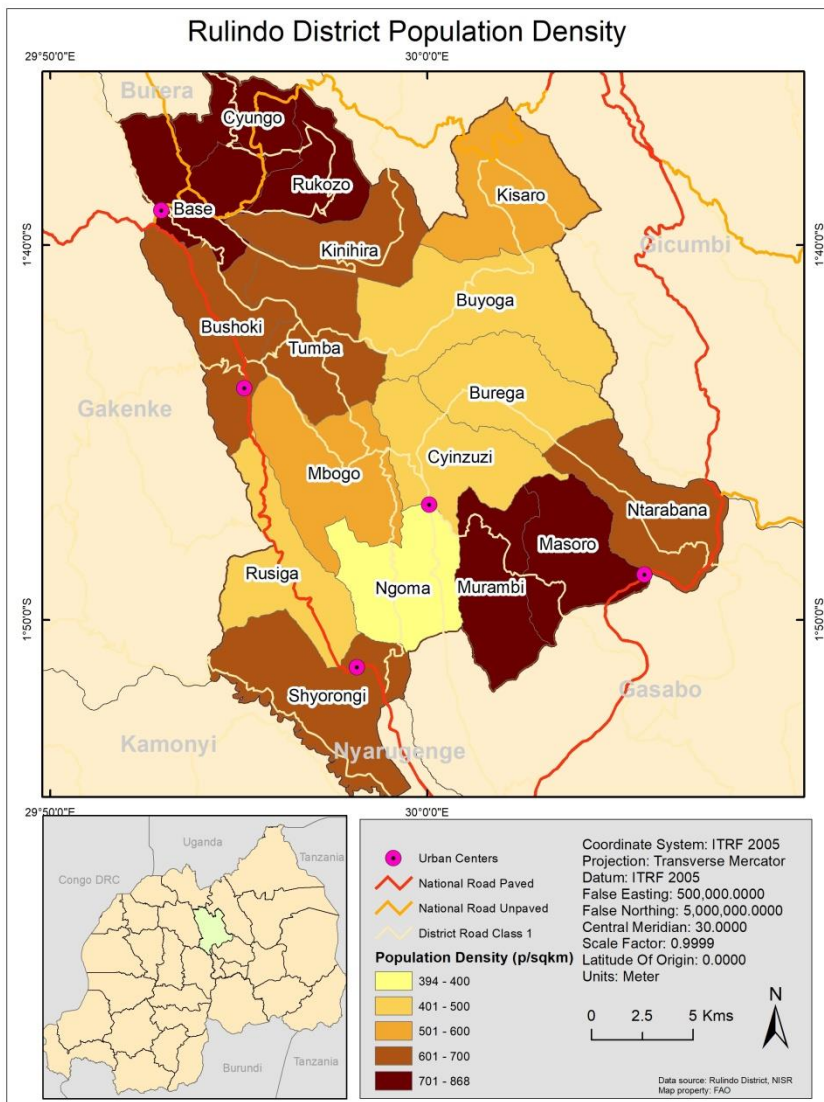
Activity	Agents	Role in the Value Chain	Challenges
<b>Input suppliers</b>			
<b>One-day chicks</b>	- Local agro-dealer	- Distribution of One day chicks	- Recurrent infectious diseases
<b>Feeding</b>	- Farmers (home-made feed)	- Egg production	- High cost of ingredients
<b>Egg production and selling</b>	- Business-oriented farmers	- Egg production	- High price volatility - Antimicrobial resistance

