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WATER GLOBAL PRACTICE **CASE STUDY**

Assessment of Farmer-Led Irrigation Development in Rwanda

Innocent Nzeyimana

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1818 H Street NW, Washington, DC 20433
Telephone: 202-473-1000; Internet: www.worldbank.org

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Executive Summary

Only nine percent of Rwanda's potential irrigation areas are currently irrigated. In other eastern and central African countries (such as Ethiopia, Kenya, Tanzania, and Uganda), on average, 2 percent of cultivated areas are under irrigation (FAO, 2015).

Irrigation development in Rwanda is typically not demand-driven. Existing irrigation developments have mostly resulted from government-led initiatives and donor support with the aim of achieving food security. A few irrigation projects have also been initiated by private commercial farmers and smallholder farmers with use of small-scale irrigation technology (SSIT).

Farmer-led irrigation development (FLID) is defined as a process by which small-scale farmers or commercial farmers drive the establishment, improvement, and/or expansion of irrigated agriculture, often in interaction with external actors. It typically involves entrepreneurial investments by farmers either alone or in groups.

Farmer-led irrigation development depends on farmers driving the improvement in irrigated agriculture through knowledge production, technology use, investment patterns, market linkages, and improved governance of land and water (Woodhouse *et al.,* 2017). Small-scale farmers often work closely with external actors, and the process typically involves entrepreneurial investors acting either alone or in groups. FLID cuts across existing classifications—defined by crops, governance, scale, and technologies—and usually focuses on high-value horticultural crops.

Status of FLID in Rwanda

Areas under FLID in Rwanda are mainly concentrated in the Eastern and Southern Provinces – , which are most prone to droughts or erratic rainfall.

FLID initiatives appear as small-, medium-, and large-scale farming. Small-scale FLID involves individual smallholder farmers, commercial farmers, and community enterprises, such as cooperatives, on land ranging from 0.10 to 10 hectares. These farms also benefit from using small-scale irrigation (SSI) equipment obtained at a 50 percent government subsidy. Other FLID activities include marshland and hillside irrigation schemes at medium- (10 to 100 hectares) to large-scale (more than 100 hectares), developed with financial support from the Government of Rwanda (GoR) and development partners (DPs), or private commercial farmers (MINAGRI, 2014a).

Farmer-led small-scale irrigation (SSI) is characterized by various types of technology, such as pumps (i.e., motorized pumps, treadle pumps, and solar-powered pumps), water distribution systems (i.e., drip, sprinkler systems.), hand-watering kits, and open surface systems used in rice and vegetable marshlands. Only 13 percent of smallholder irrigated farms use such FLID technologies , whereas the

other 87 percent of smallholder farmers cultivate on irrigated marshlands and hillside land developed with government and donor support.

In addition, about 70 percent of smallholder irrigated farms in Rwanda use lowland marshlands developed with gravity irrigation canals. About 17 percent of smallholder hillside irrigated farms have pressurized developments, such as drip, sprinkler, and pivot systems, which use electrical power as the source of energy (RAB, 2018). Most of these systems use water pumped from lakes or rivers, from groundwater sources tapped through drilling, or from small dams or reservoirs accessed via rainwater harvesting.

Water Resources

Rwanda has abundant water resources. However, they are not evenly distributed. In term of annual water volumes, Rwanda has about 6 to 7 billion cubic meters of surface water, 4.50 to 5 billion cubic meters of groundwater, and 27.50 billion cubic meters of rainwater. Annual water storage per person is estimated at 447 cubic meters per year, while total renewable water resources are about 6.80 billion cubic meters per year. Annual renewable water available per capita is estimated at 670 cubic meters (NISR, 2017). These resources are enough to irrigate 110,107 hectares of potential FLID areas identified in Rwanda (MINAGRI, 2010b).

Market Assessment

The Rwandan agricultural market is mostly dominated by food crops, especially maize (flour), rice, and soybeans (particularly for domestic agro-industries). Major crops cultivated in FLID areas in Rwanda consist of maize, rice, soybeans, and horticulture products (such as fruits and vegetables).

The population of Rwanda is projected to grow to 16.90 million by 2032 (NISR, 2012). This growth, coupled with increasing urbanization and household incomes, is among the key factors behind the increasing demand for maize, rice, and vegetables. The domestic demand for rice is met at 51 percent by local production and 49 percent by imports, especially from Tanzania and Asian countries (India, Pakistan, and Thailand). Locally produced maize satisfies the domestic market at 83 percent, while the remaining 17 percent of domestic demand is met by imports. Local soybean production and productivity are too low to satisfy the increasing demand by the domestic market, which is still rather small. The most frequently purchased horticulture crops in Rwanda are represented by vegetables (77.30 percent) and fruits (20.30 percent); the remaining 2.40 percent of horticulture products include chilies, flowers, nuts, and spices (NAEB, 2014a). Production of high-value horticulture crops is not equally distributed across the country. Smallholder farmers engaged in FLID who produce vegetables are concentrated in the Southern, Northern, and Western Provinces, while fruits are mostly produced in the Eastern Province.

Availability of energy resources will be critical to expanding the domestic agriculture supply chain. Biomass is the most important energy source in Rwanda, and more that 94 percent of households use biomass for cooking. About 85 percent of primary energy comes from biomass sources, such as agriculture waste, charcoal, and wood. As Rwanda aspires to expand areas under irrigation by scaling

up cost-effective marshland and SSIT, energy demand to expand FLID will undoubtedly increase and smallholder farmer-led irrigators will benefit from affordable tariffs forelectricity.

Enabling Environment Policy and Institutional Framework

The current agriculture policy and the Fourth Strategic Plan for Agriculture Transformation (PSTA-4) established a framework to promote FLID and sustainable water management. This framework allows farmers, especially smallholder farmers, to move from rainfed farming to irrigated agriculture, aiming to help them increase crop and land productivity.

PSTA-4 aims to build a resilient and climate change-responsive agriculture. Agriculture in Rwanda is, which is still highly dominated by small-scale subsistence rainfed farming reliant on traditional technologies and practices, thus making the sector vulnerable to rainfall variability. The plan promotes development of affordable and sustainable FLID technology through scaling up of SSIT for improved crop and land productivity and commercial farming (MINAGRI, 2018d).

According to the Rwanda Irrigation Master Plan, the country has a national irrigation potential of 589,713 hectares distributed across six domains (groundwater resources, lake water sources, marshlands, rivers and flood water, runoff from dams, and runoff from reservoirs), out of which only 10 percent (52,936 hectares) is developed for agricultural production (MINAGRI, 2010b).

The National Irrigation Policy establishes a supportive environment for the development and expansion of efficient and cost-effective FLID that contributes effectively to the national economy. SSI strategy is now being implemented to promote low-cost and sustainable farmer-led investments in irrigation to support the country's vision of rural poverty alleviation. The policy also promotes widespread use of demand-driven, affordable, and already-assembled SSI equipment that is locally fabricated (MINAGRI, 2014c).

Moreover, considering an increasing competition for water resources among different economic sectors and realizing that the development and expansion of FLID will require huge quantities of water resources, the GoR has put in place a National Policy for Water Resources Management that provides a comprehensive framework for equitable and sustainable allocation of water resources across different sectors to meet the social and economic needs of present and future generations (MINIRENA, 2011).

The Rwanda National Water Resources Master Plan was adopted to ensure sustainable water resource development, management, and usage in the country. The plan supports decision making to quantify available water resources, as well as demand by sector, and to propose a management plan for optimal and rational use of available resources. The plan acknowledges that water for economic development is principally required for the agriculture sector's growth and, more precisely, for the irrigation subsector (MINIRENA, 2015). Additionally, the National Land Use and Development Master Plan was adopted to reduce high pressure on arable land, which is the key factor of agriculture production because of the steady growth of both the population and the economy (MINIRENA, 2010).

Furthermore, because FLID involves different stakeholders, the Ministry of Agriculture and Animal Resources (MINAGRI) has been collaborating and partnering with civil society organizations, DPs, farmer organizations and cooperatives, financial institutions, other ministries, private entities, and so on, to achieve transformation of the sector through FLID**.**

To address the yield gap within FLID, the government has been implementing the Crop Intensification Program since 2007 to expand access to and use of fertilizers and improved seeds, access to financial services, irrigation, access to markets, mechanization, postharvest handling technology and storage mechanisms, proximal extension and advisory services. In addition, equipment and farm machinery are exempt from value added taxes to promote FLID (MINECOFIN, 2012).

FLID Supply Chains

FLID equipment and accessories are mostly dominated by animal, manual, and mechanical tools used to perform farming activities. Such activities include land preparation, crop production and management, spraying, harvesting, post-harvesting, storage, and processing for the commodities identified under FLID, namely, maize, rice, soybeans, and vegetables (cabbages, eggplants, green peppers, onions, and tomatoes).

In FLID initiatives, land preparation is performed using manual labor and hand tools. A few large-scale commercial farms (such as the agro-processing industry military farm, Bramin Farm, ProDev Bugesera, and NAVR) and a small number of cooperatives (such as the Kooperative y'Abahinzi Borozi mu kibaya cy'Umuvumba (KABOKU)), and others mostly growing cash crops (such as maize, paddy rice, and soybeans) use two- and four-wheel tractors with plowing and harrowing implements for land preparation. The tractors are usually owned or hired.

Additionally, most farmers involved in FLID practice manual plowing with a hoe, and use other hand tools, such as machetes or sickles, pitchforks, rakes, wheelbarrows, and watering cans and sprayers. Two-wheel tractors (known as power tillers), four-wheel tractors, and other post-harvesting equipment, including shellers, threshers, and winnowers, also are used in FLID supply chains. The lack of spare parts for agriculture machinery is the main challenge facing FLID, because most equipment is imported.

The planting or sowing of most crops is performed manually in most FLID schemes. About 17 percent of farmers on these schemes use mechanized tools for spraying mainly for crops such as coffee, (Irish) potatoes, paddy rice, tea, and vegetables (World Bank, 2017a). Only commercial farms, and cooperatives use mechanized planting, harvesting and seeding for such commodities as maize and soybeans. On medium- and large-scale commercial farms, spraying is done with boom sprayers for crops like maize, rice, and soybeans.

To transport harvested produce, most small-scale farmers use bicycles, motorcycles, power tillers (connected to trailers), and/or wheelbarrows. Many large-scale farmers and some well-managed cooperatives employ their own transport equipment, including trucks and trailers, while others use "pay-per-kilogram" transport services consisting of private trucks owned by local traders.

Furthermore, most small-scale FLID farms suffer from lack of appropriate postharvest facilities. Storage facilities and postharvest practices are still rudimentary, and farmers need postharvest processing equipment (for beans, maize, rice, and soybeans), such as shellers, threshers, and winnowers.

Government Subsidies

In the subsidized farmer-led SSIT program, smallholder farmers access FLID equipment and accessories through registered FLID suppliers and distributors. The FLID equipment is distributed across the country by various wholesalers and dealers. The government, through the Rwanda Agriculture and Animal Resources Development Board (RAB), has recruited service providers to supply and distribute farmer-led SSIT equipment subsidized at 50 percent (MINAGRI, 2014a). Most of these companies import FLID equipment mainly from China, India, Kenya, South Africa, and a few European countries. Most hand tools used by farmers are available in rural city centers and sold by local dealers or traders.

From 2016 to date, imported hybrid maize seeds and soybean seeds have been distributed to smallholder farmers with a government subsidy of 75 and 85 percent, respectively. Between 70 and 80 percent of large-scale farmers obtain their improved paddy rice seeds from other suppliers or nongovernment organizations (NGOs) (NISR, 2018a). Registered companies that supply and sell vegetable seeds are also the ones that supply and sell pesticides and insecticides.

The government only allows importation of subsidized mineral fertilizers by eight approved companies. The Agro Processing Trust Corporation Ltd. (APTC) is the only authorized company to distribute government-subsidized mineral fertilizers; APTC sells the government subsidized mineral fertilizers to farmers through a network of about 1,000 agro-dealers in the country (MINAGRI, 2014b).