## Annex 6 – Summary of actors, their role, and challenges in the egg value chain

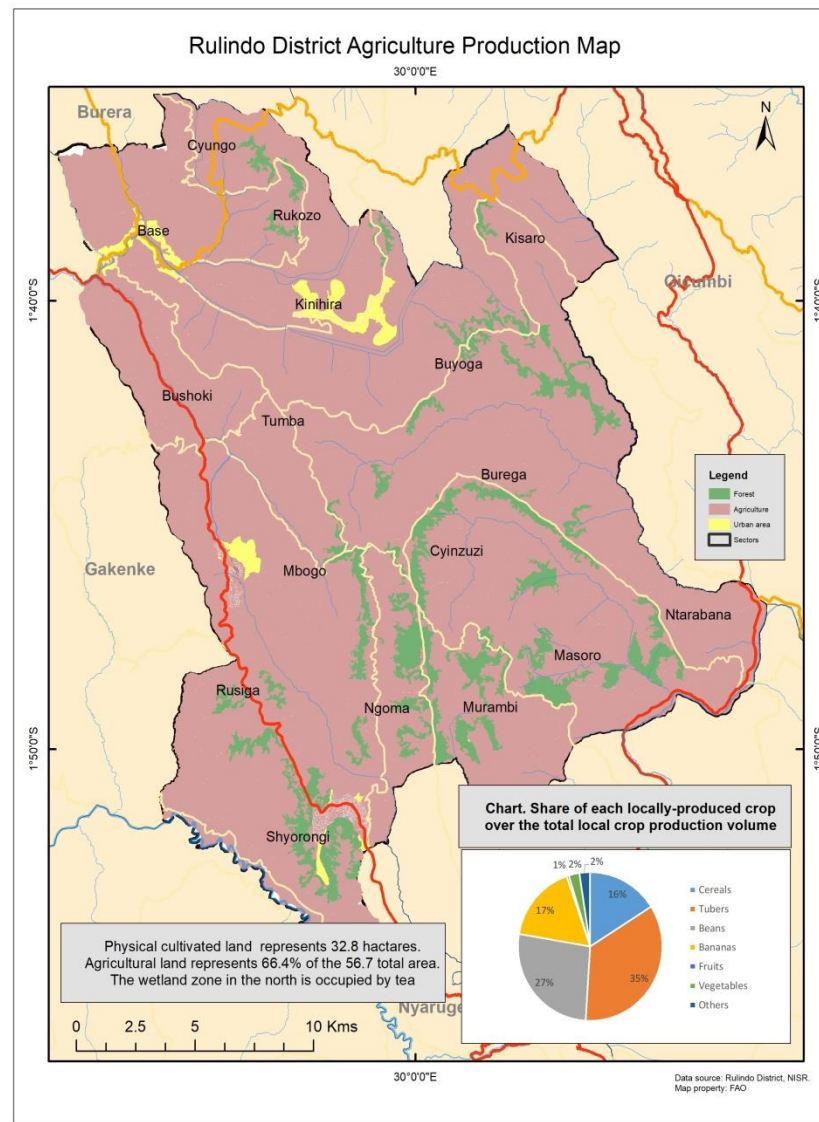
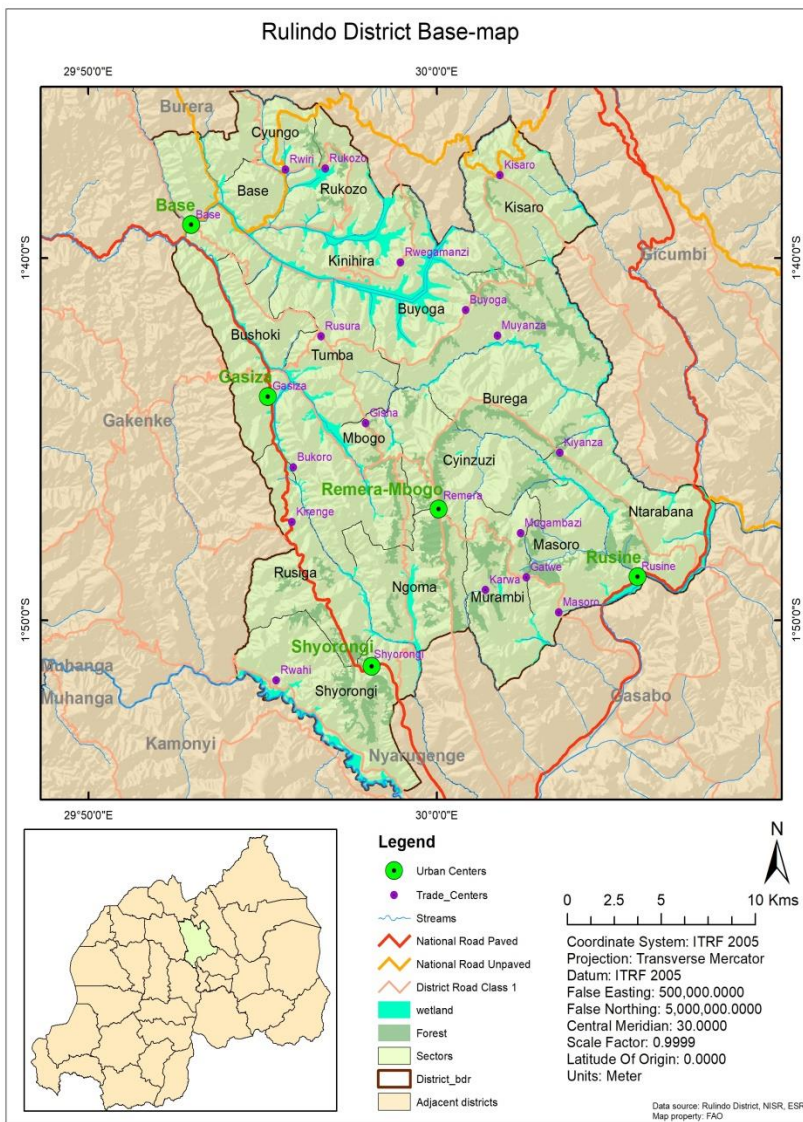
Activity	Agents	Role in the Value Chain	Challenges
<b>Input suppliers</b>			
<b>Production</b>	- Farmers	- Milk Production	<ul style="list-style-type: none"> <li>- High cost of feed ingredients</li> <li>- Recurrent animal diseases</li> </ul>
<b>Processing</b>	- MCCs	- Milk collection centres	<ul style="list-style-type: none"> <li>- Rejection due to milk-borne pathogens and antibiotic resistant</li> <li>-</li> </ul>