The GoR has strengthened its financial institutions and diversified products to increase access to institutions and usage of financial products and services. The available financial services are provided by financial institutions, such as commercial banks, microfinance institutions (MFIs), nonbanking MFIs, savings and credit cooperatives (SACCOs), insurance companies, and pension funds. The loan portfolio for the agriculture sector (agriculture production, trading, and processing) from the formal financial sector (banks, MFIs, and SACCOs) increased from RF 57 billion (US$ 20 million[1]) in 2012 to RF 90 billion (US$ 110 million) in 2016 (World bank, 2018).

Within the FLID supply chain, DPs provide loans and/or grants to the GoR. These loans and grants support farmer initiatives through government projects or NGOs. With government support, smallholder farmers practicing FLID can easily access inputs, equipment, and training to improve their skills in developing FLID value chains. In addition, DPs are engaged in a constructive policy dialogue, and in most cases, their role is purely technical to ensure sustainability of their financial

[1] Exchange rate US$ 1 = RF 820

support to the government.

Most FLID equipment and accessories are imported, including spare parts. Only simple equipment, tools, and machinery are manufactured in the country. The government, through the Rwanda Workforce Development Authority (WDA), has initiated national programs to support the local manufacturing subsector. Some educational developments have occurred through integrated polytechnic regional centers (IPRCs) and integrated technical and vocational education training centers (TVETs) across the country. Since the establishment of IPRCs and TVETs, the technical capabilities of local manufacturers have improved, as more complex equipment can be designed and adapted to be produced locally.

Regarding post-sale assistance and maintenance services, most smallholder farmers are organized into cooperatives for specific crop production; cooperatives sell crops to potential buyers or up-takers, who usually collect products at farm gates and transport them to markets. Depending on agreements between FLID producers and buyers, cooperatives can move harvested produce from farm gates to markets. The government assists farmers in numerous ways by providing technical coaching. For instance, the GoR establishes markets or selling points for products near farms. This support includes construction of various facilities and even roads. The government also assists FLID practices by linking farmer organizations to potential buyers, identified and selected by commodity.

Engagement with the private sector helps farmers with the maintenance of FLID equipment and accessories. Smallholder farmers who organize into cooperatives and irrigation water users' associations (IWUAs) pay water fees for maintenance of the equipment. Government-recruited companies supply the SSI equipment, while cooperatives and IWUAs draw up contracts with service providers for repair and maintenance. In addition, farmers get support (through repairs and spare parts) from local FLID suppliers and dealers. Commercial FLID farms have their own workshops to repair and maintain irrigation equipment and farm machinery.

For the FLID supply chain to be effective and efficient, several key private and public sector participants are involved. Districts, sectors, and offices are key stakeholders that deliver agriculture extension and advisory services and serve as focal points representing the needs of local communities and coordinating multisector responses.

FLID Business and Financing Models

Several business models enable access to FLID equipment in Rwanda. Such business models fall into categories, according to farm size. Most smallholder farmers own small agricultural hand tools. The country has more than 300 local traders or small-scale suppliers, and it has 7 midsize SSIT suppliers. Some smallholder farmers prefer to rent or borrow SSIT equipment from other farmers or from cooperatives, while others own larger pieces of equipment, like power tillers with sprayingor plowing equipment. They prefer to rent farm machinery of larger capacity (that is, tractors) from private service providers or RAB (World bank, 2017a).

Medium- to large-scale farmers operate FLID marshland and hillside schemes developed with

financial support from the GoR or DPs. These farmers are grouped into cooperatives and IWUAs. They obtain ownership of these irrigated schemes only after signing transfer agreements for operation and maintenance (O&M) of the infrastructure. Whereas marshlands under FLID are state property leased to smallholder farmers or cooperatives for a period of 49 or 99 years (MINILAF, 2013), hillside FLID schemes are developed on private land (farmer-owned land), and the irrigation infrastructure (pressurized irrigation systems like drip, pivot, and sprinkler systems) developed on this land is part of the government support.

Established IWUAs collect water fees from smallholder water users to ensure a budget for operation, management, and maintenance of the irrigation infrastructure. The water fee comes from crop sales to cooperatives after harvests, and this money goes into bank accounts managed by the associations. Most medium- to large-scale farmers use basic farm equipment described above for small-scale farmers.

Since 2015, the GoR has subsidized up to 50 percent of the cost of SSIT equipment (MINAGRI, 2014a). Farmers and cooperative members, as well as other groups, can apply for the subsidy and access equipment as individuals or groups of farmers from the seven midsize suppliers who signed a memorandum of understanding with the government. This model has increased demand for SSI equipment considerably. Some small-scale farmers purchase SSIT mobile kits, not only to irrigate their plots but also to irrigate neighboring plots for a fee. Another business model is the cooperative service one. Successful cooperatives purchase equipment and rent or loan it to members.

Regarding FLID financing, the government has attempted to reform policies and increase access by smallholder farmers to financial services. As a result, different commercial banks (public and private), MFIs, and other financial service providers continue to expand their financial services to poor rural communities, especially smallholder farmers.

CHAPTER 1

Introduction

Country Context

According to the World Bank, Rwanda is a low-income economy with an approximate gross domestic product (GDP) per capita of US$771 (World Bank, 2017b). The country consists of 26,338 square kilometers, of which 18,095 square kilometers are classified as arable (agriculture) land (NISR, 2014). Since the end of the genocide in 1994, Rwanda has achieved impressive economic growth and reduction in poverty. Although the country still depends on official development assistance (ODA)—which finances approximately 40 percent of the country's annual budget—Rwanda's economy grew by 7.90 percent per year (NISR, 2016). As of 2016, the economy was more than 3.50 times larger than it was in 2000 (NISR, 2018b).

The agriculture sector has been an engine for growth, propelling the country towards middle-income status. Economic gains have largely been driven by investments in the agriculture sector, which contributes to 33 percent of the GDP (MINAGRI, 2018a), 72 percent of employment, and 52 percent of exported goods (BNR, 2016). Despite Rwanda's strong economic growth and falling poverty level, it continues to have one of Africa's highest population densities. Poverty levels are predominantly higher in rural areas, where rainfed agriculture is prevalent.

The agriculture sector is the largest single source of employment for people 16 to 24 years of age, representing more than 50 percent of the rural population. Many of these young people are underemployed due to the small size of farms. More than 60 percent of households cultivate less than 0.60 hectare, and 15 percent of rural household farms have less than 0.1 hectare.6 Independent rural farmers comprise 65 percent of the agriculture labor force, while wage farmers represent 35 percent. Women constitute 66 percent of the overall agriculture workforce (NISR, 2014).

Rwanda Irrigation Subsector

The Rwanda Irrigation Master Plan identified and mapped 589,713 hectares of potential irrigation areas, which is approximately 22 percent of the country's land area (MINAGRI, 2010b). Rwanda irrigates about 9 percent of its potential irrigation area (RAB, 2018), whereas other eastern and central African countries, such as Ethiopia, Kenya, Tanzania, and Uganda, irrigate an average of 2 percent of their cultivated areas (FAO, 2015).

Irrigation is not new to Rwanda. Farmers have traditionally irrigated rice crops by lowering groundwater into marshlands by digging drains. They typically build unsaturated zones between drains by piling up excavated soil. During the dry season, when groundwater levels drop, farmers construct soil check dams in drains to maintain groundwater levels at crop root zones. If the

groundwater is not sufficient, farmers build wood-pole weir structures across main streams to divert water into earthen canal networks.

In the 1970s and early 1980s, irrigation development emphasized rice-producing schemes with external assistance from countries such as Canada, China, France, and the Republic of Korea. In 2003, the Government of Rwanda (GoR) developed the Marshland Master Plan (MINAGRI, 2001), resulting in the swamp reclamation and irrigation development under the Rural Sector Support Project (RSSP) funded by the World Bank. The first three phases of RSSP focused on medium- and large-scale rice production and developed almost 13,000 hectares of irrigated marshlands (MINAGRI, 2018c)

Following the development of the irrigation master plan in 2010, Rwanda initiated and implemented additional irrigation projects. With these projects, the GoR set its target to develop 40,000 hectares of irrigated land by 2017 and 100,000 hectares by 2020. As of June 2018, 52,936 hectares had been developed (RAB, 2018). By 2024, Rwanda aims to develop 102,284 hectares of irrigated land (MINAGRI, 2018d). Most of these systems use such water sources as groundwater, lakes, rivers, wetlands, or water reservoirs of various sizes (small, medium, or large dams).

Notes

1. Rwanda's population of more than 11 million people—half of them under age 19—is projected to rise to about 16 million by 2020 and to about 26 million by 2050 (MINAGRI, 2018d).
2. More than 90 percent of Rwanda's low-income residents live in rural areas (MINAGRI, 2018d).
3. For more information on Rwanda's irrigated lands, see the June 2018 irrigation progress report issued by the Rwanda Agriculture and Animal Resources Development Board (RAB) at ww.rab.gov.rw
4. For more irrigation data, see table 2.1 in chapter 2 and the June 2018 Progress Implementation report issued by RAB at www.rab.gov.rw

CHAPTER 2

Assessment of Farmer-Led Irrigation in Rwanda

Development of Farmer-Led Irrigation in Rwanda

In Rwanda, existing irrigation systems have developed mostly because of initiatives by the GoR and support from donors in an effort to achieve food security. Irrigation systems represent a variety of technologies, such as pumps (for example, motorized pumps, solar pumps, and treadle pumps), technologies to distribute water (for example, pivots, drip and sprinkler systems, and buckets or watering cans), and surface systems used in rice marshlands. In 2015, the GoR initiated a small-scale irrigation technology (SSIT) program to support farmers by subsidizing 50 percent of the irrigation kits. By June 2018, small-scale farmers had used these kits to irrigate 6,874 hectares (table 2.1). Rwanda aims to develop 24,574 hectares of farmer-led irrigation with these kits by 2024 (MINAGRI, 2018d).

Private and commercial farmer-led irrigation schemes are rare in the country. There are two prominent FLID ventures in the Eastern District of Rwanda. One is Bramin Corporate Ltd. – a joint venture between Bralirwa Brewery and the maize processing company Minimex Ltd. The second is a joint venture between Rwanda's National Agriculture Export Development Board and the Rwandan company ProDev Bugesera.

Table 2.1: Number of Irrigated Hectares by irrigation category between 2012 and 2018

Irrigation Categories	Irrigated Hectares						
	FY2011/12	FY2012/13	FY2013/14	FY2014/15	FY2015/16	FY2016/17	FY2017/18 (June-18)
Marshland	22,681	24,721	27,005	29,277	35,161	36,544	37,282
Hillside	450	1,650	4,807	5,710	5,948	7,413	8,780
SSIT	—	113.50	—	400	2,444	4,574	6,874
Total	**23,131**	**26,484.50**	**31,812**	**35,387**	**43,553**	**48,531**	**52,936**

Source: RAB, 2018.

Note: SSIT = small-scale irrigation technology; — = not available.

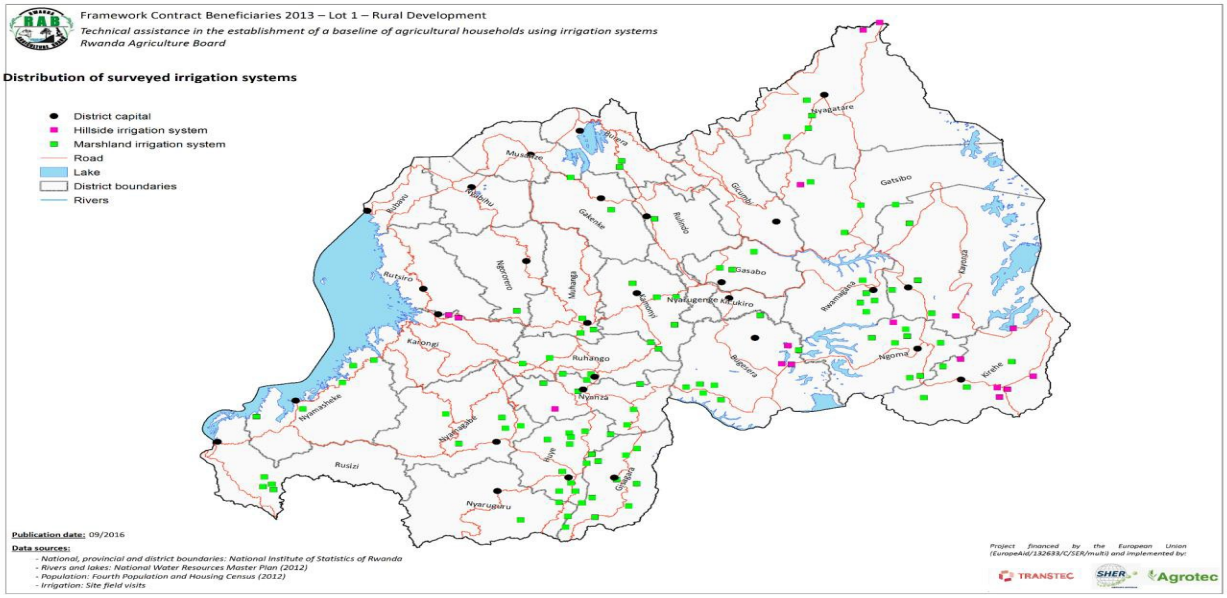
Types of FLID

In Rwanda, most farmers are primarily developing irrigation on marshlands and hillsides, and through small-scale irrigation (SSI) programs. Normally, marshlands in Rwanda are public areas,

distributed to low-income or vulnerable landless farmers for cultivation. Smallholder farmers use the marshlands mostly for vegetable production. In this case, farmers irrigate crops with buckets or watering cans. In 2008, the GoR initiated a land consolidation program for farmers to develop medium to large marshlands for rice production. The rice is irrigated through surface open irrigation canals, and water moves from water reservoirs by gravity.

Hillside irrigation schemes operate at medium to large scales. Initially these schemes are financially supported by the GoR and development partners[1], and, once developed, financial oversight is transferred to farmer associations (i.e. cooperatives and associations for users of irrigation). Other irrigation schemes, such as BRAMIN and PRODEV, are private commercial irrigated farms, mostly developed for seeds and horticulture production. The distribution of irrigation types in Rwanda is illustrated in map 2.1[2].

Map 2.1: Distribution of Irrigation in Rwanda, by Type



Source: MINAGRI and European Commission, 2016.

Current Extent of FLID

In Rwanda, FLID is concentrated in the Eastern and Southern Provinces. These areas are most prone to droughts or erratic rainfall (MINAGRI and European Commission, 2016). As of June 2018, about 6,874 hectares of irrigated lands have been developed using farmer-led SSITs, whereas 37,282 hectares of irrigated marshlands and 8,780 hectares of irrigated hillsides have been developed by the government and DPs for smallholder farmers under the national food

security program.

FLID commercial ventures, Bramin and ProDev Bugesera, occupy 600 and 250 hectares, respectively, in Eastern Province (RAB, 2018). Other FLID in Rwanda encompass the Indian Farm (700 hectares) and Nyagatare Agro Ventures Rwanda Pvt. Ltd. (NAVR) in the Eastern Province. NAVR is using public land leased from the government for 49 years for rice production (MINAGRI and NAVR, 2012)

FLID Technologies in Use

In Rwanda, smallholder farmer-led irrigation is characterized by a variety of technologies, such as pumps (i.e. motorized pumps, treadle pumps, and solar pumps), water distribution technologies (i.e. drip, sprinkler systems, buckets or watering cans), and surface open systems used in rice marshlands.

Farmer-Led SSITs

Smallholder FLID technologies used in Rwanda include a rain gun sprinkler kit, a sprinkler kit, a drip kit, and a hand-watering kit (with pumps, via gravity, or with a bucket or watering can). Only 13 percent of smallholder irrigated farms use technologies common to FLID (as described above), whereas the other 87 percent irrigate marshlands and hillsides with support from government and donors. Irrigation systems typically include the following (MINAGRI and European Commission, 2016):

- Buckets or watering cans;
- Complete drip kits;
- Sprinkler kits with pipes and plastic dam sheeting;
- Portable pumps, such as motorized deiseal or petrol pumps, solar pumps, and treadle pumps.

Farmers can access smallholder irrigation technologies through the SSIT program launched by the government in 2015. Under this initiative, farmers can acquire SSIT equipment at a 50 percent subsidy. The program aims to accelerate and promote widespread use of affordable, demand-driven, equitable, locally produced, profitable, and simple SSI equipment to increase crop productivity and to improve sustainability of irrigation development.

The SSIT program is implemented in partnership with strategic private service providers (SSIT suppliers) recruited by the government. Providers sign a memorandum of agreement to supply and set up shops for SSIT equipment across the country. The program targets individual smallholder farmers and commercial farmers, cooperatives and similar communities with consolidated land ranging from 0.10 to 10 hectares. SSIT implementation uses commercial farm management models, which includes:

(i) individual commercial smallholder farmers;

(ii) cooperative farms with consolidated land of ±5 hectares units

(iii) smallholder farmers willing to consolidate land under a small or medium-size enterprise or corporation with holdings of 5 to 10 hectares
(iv) individual commercial farmers or young farmers who have access to land ranging from 0.10 to 10 hectares (and exhibit a willingness to lease or rent SSIT equipment).

The SSIT program encourages land use consolidation for improved productivity of staple foods**.** Participants may receive a subsidy of up to 50 percent, but the actual percentage is determined by the factors such as farm area and profitability (shown in table 2.2).

Table 2.2: Weighting Factor for SSIT Subsidy Determined by Profitability and Amount of Consolidated Land

Land Consolidation(ha)	Profitability		
	High	Medium	Low
7.50–10.00	1.00	0.75	0.50
5.00–7.00	0.75	0.50	0.40
1.50–4.50	0.50	0.40	0.30
0.10–1.00	0.40	0.30	0.20

Source: MINAGRI, 2014a.

Note: SSIT = small-scale irrigation technology.

Four positive sub-criteria used to determine profitability are:

(a) choice of a high-value crop (for example, banana, vegetables such as onions and tomatoes);
(b) water availability of less than 20 meters;
(c) use of low-pressure pump capacity, and
(d) pumping and maintenance costs of the proposed type of SSIT.

Table 2.3 below shows the final subsidy allocated to each class of consolidated land (MINAGRI, 2014a).

Table 2.3: SSIT Subsidy Rate per Profitability and Amount of Consolidated Land

Land Consolidation (ha)	Subsidy Rate (%)		
	Low	Medium	High
7.50–10.00	50.00	37.50	25.00
5.00–7.00	37.50	25.00	20.00

1.50–4.50	25.00	20.00	15.00
0.10–1.00	20.00	15.00	10.00

Source: MINAGRI (2014a)

Note: Subsidy rate = weighting factor (from table 2.2) × maximum government subsidy of 50%. SSIT small-scale irrigation technology.

SSIT Kits

Smallholder farmers can purchase various types of SSIT kits with 50 percent subsidy from the government to minimize the total cost. These kits usually include the rain gun sprinkler and its stand, as well as 50-meter pipes, fittings, and a diesel or petrol pump. In case there is no nearby source of water, the kit also includes construction of a small well of 250 or 480 cubic meters.

As of 2014, the average cost of the SSIT kit was about US$1,500 per hectare (MINAGRI, 2014a). However, actual prices depend on a farmer's preference and financial capacity, and prices for farmer-led SSI equipment. More details on this can be found in chapter 8 as part of the business and financial models. Below are some depictions of the types of SSIT kits available to farmers.

Rain Gun Sprinkler Kit (photo 2.1).

Photo 2.1: Rain Gun Sprinkler Connected to a Small Rainwater Reservoir Created with Plastic Dam Sheeting

(a) Rain gun sprinkler kit connected to aportable motorized diesel or petrol pump.

(b) Reservoir for rainwater using plastic sheeting to funnel run-off.

Sprinkler Kit

Photo 2.2: Sprinkler Irrigation System Connected to a Portable, Motorized Diesel or Petrol Pump and to a Small Water Reservoir Created with Plastic Dam Sheeting

(a) Small water reservoir created with dam sheeting.

(b) Sprinkler kit connected to a portable, motorized diesel or petrol pump.

Drip Kit (photo 2.3).

(a) Small-scale farmer-led drip system.

(b) Drip kit connected to a small water reservoir created with dam sheeting.

Photo 2.3: Drip Irrigation System Connected to Small Water Reservoir Built with Plastic Dam Sheeting

Hand-Watering Kit

Hand-watering kits use one of the following: a pump, a gravity system, or a bucket/ watering can.

Hand Watering with a Pump

Smallholder farmers often use a hose connected to one of the following pumps: (a) treadle pump, (b) solar pump, and (c) diesel or petrol pump. If farmers do not have nearby sources of water, they use rainwater harvested in a small plastic water dam sheet (photo 2.4). Hand-watering kits are also part of the government subsidy.

Photo 2.4: Hand Watering with a Hose Connected to a Treadle Pump, a Solar Pump, or a Diesel or Petrol Pump and Supplied with Rainwater Harvested in Plastic Sheeting. From left to right, (a) Hand-hose connected to a treadle pump, (b) Treadle pump using rain water harvested in a small water reservoir created with dam sheeting, (c) Hand-hose irrigation, (d) Solar pump, and (c) Petrol pump connected a small water dam sheet

Hand Watering Using a Gravity System

The Rwandan government or donors have built large water reservoirs on state land that collect rainwater and runoff upstream of some smallholder farms. Once a cooperative registers as a legal entity with the Rwanda Governance Board, a title is transferred to the farmer cooperatives. The farmers (landowners with private land titles) receive water through an underground network of pipes that travel up to a water tap or water outlet installed on their plots.

The GoR and donors support irrigation networks developed for private smallholder farms. Using hoses longer than 100 meters connected to water outlets, farmers can irrigate their plots and easily provide water to their neighbors. Individual farmers or a group of farmers own, use, and maintain the water outlet (photo

2.5). In such cases, farmers sign agreements with the established water users' association (WUA) stipulating that the government has transferred operation and management of the infrastructure to them and that they agree to pay water fees (after season) for maintenance of the infrastructure by the WUA. Farmers also agree to operate and maintain their water taps and hoses and to purchase new ones if they break down.

Photo 2.5: Hand Watering Using Gravity and a Pipe Connected to a Water Tape Supplied through an Upstream Water Dam. From left to right, (a) and (b) Large water reservoirs built by government, (c) Water tape connected to a hand-hose, (d) Hand-hose irrigation using a water tape, (e) hand watering pipe connected to an underground pipe, (f) Hand-hose irrigation, (g) Underground pipe watering an open canal

Hand Watering with Buckets or Watering Cans

In Rwanda, most vegetables are produced in valley-bottom marshlands, which are public lands. To use this land, smallholder farmers or cooperatives obtain sub-rent permits from the government. A permit period usually lasts for 49 to 99 years, depending on the approved agriculture project. In most cases, the government distributes small plots of valley-bottom marshlands to landless and vulnerable low-income farmers who grow food crops in season A (from September to January),[3] season B (from February to May),[4] and in season C (from June to August)[5]. They grow mostly vegetables. In the case of the cooperative, the length of the sub-rent permit (usually 99 years) and the size of the plot will depend on the approved agriculture project.

Land tenure and land rights are well described in the Rwanda Organic Land Law (law 08/2005), which determines the use and management of land in Rwanda (MINILAF, 2005) and in law 43/2013 (MINILAF, 2013), which outlines the governance arrangement related to land in Rwanda. Article 19 of law 43/2013 shows that swamplands or marshlands belong to the state and that they can be lent to a person or group of people based on an agreement concluded between parties. The law's article 17 shows that the leasing period cannot be less than 3 years and cannot exceed 99 years; this period can be renewed (MINILAF, 2013). Allocation and acquisition of land for investment should be based on an approved business plan by a competent authority in accordance with value of the investment.

In valley-bottom marshlands, water is usually available as groundwater near the soil surface. Smallholder farmers dig drainage canals of less than 0.50 meter to access water for food crops and vegetables (photo 2.6). Farmers believe that this system is labor intensive and not as efficient as solar pumps and motorized diesel or petrol pumps.