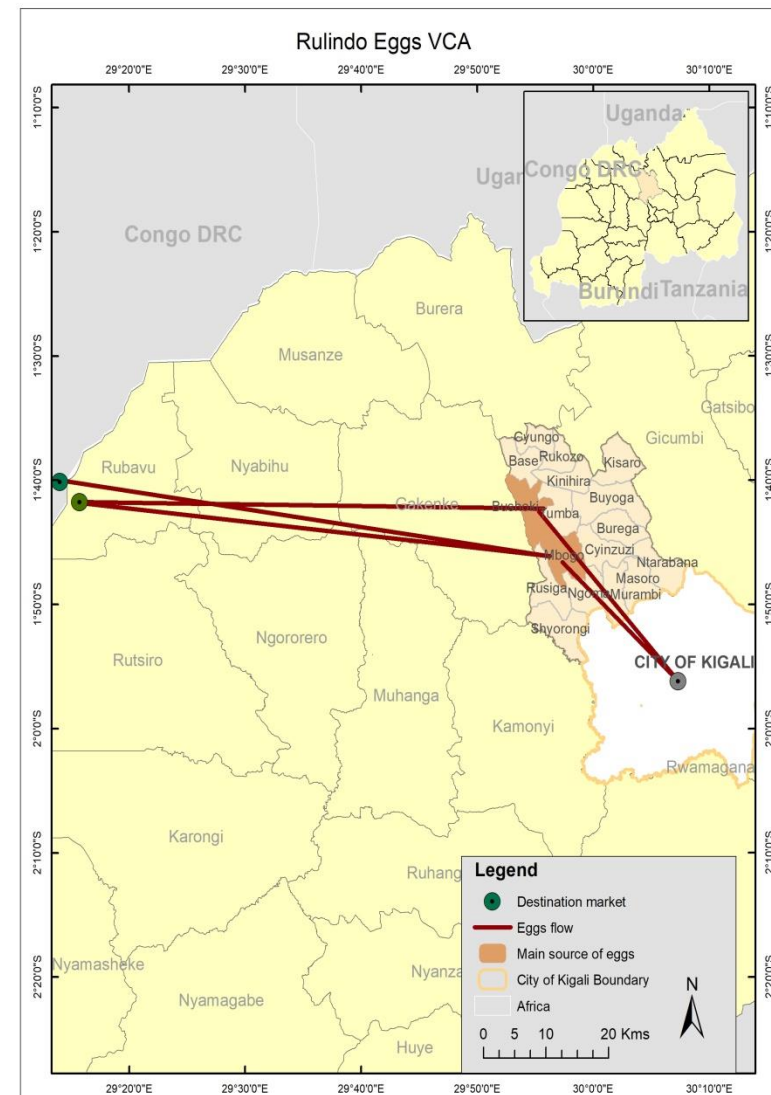
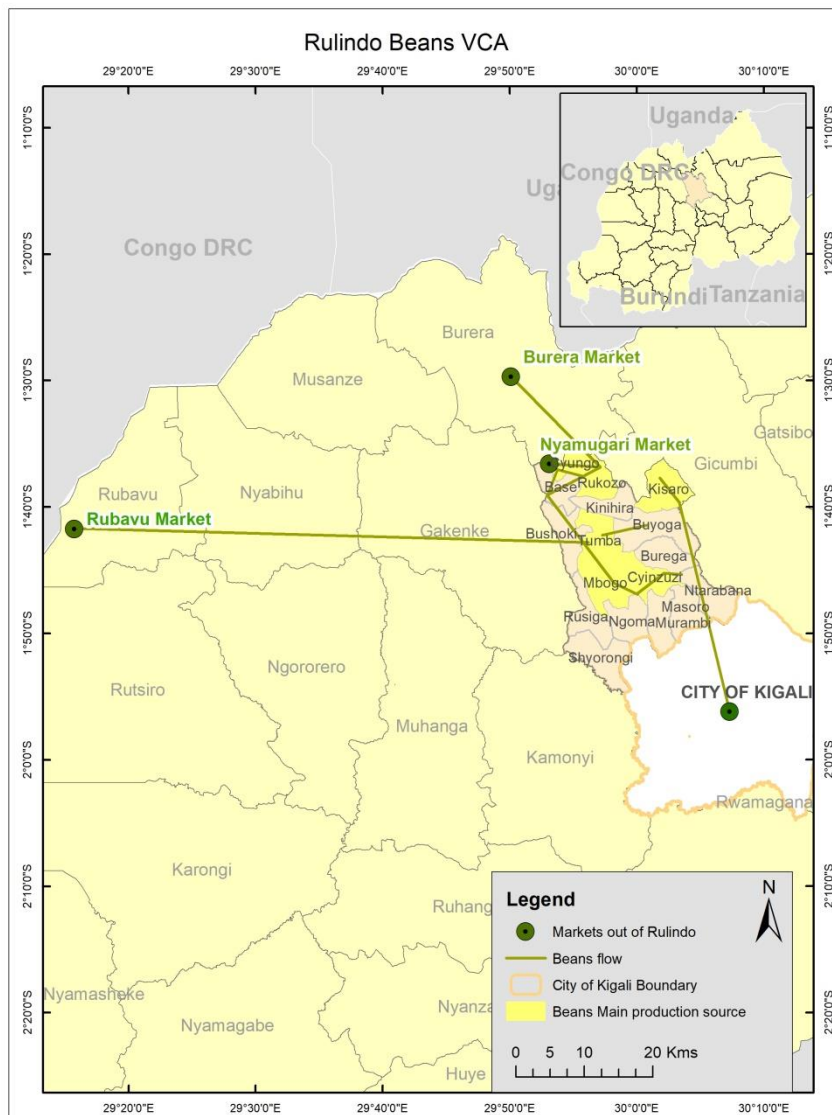
## Annex 7: Produced maps