(a) Watering maize with buckets

(b) Watering cabbages with a can

<Photo title>Photo 2.6: Hand Watering with Buckets and Watering Can

(c) Watering a kitchen garden of vegetables

(d) Watering vegetables with a can

Medium- to Large-Scale FLID

Development of farmer-led irrigation on marshlands and hillsides at medium (10 to 100 hectares) to large scale (greater than 100 hectares) occurs with financial support from the government and development partners. These schemes are later transferred to cooperatives and irrigation water users' associations (IWUAs) after signing a transfer agreement for the operation and maintenance of infrastructure.

Approximately, 70 percent of smallholder irrigated farms in Rwanda use lowland marshlands developed with gravity irrigation canals. These are mainly well-drained marshlands developed and distributed to vulnerable smallholder farmers for rice and vegetable production (RAB, 2018). See photo 2.7 for examples.

Photo 2.7: Gravity Irrigation Systems on Marshlands Used to Grow Rice and Vegetables

(a) Farmer-led irrigated marshland under rice production.

(b) Farmer-led irrigated marshland under rice and vegetable (that is, onion) production.

(c) Maintenance of irrigation canals by smallholder farmers.

(d) Farmer-led irrigated marshland under rice production.

As mentioned earlier, marshlands are state lands leased to smallholder farmers or cooperatives for 49 or 99 years, depending on the approved agriculture projects. In contrast, irrigation infrastructure development of hillside FLID schemes occurs on private land (the farmers' land) through government support. These smallholder farmers organize under cooperatives for crop production and under IWUAs to ensure maintenance, management, and operation of irrigation infrastructure. After the IWUA has obtained legal entity, the government transfers the irrigation infrastructure to the established IWUA by signing an irrigation management transfer agreement.

The IWUA has the responsibility to collect water fees from the smallholder water users to ensure a budget for operation, management, and maintenance of the irrigation infrastructure. Water fees are deducted from sales of crops sold to the cooperative after each harvest. Subsequently, the fees go into a bank account opened at any nearby microfinance institution and managed by the established IWUA. About 85 and 92 percent of the marshland and hillside FLID schemes, respectively, are operated by an IWUA. The remaining 15 and 8 percentare operated by a producers' cooperative (MINAGRI and European Commission, 2016).

About 17 percent of smallholder irrigated farms on hillsides are developed with pressurized irrigation systems, such as drip, sprinkler, or pivot systems (photo 2.8), which use electrical power for energy. Most of these systems use water pumped from lakes or rivers, groundwater accessed through drilling, small water dams or reservoir tapped by rainwater harvesting (RAB, 2018). In Rwanda, 77,637 households participate in FLID, out of which 40 percent are headed by a woman (MINAGRI and European Commission, 2016).

Photo 2.8 Farmer-Led Hillside Irrigation Systems

(a) Pivot system under maize

(b) Sprinkler system under French bean

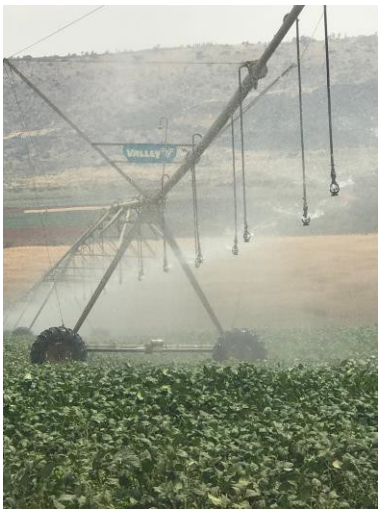
Commercial FLID

In Rwanda, Bramin was the first FLID commercial farm, which was a joint venture between Bralirwa,[6] the Heineken Group brewery in Rwanda, and Minimex, the leading maize milling company in Rwanda. Bramin is a mechanized and irrigated maize farm; it is the first modern large-scale maize farming enterprise in Rwanda. The Bramin farm is technically managed by Seed Co, a South African seed development and production company.

Bramin farm is located in Ndego Sector, District of Kayonza, Eastern Province**.** The irrigation infrastructure is a pressurized system consisting of sprinkler and pivot systems (photo 2.9), which uses diesel generators for energy. The irrigated area amounts to about 450 hectares developed with an investment of about RF 1.70 billion (about US$2 million). Bramin sells its maize to Bralirwa after the maize has been processed into grits by Minimex. Production targets for Bramin are 9 to 10 tons per hectare for commercial maize, 5 to 6 tons per hectare for maize seed, and 2.50 to 3 tons per hectare for soybeans or soybean seeds. Other commercial farms in Rwanda include ProDev Bugesera, Nyagatare Agro Ventures Rwanda Pvt. Ltd., and the Agro-Processing Industry military farm (which is mechanized but not irrigated).

Photo 2.9: Pivot and Sprinkler Systems on the Bramin Farm

(a) Bramin farm



(b) Soybeans under center pivot at Bramin farm

Notes

1. Such as the African Development Bank (AfDB), the International Fund for Agricultural Development (IFAD), the Japan International Cooperation Agency (JICA), the Republic of Korea through the Korea International Cooperation Agency (KOICA), and the World Bank.
2. Map 2.1 does not illustrate commercial private farmer-led irrigated farms and farmer-led SSIT sites.
3. Season A: Long rain season.
4. Season B: Short rain season.
5. Season C: Dry season.
6. Bralirwa: "Brasserie et Limonaderie du Rwanda."

CHAPTER 3

Water Resources and Market Assessment—Potential for Expansion of Farmer-Led Irrigation

Availability of Water Resources

Rwanda has abundant water resources that are not evenly distributed. Rainfall is high in the western part of the country and low in the east, and there are long dry periods between rainy seasons. Variability is a critical issue for farmers with land on hillsides because water cannot be retained. Farms in the eastern part of the country—where rainfall is lowest—are therefore the most vulnerable (MINAGRI, 2010b).

Rwanda annually accounts for 6 billion to 7 billion cubic meters of surface water, 4.50 billion to 5 billion cubic meters of groundwater, and 27.50 billion cubic meters of rainwater. Annual water storage per person is approximately 447 cubic meters. Annual renewable water resources are estimated at 6.8 billion cubic meters. Renewable water availability per capita is about 670 cubic meters per year. In 2000, the total water consumption was about 150 million cubic meters, of which agriculture accounted for 68 percent, domestic needs accounted for 24 percent, and industry accounted for 8 percent (NISR, 2017b).

Eastern Rwanda has abundant rivers and lakes that could be harnessed for farmer-led irrigation (FLID). The central and eastern parts of the country have potential for using groundwater resources, especially for development of springs and boreholes.

Rivers and Flood Water

The river network of Rwanda is abundant and dense (map 3.1). Three major rivers cross the Eastern and Southern Provinces of Rwanda: the Akanyaru, the Nyabarongo, and the Akagera. These rivers pass through 18 districts of Rwanda, covering 79,847 hectares of potential FLID area that could be irrigated with surface water (MINAGRI, 2010b). In addition, the Rwanda Irrigation Master Plan has identified small and medium rivers that could have small reservoirs with FLID potential to irrigate an additional 125,627 hectares (MINAGRI, 2010b).

Rwanda is divided between the Congo Basin in the west and the Nile Basin in the east. About 85 percent of the surface flow drains to the Nile Basin, and the remaining 15 percent flows to the Congo Basin. The Upper Nile Basin occupies 76 percent of the country's area and drains 90 percent of the surface waters through the Nyabarongo and Akagera Rivers, which are the main tributaries of Lake Victoria. The Akagera River contributes 10 percent of the water in the Nile Basin. The Congo Basin occupies 24 percent of the country's area and drains 10 percent of the surface waters from the Lake Kivu Basin to Lake Tanganyika (MINAGRI, 2010b).

The Rwanda National Water Resources Master Plan identified and described nine water catchments to explain trends in availability of water resources (MINIRENA, 2015): (a) Lake Kivu (CKIV), (b) Rusizi, (c) Upper Nyabarongo, (e) Lower Nyabarongo, (d) Mukungwa, (f) Akanyaru, (g) Upper Akagera, (h) Lower Akagera, and (i) Muvumba (map 3.1). Seven of these water

catchments are part of the Nile Basin, while two (that is, Rusizi and Lake Kivu) are part of the Congo Basin. Table 1 in the Appendix illustrates the characteristics of the nine water catchments.

Lake Water Resources

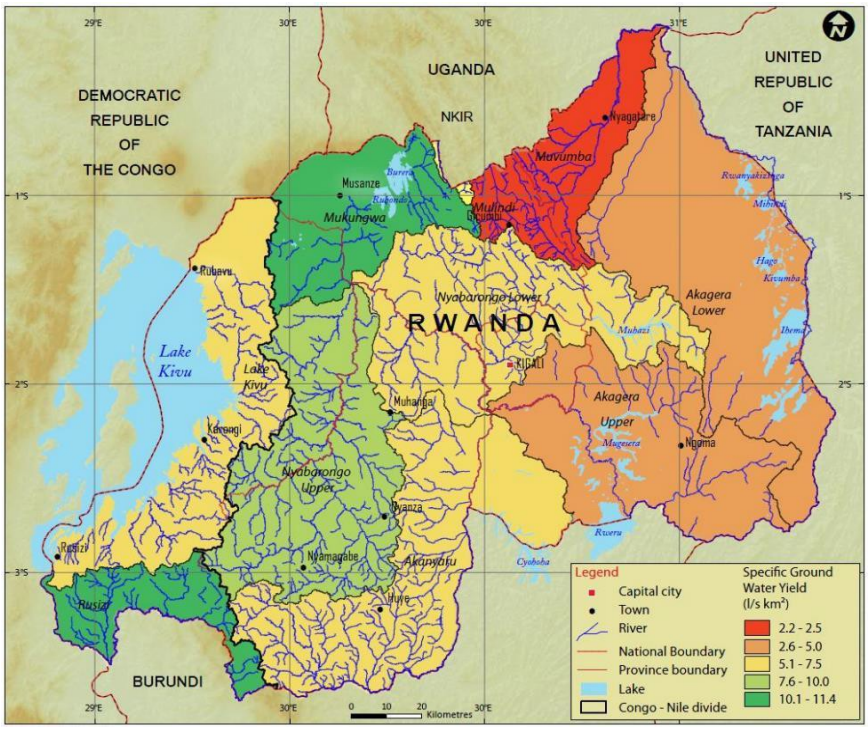
Rwanda has 22 lakes, mostly concentrated in the Eastern, Northern, and Western Provinces (map 3.1). These lakes have been identified as potential water sources for FLID. In the Eastern Province, existing lakes include the Bilira, Cyambwe, Cyohoha, Gaharwa, Gashanga, Ihema, Kidogo, Kilimbi, Mpanga, Mugesera, Muhazi, Mirayi, Nasho, Rumira, and Sake. The Rwanda Irrigation Master Plan states that these lakes have the potential to irrigate 110,107 hectares (MINAGRI, 2010b) of FLID areas. The estimated volumes of these lakes appear in table 2 in the Appendix.

Groundwater Resources

There is insufficient data available to help quantify groundwater volume in Rwanda. Available data come from borehole studies conducted for domestic water supply projects. Although such data are unsuitable for planning irrigation, they provide information on potential areas where groundwater may exist. The maximum range of drilling has been 120 to 150 meters, with corresponding yields of 60 to 100 cubic meters per hour (RNRA, 2014). Most of the boreholes yielding potential groundwater resources lie close to marshlands and rivers; these are potential FLID areas that could be developed with groundwater resources.

The Mukungwa and Rusizi water catchments present high potential for FLID based on their high-yielding groundwater potential of up to 11.4 cubic meters per hour. The Upper Nyabarongo, Akanyaru, and Lake Kivu water catchments show medium-yielding potential for groundwater use for FLID (RNRA, 2014). There is a significant supply of potable water and FLID in the Akanyaru and Upper Akagera water catchments. The nine water catchments and their groundwater yields appear in map 3.1. In addition, the Rwanda Irrigation Master Plan estimated about 36,432 hectares of potential FLID areas for the springs and boreholes in Rwanda (MINAGRI, 2010b

Map 3.1: Catchments and Groundwater Yields, Rwanda



Source: RNRA, 2014.