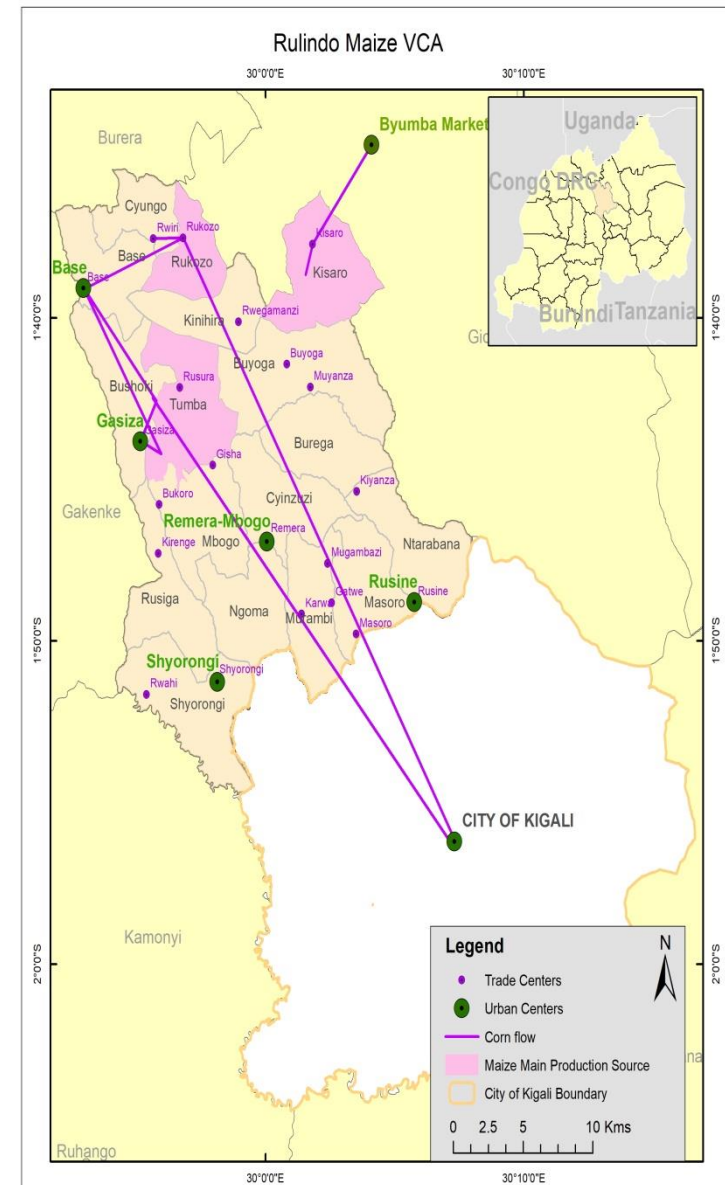
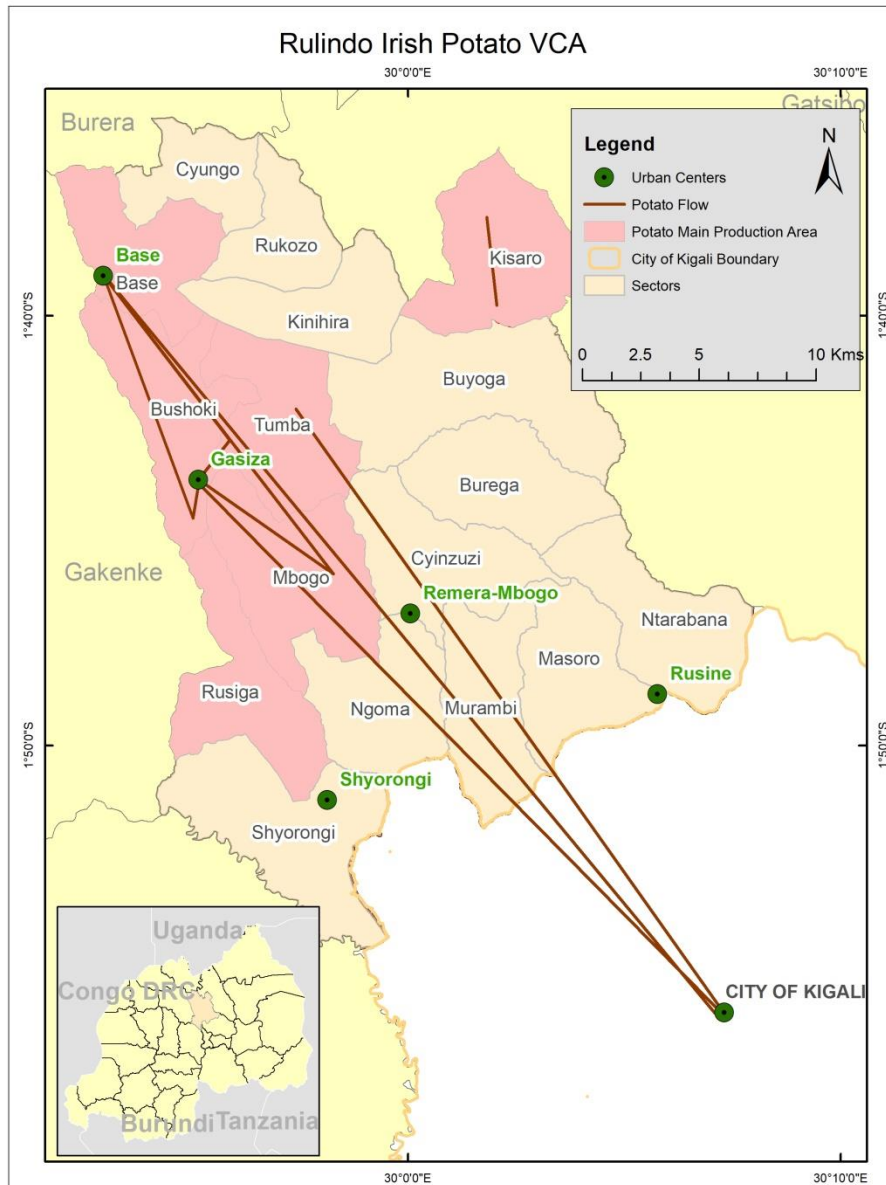