Water Uses and Water Demand

Table 3 in the Appendix illustrates the levels of water use in the nine water catchments. Rwanda only uses 1.75 percent of its renewable water resources. Indicating that Rwanda loses almost all its water resources through evaporation or runoff to other downstream countries. Irrigation water use accounts only for about 1 percent of the country's available water resources (RNRA, 2014).

The National Water Resources Master Plan (MINIRENA, 2015) illustrates important findings regarding the water demand for agriculture development in the nine catchments and the 2040 water balance projections (table 3.1).

Table 3.1: Projections of Water Demand for Agriculture Development in the Nine Water Catchments, Rwanda, 204

Water Catchment	Average Renewable Resource (x1,000m^3)	Irrigation Demand (x1,000m^3)	Other Demands (x1,000m^3)[a]	Overall Demand (x1,000m^3)[b]	Overall Demand (%)	Overall Demand Over Average Renewable Resource (%)
Akanyaru	798	370	171	541	**16.08**	**67.79**
Lake Kivu	898	150	163	313	**9.30**	**34.96**
Lower Akagera	907	410	67	477	**14.18**	**52.59**
Lower Nyabarongo	899	370	237	607	**18.04**	**67.52**
Mukungwa	905	13	139	152	**4.52**	**16.79**
Muvumba	193	145	71	216	**6.41**	**111.92**
Rusizi	432	8	38	46	**1.37**	**10.65**
Upper Akagera	504	458	199	657	**19.52**	**130.36**
Upper Nyabarongo	1,290	190	166	356	**10.58**	**27.60**
Total	**6,826**	**2,114**	**1,251**	**3,365**	**100.00**	

Source: MINIRENA, 2015.

Note: a. Water supply, livestock, fishponds, and so on. b. Irrigation, water supply, livestock, fishponds, and so on.

Table 3.1 illustrates that by 2040 agriculture development is expected to place excess water demands on the Upper Akagera and Muvumba water catchments. Demand for irrigation water will be the main driving factor to influence that critical situation. High water demands are also observed in the Lower Nyabarongo and Akanyaru water catchments. Mitigation measures should consider development of small, medium, and large water reservoirs to harvest rainwater and to collect runoff, which can be used for FLID.

Market Assessment

Energy Availability

In Rwanda, biomass is the most important energy source. More than 94 percent of all households use biomass for cooking. In total, about 85 percent of primary energy is derived from biomass sources, such as wood, charcoal, and agricultural waste (MININFRA, 2013). With the country's relatively fast economic growth over the last decade, the demand for power, mainly electricity, has increased annually by 7 percent. The government of Rwanda (GoR) launched an aggressive program to increase access to electricity services to all sectors of the economy. By 2020, the goal is to have 100 percent access (MININFRA, 2016).

In addition, the GoR introduced a new strategy to access less costly energy technologies and increase private participation in the energy sector. Implementation of the new strategy includes provision of off-grid solar home systems and mini grids that can provide higher levels of electricity to both households and to small and medium-size businesses. To support private investments in this sector, the government established a risk-mitigation facility to increase development of mini grids in suitable locations—including remote ones—and continued the Electricity Access Rollout Program, which supports rural electrification.

Rwanda also has a host of energy investments. Implementation of these investments will have a positive effect on reducing the electricity tariff. A key constraint to expanding FLID technologies is the high cost of energy. As of August 2018, the price for a water treatment plant and a water pumping station stands at 126 RF (US$ 0.15) per kilowatt hour[3]. This tariff is higher than those of other countries in the region, and its supply is still unreliable, which discourages industrial growth and business expansion. As Rwanda aspires to expand areas under irrigation by scaling up cost-effective marshland and small-scale irrigation technologies, the energy demand to expand FLID will undoubtedly increase.

Smallholder farmer-led irrigators will benefit from such affordable tariffs for electricity. In January 2017, the government reviewed electricity tariffs and reduced them by 51 percent for smallholder farmers and between 28 and 34 percent for small, medium, and large enterprises.

Domestic Market

In Rwanda, the domestic market is dominated by food crops, which remain a government priority

[3] Exchange rate US$ 1= 850 RF

to meet food security and dietary needs. Major crops cultivated by farmers practicing FLID are maize, rice, soybeans, and horticulture, especially vegetables and fruits. FLID initiatives play a crucial role in achieving the GoR's vision to transform predominantly subsistence farming into a fully monetized commercial agriculture sector by 2020.

At the domestic level, the market is mostly dominated by food crops, particularly maize (flour), rice, and soybeans (especially for domestic agro-industries). The population of Rwanda is projected to grow to 16.9 million by 2032 (NISR, 2012). This growth—as well as urbanization and higher household incomes—are some of the key factors driving demand for food crops=. To meet this demand, the domestic agrifood industry must fill the population's dietary needs. Improving aggregation and consumer-producer market infrastructure and certification of food products are expected to play increasingly important roles in growing markets for FLID agricultural produce. The market is growing for higher-value niche products, especially vegetables and fruits in urban hotels, restaurants, and supermarkets. Apart from these horticulture products, other crops in high demand include cereals, such as maize, soybeans, and rice.

A detailed description of the production and demand for individual food crops can be found in Appendix B.

Competitiveness of Retail Pricing of Food Commodities

Market prices for FLID products depend on demand, seasons, and location (urban versus rural areas), and particularly rainfall regime. Farmers can take advantage of the high prices in the dry season (season C[2]), when there is limited availability of crops from rain-fed farms. Prices are usually high for FLID crops such as Irish potatoes, paddy rice, vegetables, and other staple foods produced in marshlands.

In Rwanda, prices of staple foods usually start to rise in September when food stocks from season B[3] harvests gradually decrease. In fact, staple food prices are usually lower in January and February after season A[4] harvest, as well as in July and August after the season B harvest. The harvest is likely the main determinant of food prices during subsequent months.

Figures 3.1 and 3.2 show consumer price variations for rice, maize, soybeans, and vegetable products in Rwanda. During the last five years, the annual consumer price variation for vegetables averaged 0.70 percent. In addition, vegetables and fruits were more expensive in urban areas than in rural areas, due to the potential higher demand for these products in urban areas. Factors explaining the gap between rural and urban market prices include (a) transport cost, (b) large chains of intermediaries, and (c) profit margins between farm-gate and urban market places (MINICOM, 2014).

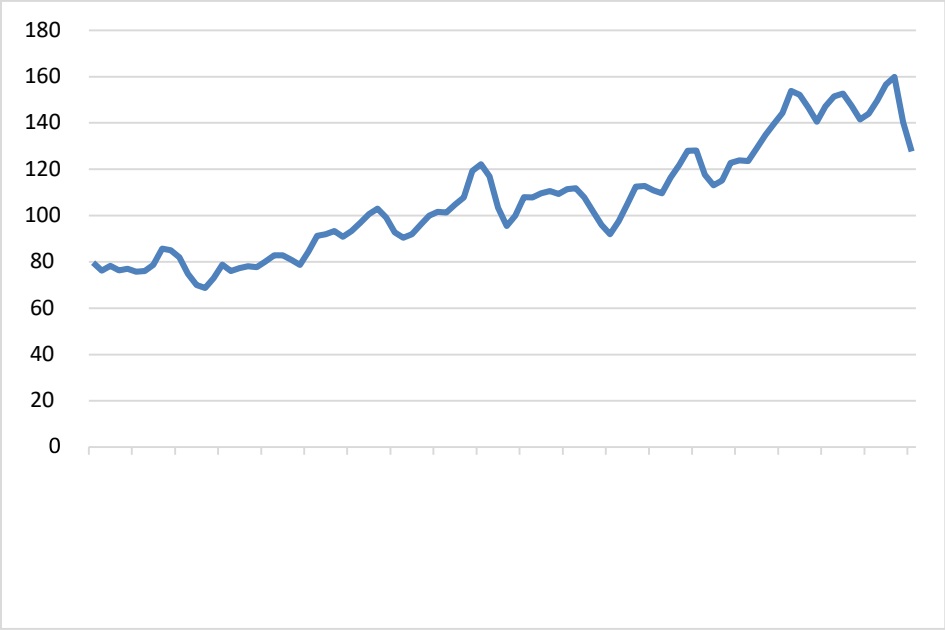
On the other hand, for the last five years the annual consumer price variation for cereals such as beans, maize, rice, and soybeans, recorded an average increase of 0.30 percent. In 2016, the annual consumer price variation registered for cereals increased about 1.3 percent (NISR, 2018c). Most of these cereals (with the exception of rice) were much less expensive in rural areas than in urban areas. However, rice is expensive in rural areas, because it is locally produced, milled in urban

centers, and then returned to rural areas for sale (MINICOM, 2014).

The market prices of FLID products are mainly limited by inadequate postharvest facilities and the processing system for perishable crops (that is, legumes, and vegetable) at the farmer level (in cases of high production). Other challenges include a lack of links between FLID producers and off-takers, as well as non-supplementary intensive quality technical assistance to ensure proper handling of the produce.

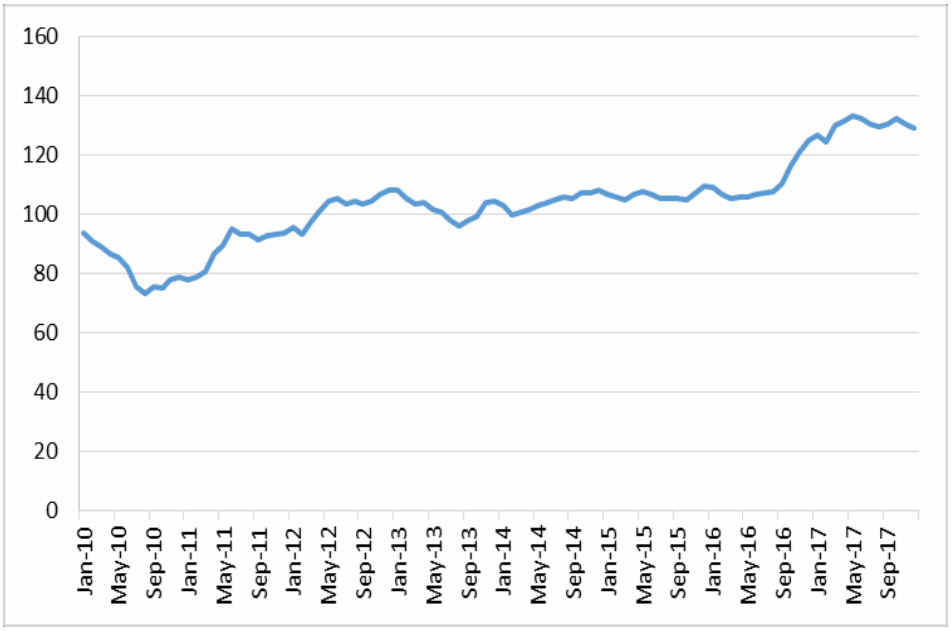
Figure 3.1: Consumer Price Variations for Vegetables, Rwanda, January 2010 to December 2017

- x-axis (Period) and y-axis labels (Price variation)



Source: NISR, 2018c

Figure 3.2: Consumer Price Variations for Cereal Products, Rwanda, January 2010 to December 2017



Source: NISR, 2018c

Export Markets

Rwanda has had limited success in penetrating the large markets of Kenya, Tanzania, and Uganda. In fact, these countries have developed large private sectors, which allow them to import inexpensive raw materials. However, Rwanda has tried to develop regional markets for its products, particularly in Burundi, the Democratic Republic of Congo, Tanzania, and Uganda. Integration with the East African Community (EAC) countries has improved Rwanda's access to large markets by increasing exports to EAC countries to an estimated US$ 55 million in 2015 compared to only US$20 million in 2011 (English *et al*., 2016).