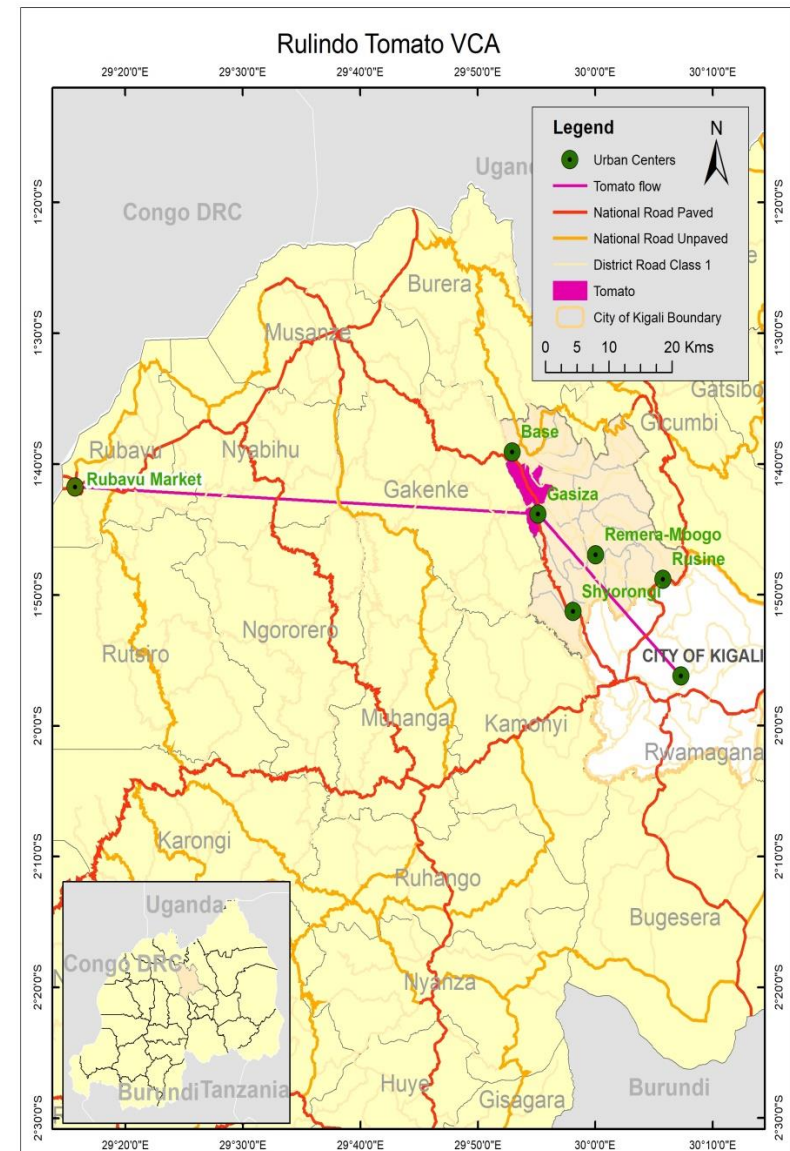
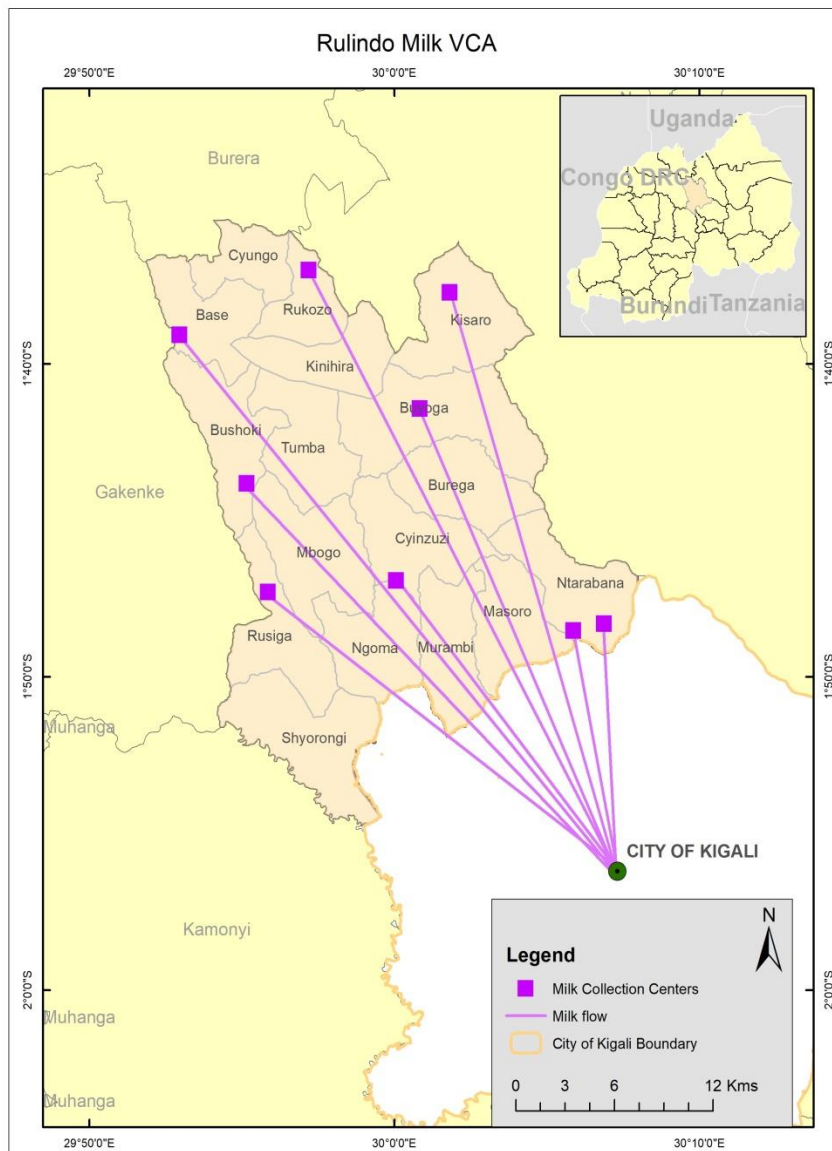












## **Annex 8: Focus Group Discussion Guide**

1. What is the household size (Male, female, children, etc)?
2. How many meals do take per day (breakfast, dinner, lunch)? What is the composition of each meal?
3. Do the children eat at the same as the parents? Do they have a particular meal?
4. Who is in charge of cooking? How long does she/he use?
5. Where do you buy food commodities? Who is in charge?
6. Do you have left-over? If so, what do you do with leftovers?
7. Do household members have access to animal source food?
8. On average, what are your monthly expenses?
9. What do you use for cooking (charcoal, LPG, woods)?
10. Do you go out as household members?
11. Have you received any training on food safety?
12. Do you receive any support from the Government?
13. How do you cope with the food insecurity?

## Annex 9: Interview guide

### I. Background Information

No.	Question	Response options	Response
1	Name of the city		
2	Address		
3	Date	DD/MM/YYYY	
4	Interviewer	Initials	
5	GPS Coordinates	Latitude	
6		Longitude	
7		Altitude	
8	Gender of respondent	1= Female 2= Male	
9	Age of respondent	Years	
10	Marital status	1= Single / never married 2= Married 3= Widowed / divorced / separated	
11	How many people are there in your household?	Number	

### II. Details regarding Drinking Water and Cooking

	Question	Response Codes	Response
12	Type of House	1= House with permanent roof 2= House with temporary roof 3=Other	
13	Type of cooking fuel used by your HH?	1= LPG gas 2= Electric 3=Firewood 4=Kerosene 5=Dung 6= Charcoal 7=Other	
14	Do you own a refrigerator?	1= Yes 0= No	
15	Do you own a microwave?	1= Yes 0= No	
16	What is the main source of water used for drinking and cooking?	1= Piped Water in the house 2= Dug Well in the house 3= Surface Water (Pond, river, stream) 4= Common water pump in the neighborhood Delivered Water (truck tanker, etc.) 5= Other (Specify)	
17	In the last year, have there been times when your household did not have sufficient quantities of drinking water when needed?	1= Very Often 2= Often 3=Sometime 4= Rarely 5=Never	
18	Do you treat the water in any way before you use it?	1= Yes 0= No	

19	If yes, how do you treat the water?	1= Boil 2=Add Bleach/Chlorine 3=Strain with a cloth 4= Let it stand 5= Solar disinfection 6= Other (Specify)	
20	How often do you wash fruits and vegetables with clean water?	1= Never 2= Sometimes 3= Always	
21	How difficult is it for you to access clean water to wash fruits and vegetables?	1= Not difficult 2= Somewhat difficult 3= Very difficult	
22	Within the last twelve months, have you or has anyone else in your household received any information about food safety?	1= Yes 0= No	
23	Who provided that information? <i>Check all that apply.</i>	1= Government agency 2= NGO 3=School 3= Print Media 4=Social Media 5= Other (Specify)	
24	What actions did you take/what things have you changed?	1= None 2= Started treating drinking water 3= Started washing fruits and vegetables 4= started fully cooking the food (instead of consuming raw) 5= Other (Specify)	
25	What is your total household income PER MONTH?	Local currency	
26	How much money does your household spend PER MONTH on food purchase from retailers? (This includes groceries, fruits, vegetables, animal products, fish, etc.)	Local currency	
27	How much money does your household spend PER MONTH on food purchased from restaurants/food service outlets? (Including home delivery, take away, office/school canteen, etc.)	Local currency	

### III. Family Members Engaged in Shopping and Cooking

Family Member Code (Relationship to Respondent) (See Code A)	Age (years)	Sex 1= Male 2= Female	Education (Code B)	Height (in Inches)	Weight (in KG)	Role in Shopping Food 1= High 2= Medium 3= Low 4=None	Role in Cooking Food 1=High 2=Medium 3=Low 4=None	Time Spent in cooking during weekday (minutes)	Time Spent in cooking on a typical weekend (minutes)

**CODE A:** 1=Respondent himself/herself, 2=Wife or Husband, 3=Son/Daughter, 4=Grandchild, 5=Father/Mother, 6=Sister/Brother, 7=Niece or Nephew, 8=Son/Daughter in law, 9=Brother/Sister in law, 10=Father/Mother in law, 11=Other family relatives, 12= other non related

**CODE B:** 1= Illiterate, 2= Literate, no formal education, 3= Primary school (up to Standard 5), 4= Middle school (Standard 5-8) , 5= High school (Standard 10) 6= Higher secondary school (+2), 7= Graduate (BA/BSc/BCom/Diploma), 8= Professional degree/Post graduate

**IV. Dietary Preference of the family members**

Family Member Code (Use the same as Question III)	Vegetarian 1= Yes, 2=No	Non Vegetarian 1= Yes, 2=No	Vegan 1= Yes, 2=No	Mostly Vegetarian (Fish) 1= Yes, 2=No	Following a health diet 1= Yes, 2=No	Following a Religious diet 1= Yes, 2=No	

## V. Consumption Pattern

In a typical week, how many meals are:

- Prepared at home
- Packaged foods (Boxed foods like cereals etc., frozen foods, Ready to eat)
- or prepared outside the home (School meal, office meal, restaurants, fast foods, street food vendors). Takeaways and home delivery will also be included here.

[illegible]

Code A: 1= school meal, 2=office meal, 4=government/community canteen, 3=Full serve restaurant/Food service (including take away and delivery), 4= Fast Food Restaurant (including takeaway and delivery), 5=Street food (including take away), 6= other (Specify)



## VI. Frequency of Food Consumption

Thinking about the food that was eaten in your household over the **PAST WEEK** (last 7 days), answer each of the following questions in relation to how many times each food group was consumed in the past week by the family member

**Consumption = Consumed number of times per week**

Family member Code from Ques III	Cereals	Eggs	Chicken	Red Meat	Fish	Roots and Tubers	Green Leafy Vegetable	Other Vegetable	Pulses and legumes	Fresh Milk	Milk Products Butter/Cheese/Yogurt	Fresh Fruit	Dried Fruit	Salted snacks and Crisps	Chocolate / Bakery/ Confectionary