Export markets for FLID crops are primarily dominated by basic foods, such as rice and maize. The Democratic Republic of Congo is the major market for Rwanda's cross-border trade. Between 2006 and 2013, Rwanda's maize exports grew annually by 37 percent, or from 550 to 7,500 tons (English *et al*., 2016), primarily driven by the increasing demand for maize products in urban markets of the Democratic Republic of Congo. The annual growth rate of Rwanda's rice exports from 2006 to 2014 is estimated at 65 percent, with an average of 4,816 tons. The value of these exports equates to about US$ 217,000. Rwanda has a weak export market for rice because of high domestic demand and insufficient local production. Regarding soybeans, Rwanda exported just 125 tons of soybeans between 2006 and 2014 because domestic production is still too low to meet the demand. (Cambridge Resources International, 2017).

Within the EAC, continued market integration is expected to expand Rwanda's regional market as FLID products are tailored to EAC consumers. Rwanda may find opportunity in regional urban markets for selling higher-quality products, especially vegetables and fruits. The main market for FLID horticultural exports (fruits, vegetables, and flowers) is Europe, but many opportunities exist in other regions, especially in west Africa. For FLID horticultural exports, emphasis needs to be put on improving aggregation, standards compliance, and logistics in the domestic segment of the supply chain to access larger international markets.

Notes

1. New electricity end-user tariffs, communicated by the Rwanda Utilities Regulatory Authority on August 10, 2018.

2. Season C: from June to August.

3. Season B: from February to May.

4. Season A: from September to January.

CHAPTER 4

Enabling Environment for Farmer-Led Irrigation

In 2017, the government of Rwanda (GoR) adopted the East African Community's Vision 2050 (EAC, 2016). The goal is to raise living standards in Rwanda and to create high-quality livelihoods for its citizens. The GoR adopted the National Strategy for Transformation (NST 1) as a new implementation instrument for the remainder of Vision 2020 and EDPRS II (MINECOFIN, 2017). Both Vision 2050 and NST 1 emphasize the essential role of the agriculture sector in poverty reduction and food security.

Under the economic transformation pillar,[1] NST 1 targets implementation, in partnership with the private sector, of building effective and innovative irrigation systems to increase the area under irrigation from 48,508 hectares in 2017 to 102,284 hectares in 2024 (MINAGRI, 2018d).To achieve the rapid agriculture transformation for economic growth as stipulated in NST 1, the GoR adopted the National Agriculture Policy (NAP), and the fourth Strategic Plan for Agriculture Transformation (PSTA-4) as the enabling environment frameworks (MINAGRI, 2018d).

Legal and Policy Framework

Appendix D details the existing laws, policies and regulations that impact FLID.

Institutional Arrangements for FLID

The multisectoral nature of FLID involves different stakeholders, including various sector ministries, civil society organizations, development partners, the private sector, farmers' organizations and cooperatives, and financial institutions. MINAGRI—along with its implementing agencies, the Rwanda Agriculture and Animal Resources Development Board and the National Agricultural Export Development Board are responsible for defining policy options and regulations that support and accelerate FLID initiatives. This includes outlining strategic planning, implementing the monitoring and evaluating system to track progress of FLID indicators, and providing required resources (human and financial) for effective implementation.

FLID Coordination Groups

Under the sector coordination framework defined in PSTA-4, the Rwandan ministry coordinates FLID activities with other sector priorities by state and nongovernmental actors in the agriculture sector through the following sector coordination mechanisms:

- *Agricultural Sector Working Group.* This forum brings together civil society organizations, development partners, farmer groups, including irrigation water use associations and cooperatives, financial institutions, government agencies, nongovernmental organizations, and members of the private sector to discuss agriculture

development issues.

- *Sector-Wide Approach Group.* A coordination platform that brings together MINAGRI and budget support development partners to discuss issues related to budget support in the agriculture sector.
- *Subsector working groups.* Arrangements to enhance stakeholders' roles in advising, coordinating, financing, monitoring, and planning for the sector. It brings together the agriculture sector stakeholders under four permanent specialized clusters: agribusiness, markets, and export development, crop development, livestock development, and planning and budgeting.
- *Forward Looking Joint Sector Review.* Forum for working group stakeholders to discuss priorities in the implementation of the PSTA for the next fiscal year.
- *Backward Looking Joint Sector Review (BL-JSR).* An endeavor that brings together sector working group stakeholders to monitor progress in implementing the on-going PSTA for the past fiscal year

Table 4.1 presents a summary of institutional roles and responsibilities for the development and management of irrigation schemes.

Table 4.1: Institutional Roles and Responsibilities for Irrigation Development

No.	Institutions	Roles and Responsibilities
1	Farmers' cooperatives	Extension and advisory services, marketing for agricultural produce
2	Irrigation water users' associations	Allocation and distribution of irrigation water, collection of irrigation service fees, maintenance of irrigation infrastructure
3	Ministry of Agriculture and Animal Resources (MINAGRI)	Policy creation, coordination, mobilization of funds, monitoring and evaluating, strategic planning,
4	Ministry of Education through the Workforce Development Authority	Preparation of training modules or materials; capacity building by accommodating farmers and offering internships
5	Ministry of Finance and Economic Planning	Financing feasibility studies, funding the public-led irrigation projects, funding expropriation (if need be)
6	Ministry of Infrastructure	Provision of access roads, utility services (electricity), and other infrastructure

7	Ministry of Justice	Legal opinion, especially for big irrigation projects
8	Ministry of Local Government through the districts	Mobilization, resolution of disputes
9	Ministry of Trade and Industry	Policy to support value chain development, regulations for commodity pricing, agro-industry development
10	Rwanda Agriculture and Animal Resources Development Board	Identification of irrigation potential areas to be developed; feasibility studies; development of site-procurement process to select companies to develop sites and ensure supervision; recruitment of staff to manage sites or schemes; provision of extension services; capacity building of the farmers' organization and cooperatives
11	Rwanda Cooperative Agency	Famers' cooperative registration, training in cooperative management
12	Rwanda Environment and Management Authority	Environmental impact assessment for irrigation projects
13	Rwanda Governance Board	Legal personality for IWUAs
14	Rwanda Standards Board	Regulations of standards for seeds, fertilizers, irrigation equipment, and pesticides
15	Rwanda Water and Forestry Authority	Water regulation
16	Service providers-individual private companies	Services for the operation and maintenance of irrigation infrastructure

Source: www.gov.rw

Notes

1. Outcome 6.1: Increased productivity, quality, and sustainability of crops (MINECOFIN, 2017).

2. New electricity end-user tariffs, communicated by the Rwanda Utilities Regulatory Authority on August 10, 2018

3. Season A: from September to January. Season B: from February to May.

CHAPTER 5

Analysis of the Supply Chain for Farmer-Led Irrigation

From the fiscal year 2013/14 to 2017/18, the government of Rwanda (GoR) shifted its policy towards supporting farmers from a public-led approach to a public-facilitating approach (MINAGRI, 2014d). The policy stemmed from the third phase of Rwanda's Strategic Plan for Agriculture Transformation (PSTA-3). In 2018, the government approved the fourth phase of the strategic plan (PSTA-4), which aims to promote value chain development with the GoR as a market enabler.

This chapter will cover the following topics: (a) the supply chain for accessories, equipment, and other inputs used in FLID; (b) major suppliers and distributors and their networks; (c) the availability of financial services; (d) the role of donors in developing the supply chain; (e) the local manufacturing capacity for equipment and accessories; (f) the competitiveness of retail pricing (margins for market participants); (g) the adequacy of post-sale assistance and maintenance services; and (h) key private and public sector participants in FLID.

Supply Chain for Equipment and Accessories

Hand Tools and Machinery for Developing FLID Markets

In farmer-led irrigation development, famers prepare land, using manual labor and/or hand tools. A few large-scale commercial farms own or hire tractors (with two and/or four wheels) with plowing and harrowing capabilities for land preparation. These commercial farms include Bramin farm, ProDev Bugesera, the Agro-Processing Industry military farm, and Nyagatare Agro Ventures Rwanda Pvt. Ltd. (NAVR), as well as a small number of cooperatives (for example, Kooperative y'Abahinzi Borozi mu kibaya cy'Umuvumba [KABOKU][1] and others that mostly grow cash crops, such as maize, paddy rice, and soybeans). NAVR is a commercial company growing rice on about 700 hectares of public land in the Nyagatare District; the Rwandan government leased the land for commercial rice production for 49 years (MINAGRI and NAVR, 2012).

Most farmers plow manually with a hoe and other hand tools, such as machetes or sickles, pitchforks, rakes, watering cans and sprayers, and wheelbarrows. These hand tools are mainly used for commodities, including cassava, coffee, Irish potatoes, maize, paddy rice, soybeans, tea, vegetables, and other food and cash crops (World Bank, 2017a).

Photo 5.1: Land Preparation with Four-Wheel Tractors, KABOKU Cooperative Farm

(a) Land preparation: Tractor plowing land with chisel plow (b) Land preparation: Tractor plowing land with disc tandem

Photo 5.2: Land Preparation with Power Tillers, Mostly on Terraces Developed on Hillsides

(a) Land preparation: Power tiller plowing land with disc plough (b) Land preparation: Power tiller plowing land with moldboard plow

FLID producers also use two-wheel tractors (known as power tillers), small four-wheel tractors, and other post-harvesting equipment, including shellers, threshers, and winnowers. Farmers are most familiar with the four-wheel tractors with more than 65 horsepower, but these are costly, even for a cooperative or private contractor. Small two-wheel tractors are not widely available. Tractor implements most commonly used and sought by farmers engaged in FLID include plows and trailers, which are mainly used by large-scale commercial farmers and cooperatives for commodities, such as maize, paddy rice, soybeans, and tea (table 5.1). The main challenge for FLID is the lack of spare parts, as most equipment is imported.

Table 5.1: Use of Mechanized Products to Prepare Land for FLID

Mechanized Products	Uses and Availability	Regions	Crops	Product Examples	Business Models
Hand tools	Widely available, mainly through small village shops. Widely used by all smallholder farmers.	All	Beans, cassava, coffee, Irish potatoes, maize, rice, Soybeans, tea, vegetables, and others	Hoes, machetes, sickles, pitchforks, and shovels	100% purchased on an individual level.
Four-wheel tractors	Rwanda has 150 operational tractors by Bota, John Deere, or Mahindra. Large dealers operate in Kigali and deliver to all of Rwanda.	In the capital of Kigali and elsewhere, mainly in the east	Beans, maize, rice, Soybeans, tea, and other (cash) crops grown on a larger scale; in some cases, only use for transport	Mostly 75-hp tractors	Purchased by individuals (large commercial farmers) or by cooperatives. Also purchased by private service providers and rented out.
Two-wheel tractors (frequently called power tillers)	Available in urban areas and used by commercial farmers and cooperatives.	Kigali	Beans, maize, rice, soybeans, and tea	Mostly 15-hp tractors	Mainly purchased by cooperatives and used (free or for a small fee) by cooperative members.
Implements	Available at big dealerships in Kigali. Direct link between dealers and sellers of tractors and power tillers for large-scale plowing and spraying.	Kigali	Beans, maize, rice, Soybeans, tea, and other (cash) crops grown on a larger scale	Disc plow and moldboard plow, as well as harrower, rotary tiller, and others	Direct link to sellers of tractors and power tillers. Purchased by large commercial farms or purchased by cooperatives and rented to or borrowed by cooperative members.

Source: World Bank, 2017a.

Most farmers manually plant or sow the majority of their crops. Commercial farms and cooperatives mechanically plant and seed such commodities as maize and soybeans. NAVR also uses mechanization to transplant rice seedlings. Farmers can mark out planting stations with planting wires, but they could mechanize this process to some extent with simple markers. NAVR

uses small rice planters and transplanters for both human-powered and motorized versions.

Photo 5.3: Rice and maize planting using Mechanized Equipment

(a) Two-wheel rice transplanter used in planting rice in marshland; (b) Mechanized maize seed planter attached to a tractor

In Rwanda, about 17 percent of farmers practicing FLID use mechanization for spraying—16 percent with knapsacks and 1 percent with two-wheel tractors (World Bank, 2017a). These farmers mainly spray coffee, Irish potatoes, paddy rice, tea, vegetables, and other food crops. On medium and large commercial operations, farmers use boom sprayers for crops such as maize, rice, and soybeans. However, mechanized harvesting is not common in Rwanda, and normally only occurs on medium and large private commercial farms for crops such as maize, rice, and soybeans.