## VII. Types of retailer used for food purchase

No.	Question	Options	Permanent Wet Market	Temporary Wet Market	Government ration shop	Small local shop	Specialty store (bakery, dairy)	Street vendor	Mobile door-to-door vendor	Grocery Store	Internet (delivery)
28	Do you shop for food in these places?	1= Yes 0= No									
29	If yes, how often do you shop in each place?	1= Everyday 2= 2-6 times a week 3= 1 time a week 4= 2-3 times a month 5= 1 time a month or rarely									
30	How far is it from your house?	Meters									
31	What form of transportation do you use to get to each place?	1= Walking 2= Bicycle 3= Motorbike 4= Car 5= Public transit 6= Other (Specify)									

### VIII. Food purchased from a retailer

No.	Question	Options	Meat or Poultry	Dairy	Eggs	Cereals	Fresh Vegetables	Roots/Tubers	Fruits	Soft Drinks	Crisps	Sweet Biscuits or Confectionery
32	Where do you get each of these foods? <i>Check all that apply.</i>	1= Don't consume 2= Purchase from a retailer (includes government ration shops) 3= Purchase from restaurants/food service outlets 4= Grow/produce at home 5= Receive as gift from family or friends 6= Receive from NGO/food aid 7= Other (Specify)										
33	If "purchase from a retailer", from which type of retailer do you most often purchase this food?	1= Permanent Wet Market 2= Temporary Wet Market 3= Government ration shop 4= Small local shop 5= Specialty store (bakery, dairy) 6= Street vendor 7= Mobile door-to-door vendor 8= Grocery store 9= Internet (delivery)										
34	Which do you most often buy?	Check all that apply.	1= Mutton 2= Chicken 3= Other (Specify)	1= Milk 2= Butter 3= Cheese 4= Ice cream 5= Other (Specify)			Pre-specified options			1= Soda 2= Hershey's Milk 3= Energy drinks 4= Other (Specify)		Pre-specified options
35	How much money do	Local currency										

	you spend on each occasion that you buy it?											
36	How much do you spend on this every month?	Local Currency										

## IX. Food Waste and Loss

37. How much food does your household throw away every week?

Options	Please tick the appropriate option
Very excessive amounts	
A reasonable amount	
Very Little	
None	

38. What are the main reasons for food waste?

Options	Rank the top three options
We don't waste any food	
Some members do not finish their meal	
Some family members do show up for meals	
We prefer to eat the freshest food	
Food stays in the fridge/freezer too long	
We buy too much food	
We cook too much food	
Other (Specify)	

39. What do you do with the food you reject?

Options	Rank the top two options
Put in household trash	
Compost	
Feed to animals	
Give to someone else	
Other (Specify)	

## X. Reasons for buying from Preferred Source

How important are each of the following factors when deciding where to purchase your food? [READ ALL]	Not important	Somewhat Important	Important
<i>Affordability</i>			
Offers a competitive price			
I can bargain on price			
Offers credit			
I am able to buy in small quantities			
<i>Convenience</i>			
Close to my home			
Open at a time that is convenient for me			
I can buy everything I need there ["one stop shop"]			
Offers easy parking			

Offers home delivery			
<i>Quality of Service</i>			
I trust the vendor			
I feel safe and secure			
Offers friendly service			
It provides a clean, comfortable environment			
<i>Quality of Products</i>			
Has a wide range of products			
Products taste good			
Products are well presented			
Products are fresh			
Products have a long shelf life			
Food is safe to consume			
Product is quality assured or offers a quality assurance logo			

## **XI. Food Security and Nutrition Education**

N o.	During the last twelve months was there a time when....	Options	Response
37	You or others in your immediate household were worried you would run out of food because of the lack of money or other resources	1= Yes 0= No	
38	You or others in your immediate household were unable to eat healthy and nutritious food because of the lack of money or other resources	1= Yes 0= No	
39	You or others in your immediate household ate only a few kinds of food because of a lack of money or other resources	1= Yes 0= No	
40	You or others in your immediate household had to skip a meal because there was not enough money or other resources to get food	1= Yes 0= No	
41	You or others in your immediate household ate less than you thought you should because of a lack of money or other resources	1= Yes 0= No	
42	Your immediate household ran out of food because of the lack of money or other resources	1= Yes 0= No	
43	You or others in your household were hungry but did not eat because there was not enough money or other resources for food	1= Yes 0= No	
44	You or others in your household went without eating for a whole day because of a lack of money or other resources	1= Yes 0= No	
<i>Nutrition education</i>			
45	Within the last twelve months, have you or has anyone else in your household received any information about healthy, nutritious diets?	1= Yes 0= No	
46	Who provided that information? <i>Check all that apply.</i>	1= Government agencies 2= NGO 3= Schools 4= Print Media 5= Social Media 6= Other (Specify)	
47	What actions did you take/what things have you changed? (Please specify)		