<Photo title>Photo 5.4: Two Options for Spraying Crops

(a) Boom sprayer attached to four-wheel tractor at the KABOKU cooperative farm (b) Two-wheel sprayer Muvumba rice marshland

Photo 5.5: Two options for harvesting crops

(a) Rice harvesting at NAVR

(b) Maize harvesting at the Bramin farm

For small-scale FLID, farmers use bicycles, motorcycles, power tillers (connected to trailers), and wheelbarrows to transport harvested produce. On the other hand, many large-scale farmers and some well-managed cooperatives have their own transport equipment, including trucks and trailers, while others use pay-per-kilogram services with private trucks owned by local traders.

Photo 5.6: Two Transport Choices

(a) Two-wheel power tiller attached to a trailer

(b) Four-wheel tractor attached to a trailer

In Rwanda, storage facilities and postharvest practices are rudimentary, and most small-scale FLID farms lack suitable postharvest facilities. In a 2014 household survey, the U.S. Agency for International Development found that only 22 percent of farmers had access to storage and only 12 percent processed postharvest facilities (World Bank, 2017a).

The 2017 Intelligence Study on Agricultural Mechanization in Rwanda indicated that smallholder farmers used threshers, shellers, and winnowers at rates of 7, 4, and 2 percent, respectively (World Bank, 2017a). Most small-scale farmers need postharvest facilities for beans, maize, soybeans,

and vegetables, as well as postharvest processing equipment such as shellers, threshers, and winnowers (photo 5.7).

Photo 5.7: Postharvest Processing Equipment Most Used for Beans, Maize, Rice, and Soybeans

(a) Maize shellers manufactured locally (b) Different postharvest machines, including sheller, winnower and thresher

Irrigation Tools and Equipment

The tools that smallholder farmers use to water crops depend on purchasing power, crop type, plot size, topography, and water sources. Details on FLID equipment and accessories appear in chapter 2 section "Farmer-Led SSITs.

Box 5.1: An Irrigation Success Story in Eastern Province

In the Kirehe District of Eastern Province, several smallholder farmers grow a variety of vegetables using small-scale irrigation equipment connected to small runoff ponds. Financed by the International Fund for Agricultural Development, the Kirehe Community-based Watershed Management Project (KWAMP) built small water ponds of various capacities—120, 250, and 480 square meters—to irrigate about 72 hectares of land dispatched for 198 beneficiaries.

<Box Source>*Source:* MINAGRI, 2016c.

Major FLID Supliers and Distributors

SSIT Suppliers and Distributors

Through the small-scale irrigation technology (SSIT) program, smallholder farmers can access irrigation equipment through suppliers and distributors registered at the Rwanda Development

Board. However, there are limited suppliers of FLID equipment, as only five dealers or suppliers exist in Rwanda: (a) Balton Rwanda, (b) Davis and Shirtliff, (c) Future-pump, (d) Jain Irrigation Systems Ltd., and (e) Holland Greentech Rwanda Ltd. These companies distribute equipment across the country via wholesalers and dealers. Through the Rwanda Agriculture and Animal Resources Development Board (RAB), the government recruits service providers to supply and distribute SSIT equipment subsidized at 50 percent (Service providers listed in Appendix D table4) (RAB, 2018).

Most of the service providers import FLID equipment primarily from China, Kenya, India, South Africa, and Europe (primarily France, Germany, Italy, Spain, and the United Kingdom). According to RAB, Chinese products mainly dominate the market for FLID equipment in Rwanda (90 percent of imported FLID SSIT equipment) (MINAGRI, 2014a). A detailed list and description of suppliers and distributers can be found in Appendix D.

Availability of Financial Services

A key objective of the second phase of Rwanda's Financial Sector Development Programme, launched in 2012, is to enhance access to and affordability of financial services (MINECOFIN, 2012b). This is through developing a strong, efficient, and competitive banking sector offering a diversified array of financial products and services (AFR, 2016). Consequently, Rwanda's financial sector has grown substantially, and it is increasingly becoming wider and more diversified. Table 5.2 lists the available financial services provided by financial institutions, namely, commercial banks, insurance companies, bank-based microfinance institutions (MFIs), nonbank MFIs, pension funds, and savings and credit cooperatives (SACCOs). In 2016, the banking subsector was still dominating the financial industry (AFR, 2016).

Table 5.2: Number of Financial Services Provided by Financial Institutions

Category of Financial Institution	Number of financial services
Capital market	With 7 equities and 12 listed bonds on Rwanda Stock Exchange
Commercial bank	11
Cooperative bank	1
Development bank	1

Microfinance bank	3
Nonbank financial institution (insurers)	12 (10 private and 2 public)
Payment system operators (payment service providers)	13
Pension fund	55 (1 public and 54 private)

Source: AFR, 2016

Rwanda's financial sector is dominated by commercial banks in terms of total assets (with a 66.9 percent share of total financial sector assets), savings and lending. MFIs, particularly SACCOs, play an important outreach role in bringing formal proximity financial services to Rwandans that were not previously served by the commercial banking sector (MINECOFIN, 2012a).

Proximity financial services are mainly Umurenge SACCOs, which are available in every administrative sector of Rwanda. Rwanda has 416 licensed MFIs Umurenge SACCOs, and 33 licensed MFIs non-Umurenge SACCOs (BNR 2017a, 2017b). The objective of these financial services is to improve access to financial services for rural communities, including credit, insurance, and savings, on a sustainable basis (AFR, 2016).

Regarding agriculture finance, the loan portfolio to the agriculture sector from the formal financial sector has increased since 2012. The agriculture loan portfolio (agriculture processing, production, and trading) in the formal financial sector (banks, MFIs, and SACCOs) increased from 57 billion RF (US$ 70 million) in 2012 to 90 billion RF (US$ 110 million) in 2016[4]. During the same period, the Development Bank of Rwanda, the largest lender in the agriculture sector, with 41 percent of the portfolio, increased its lending from 21 billion RF (US$ 26 million) to 37 billion RF (US$ 45 million)[5]. This growth was mainly driven by agro-processing and cash crops, especially tea production. MFIs and SACCOs, representing 22 percent of loans, experienced the fastest growth among the three categories and reached 20 billion RF in 2016 (US$ 24 million)[6]. The data do not show clear trends in financial loans for FLID.

Role of Donors in Supply Chain Development

Development partners (DPs) provide loans and/or grants to the GoR. These loans and grants are used to support farmer initiatives through government projects or NGOs. Through government support, smallholder farmers practicing FLID can access subsidized equipment, inputs, and trainings to improve their skills in developing FLID value chains.

[4] Exchange rate US$ 1 = RF 820
[5] Ibid
[6] Ibid

The role of DPs is primarily technical in nature as well as in providing financial support to the government. Through various forums, DPs and GoR are engaged in a constructive policy dialogue, such as the Agriculture Sector Working Group, cluster meetings, the Development Partners Coordination Group, and public-private dialogues.

Local Manufacturing Capacity for Equipment and Accessories

Most FLID equipment, including the spare parts, is imported. Only simple equipment, machines, and tools are manufactured in the country. These include the following:

- Stands for sprinkler rain guns, mostly used in small-scale irrigation
- Polyvinyl chloride (PVC) and high-density polyethylene (HDPE) pipes
- Water tanks
- Hammer maize mills, maize kernel remover, combined maize sheller-cleaner-grader, and electric or engine maize sheller
- Rice seed planters, threshers, weeders, and winnowers, as well as combined rice thresher and winnower
- Beans threshers and wheat threshers
- Potato peelers
- Fruit pulpers
- Cassava graters, grinders, and solar dryers
- Wheelbarrows and trailers
- Grain storage systems

Major local manufacturers of this equipment appear in table 5.3

Table 5.3: Major Local Manufacturers of FLID Equipment and Accessories

Company Name	Service Provision	Contact Details
AB Engineering Manufacturing (ABEM) Ltd.	*Manufacturing of postharvest machines and their spare parts	Mobile: (+250) 788 305 190 P.O. Box 2880, Kigali
Aquasan Ltd.	* Manufacturing and supplying of water storage tanks * Manufacturing of rainwater harvesting systems * Irrigation HDPE pipes * PVC pipes and fittings	Tel: (+250) 788 380 855 or (+250) 788 306 833 Kigali E-mail: info@aquasanrw.com

	* Corrugated pipes	
Chillington Rwanda Ltd.	* Manufacturing of processing machines for maize, rice, and wheat * Manufacturing of wheelbarrows * Manufacturing of casted spare parts	Tel: (+250) 788 500 857 or (+250) 788 606 670 Kigali E-mail: info.chillingt@gmail.com
Evergreen Machinery Co. (EGMC)	*Importation of small postharvest machines	Tel: (+250) 785 922 589 and (+250) 789 682 354
Global Industrial and AgroTechnology (GIT) Ltd.	*Manufacturing of small postharvest machines and their spare parts	Tel: (+250) 788 837 255, (+250) 788 464 338 Kigali E-mail: gitltd34@gmail.com
Metal Works Solutions Ltd.	*Manufacturing of small postharvest machines and their spare parts	Tel: (+250) 788 528 040 Kigali
Orange Machinery & Parts Ltd.	*Manufacturing of postharvest and agroprocessing machines and their spare parts	Tel: (+250) 788 459 662, (+250) 783 401 358 Kigali E-mail: info@orangemachinery.co.rw
Pro Water Rwanda Ltd.	*Manufacturing and supplying of water storage tanks of various capacities	Tel: (+250) 788 351 338, (+250) 788 985 337 P.O. Box 1220, Kigali E-mail : prowaterrwanda@gmail.com
Roto Ltd.	* Manufacturing and supplying of water storage tanks of various capacity * PVC and HDPE pipes	Tel: (+250) 280 302 628, (+250) 280 302 629 Mobile: (+250) 788 303 966, (+250) 788 530 665 P.O. Box 6472, Kicukiro, Kigali E-mail: info@rotorwandatanks.com
Rwanda Plastic Industries Ltd.	*Manufacturing of PVC pipes and fittings	Tel: (+250) 783 198 254, (+250) 788 506 753 Land-line: (+250) 252 510 138 Kigali E-mail: siboxj@gmail.com, degau2006@yahoo.fr
Rwantech Boiler & Tech. Engineers Ltd.	*Manufacturing of transport trailers	Not available

Source: World bank, 2017a

There is a high demand for locally produced machinery and equipment in Rwanda because of several key factors:

(i) A lack of appropriate technology that suits local needs in agriculture machinery and equipment;

(ii) Durability, especially when compared to the low-quality machinery and equipment imported from China and India;

(iii) Convenience, which allows for tailoring to clients' specific needs and;

(iv) Proximity, as local producers are more accessible compared to importers that are normally based in a few urban centers (World Bank, 2017a).

Suppliers generally know about the quality of their imported equipment, but less about local manufacturers of equipment that produce sufficient quantity and quality. The government, through the Rwanda Workforce Development Authority, has initiated national programs to support local manufacturing subsectors and to limit/reduce imports of FLID equipment. Efforts to develop local manufacturing also are occurring. Education of Rwandans about such developments are being conducted in integrated polytechnic regional centers and integrated technical and vocational education training centers across the country.

Adequacy of Postsale Assistance and Maintenance Services

Distribution Channels

In most FLID potential areas, smallholder farmers are organized into crop-specific cooperatives that ensure collection of produce from FLID farms and sales to potentials buyers, or uptakers. They usually collect FLID produce at farm gates and transport it to markets. Cooperatives also may transport produce from farms to markets, depending on individual agreements between producers and buyers. Uptakers can also be identified by commodity:

- *Rice.* The Ministry of Agriculture and Animal Resources—together with the Ministry of Trade and Industry—established rice zones in partnership with producers in rice cooperatives, and they have appointed in each zone a rice miller who collects paddy rice.
- *Beans, maize, and soybeans.* Most cooperatives collect harvested produce at farm gates and sell in bulk to potential buyers or wholesalers. Given the fragmented nature of production, rural traders buy harvested cereals from farmers and pay them directly in cash. Most traders have contracts with farmers and move from farm to farm, purchasing the small quantities farmers can offer. Traders store the produce to supply larger orders from traveling traders.

  In a few cases, rural collectors buy, and store produce on their premises for months to sell later at higher margins. In addition, because transport is the major constraint for rural traders, traveling traders also purchase cereals from farmers and/or rural traders. They usually come from Kigali or other cities and towns across the country—and transport is their main function. They charge for produce per bag and since the bags are not weighed during transport, traders tend to reduce costs by moving large bags of more than 100 kilograms.

Consequently, transporters shoulder higher costs because of maintenance needs stemming from vehicle depreciation. The profit margin of local transporters ranges between 10 and 35 percent per load, depending on distance and road quality.

- *Horticulture high-value crops (fruits and vegetables).* Because of limited productivity and the lack of diversification, horticulture production does not meet local demand. The Rwandan Horticulture Baseline Survey of 2014 indicated that about 72 percent of horticulture products never leave the district in which they were produced (NAEB, 2014a). Local rural traders and traveling traders (that is, middlemen) typically collect the remaining 28 percent, mainly vegetables, at farm gates (photo 5.8) and transport them to whole sale traders or Kigali wholesale markets such as Kimironko, Kimisagara, and Nyabugogo or to wholesale traders. Most smallholder farmers selling to wholesale traders receive low prices for their produce, allowing wholesale traders to earn large profits by selling at five or six times the prices they paid for the produce. Only a few farmers sell directly to retail markets.

Photo 5.8: FLID Tomato Production, Nyagatare District near Muvumba River

(a) FLID tomato field near Muvumba River in Nyagatare District (b) Harvested tomato from a FLID field

Post-sale Assistance

The government provides support to farmers, that are organized into cooperatives and irrigation water users' associations (IWUAs), through study tours, training modules, mobilization, and awareness meetings to improve farmers' skills in the following:

- Conflict resolution
- Credit schemes
- Extension services
- Farming technologies
- Formation of groups
- Gender balance
- Maintenance, management, and operation of irrigation equipment

- Marketing
- Nutrition
- Organization and management of cooperatives and associations
- Saving money
- Techniques for integrated pest management

The government also helps farmers establish markets or selling points near their farms. This support includes construction of rural infrastructure, such as cold rooms and packhouses for vegetables, drying grounds for cereal, feeder roads to transport agriculture products, postharvest maize shelters, and storage facilities.

In addition, the government links farmer organizations to potential buyers, according to commodity. For cereals, the government will help organizations to sign contracts to supply beans, maize, and/or soybeans through facilitating groups or to maize milling companies.

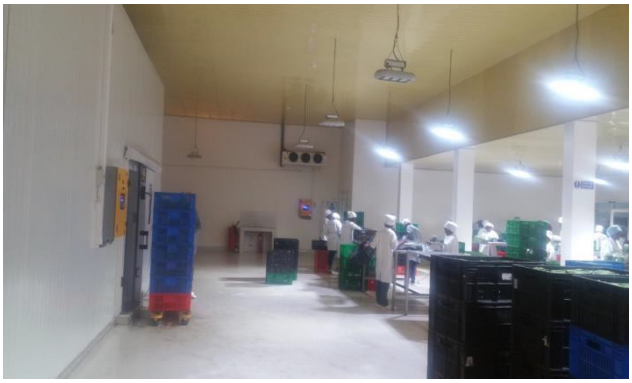
Box 5.2: Farmer's access to markets

To support the maize commodity in the Kirehe District, farmer organizations have been linked to markets, mainly World Food Program, Ets. Nkubili Alfred & Sons, BABC, NSGR, RGCC Ltd., and Kirehe Freedom Kawunga. Also, in the area closer the FLID schemes, though KWAMP value chain development found, the farmers are linked to maize processing flour companies (Ubuzima Bwiza Company located in Kigina Sector and Freedom Kawunga) granted by the value chain development fund to motivate the maize growers.

<Box Source>*Source:* MINAGRI, 2016c.

Most cooperatives do not support horticultural farmers with post-harvest activities such as grading, marketing, sorting, and storing. Thus, farmers have limited bargaining power with traders. Individual farmers do not have the capacity to trade directly on the wholesale market, because they lack time, transport and skills. To overcome these challenges, the government has started to support FLID farms with the construction of vegetable cold rooms and packhouses (photo 5.9).

Photo 5.9: Horticulture Packhouse Built in Kigali



(a) NAEB cold room and packhouse for fresh vegetables

(b) Sorting of vegetables in the NAEB packhouse

The government also assists farmers in the manufacturing of essential oil, a high-value horticulture product, by linking them with potential national and international investors, such as KK-Food, Proxifresh, Lotec Rwanda, Stevialife Sweeteners Ltd., Nature Fresh Foods Ltd., and BDA Consultancy Ltd. The investors either lease the land or work with outgrowers on contracts.

Maintenance Services

The private sector plays a key role in helping farmers maintain their irrigation equipment and accessories. Through government-recruited companies that supply equipment, cooperatives and IWUAs agree on contracts with service providers (table 4 in Annex A) for repair and maintenance of equipment. However, commercial FLID farms have their own mechanical workshops to repair and maintain irrigation equipment and farm machinery. Local dealers and manufacturing companies also provide maintenance services, depending on where commercial FLID farms purchase their equipment (as listed in table 5.3).

Key Private and Public Participants

Key private and public participants in FLID include the Rwanda Development Board, the Rwanda Ministry of Agriculture and Animal Resources, and ministries of the following:

- Education
- Environment
- Finance and Economic Planning
- Health
- Information and Communications Technology and Innovation
- Infrastructure
- Lands and Forestry
- Local Government

- Public Service
- Trade and Industry

The Private Sector Federation also plays a key role—especially its Agriculture and Livestock Chamber—as do farmer organizations and cooperatives. In addition, local government offices, districts, and sectors deliver key extension and advisory services to farmers and, more broadly, serve as focal points to local communities and coordinate multisector responses.

Notes

1. KABOKU is a cooperative of growers of beans, maize, soybeans, and vegetables in Kagitumba Cell, Matimba Sector of the Nyagatare District in Eastern Province.

2. Wheat also was part of the package.

3. Wheat seed varieties, such as Musama, EN-161, and EN-48, are also produced and sold locally by the RAB.

4. Agriculture for Best Life Company.

6. Horticulture in Reality Cooperative

CHAPTER 6

Advisory Services

Adequacy of Research and Extension Services

Rwanda's National Agriculture Policy (NAP) and the fourth phase of its Strategic Plan for Agriculture Transformation (PSTA-4) underscore innovative research, and proximal agriculture extension and advisory services as crucial factors for bridging the gap between the country's actual crop production and its potential productivity (MINAGRI 2018b; 2018d). NAP promotes a pluralistic extension system that supports capacity building of farmers and is flexible enough to accommodate variations in farm capacity, size, production systems, social status, and other factors (MINAGRI, 2018b).

Rwanda is progressing toward stronger extension and advisory services to support FLID and other agriculture activities. Interventions for improving FLID focus on four areas:

(i) Planning and coordination;

(ii) Organization and management of decentralized extension services;

(iii) Capacity building of extension agents and;

(iv) Access to agriculture extension services by farmers.

The 2015 household survey showed an increase in extension outreach services for agriculture activities, including FLID activities. In 2011, 32 percent of surveyed households reported receiving advisory services, however by 2015 this figure increased to 69 percent (with 54 percent of females) (NISR, 2017a). Both Twigire-Muhinzi (for crop farmers) and Twigire-Mworozi (for livestock producers) extension models help farmers access advisory services, appropriate agriculture technology, and knowledge. This approach has helped adaptation and adoption of technology, and increased flow of information among producers, farmer organizations, and different partners. Both models complement existing services delivered by public extension services.

The Ministry of Agriculture and Animal Resources (MINAGRI) and the Ministry of Local Government (MINALOC) are implementing these services. MINAGRI is responsible for technical support, and MINALOC handles day-to-day coordination and planning in districts. The fourth phase of the strategic plan expects public extension programs to be broadly available for FLID. Furthermore, the country's agriculture policy also recognizes the need for more specialized and high-quality services from private service providers (MINAGRI, 2018d). NAP advocates increasing the private sector's role in the delivery of extension services (MINAGRI, 2018b).

Role of Advisory Services in Establishment of Irrigation Systems

As planned in the first phase of the National Strategy for Transformation, the agriculture ministry,

in partnership with the private sector, is implementing effective and innovative irrigation systems to increase the area under irrigation from 52,936 hectares in 2018 to 102,284 hectares by 2024. Priority will be given to scaling up cost-effective marshlands and small-scale irrigation technologies.

New models for irrigation scheme management were also introduced. These included strengthening the role of farmers and irrigation water users' associations. in establishing irrigation systems, selecting adequate technology and specifications, performing efficiently operation and maintenance of irrigation schemes and crop husbandry. The models also promoted public-private partnerships that involve farmers and/or farmers organizations in the management of irrigation schemes (MINECOFIN, 2017).

The fourth phase of the strategic plan prioritizes developing and disseminating improved crop varieties and animal breeds, as well as new approaches and technology. Particularly in the following areas:

a. irrigation to improve productivity of crops and land;

b. sustainable land use and intensification and;

c. climate variability and environmental degradation.

Targeted research to support FLID under the fourth phase will guide establishment of cost-effective irrigation systems, selection of appropriate technology to operate and maintain irrigation infrastructure, and crop husbandry practices (MINAGRI, 2018d).

Formal Institutions

Intergovernmental Organizations That Support Extension Services

To develop sustainable agriculture value chains within FLID, the fourth phase of the strategic plan advocates the need to strengthen inter-ministerial planning and budgeting (MINAGRI, 2018d). Since 2013, synchronization of planning and budgeting across different sector ministries has been improving. In addition, the increasing importance of Joint Imihigo (performance contracts) supports coordination, collaboration, and synchronization among farmers' organizations, financial institutions, institutions of higher learning, nongovernment organizations (NGOs), private operators, and sector ministries.

Furthermore, NAP promotes an innovative pluralistic extension system that involves agriculture stakeholders to resolve constraints faced by smallholder farmers and other actors within the value chain. These constraints include accessing extension and financial services, accessing inputs, overcoming limitations in meeting the standards and requirements of modern markets, and so on (MINAGRI, 2018b).

The Rwandan government in 2016 adopted the Information and Communication Technology for Rwanda Agriculture (ICT4RAg) strategy to enhance agriculture and rural development by improving information and communication processes. This strategy addresses the gap between

smallholders' knowledge of agriculture practices and the knowledge available at agriculture research institutions. The ICT4RAg strategy helps the government provide smallholder FLID with advice and extension services at all levels of the value chain. At each level, an information and communication technology solution or application is necessary to systematically contribute to and accelerate agriculture productivity (MINAGRI, 2016b).

MINAGRI coordinates all activities by state and nongovernment actors in the agriculture sector. It works closely with public institutions through collaborative platforms to implement PSTA-4 activities related to irrigation development. Key sectors include education, employment of youths and women, environment, health, infrastructure, management of land and water resources, private sector development, social protection, and trade (MINAGRI, 2018d).

Off-takers and Production Extension Services

Regarding off-takers and production extension officers, MINAGRI has been implementing initiatives geared toward facilitating off-takers to work directly with farmers. Some of these initiatives include the contract farming model and land subleasing system. Contract farming provides better links for marketing, processing, and production, and strengthens stakeholder relationships in the value chain such as between farmer, bankers, custom hire machine operators, and traders. Article 4 of the Ministerial Order No 001/14 of April 2014, on sublease contracts, stipulates that the sublessee (usually a farmer) and sublessor (off-taker) conclude a contract determining activities to be conducted on the land, the duration of the contract, the agreed rent, and any other matters that relate to management and use of the land during the contract (MINIRENA, 2014).

NGOs and Community-Based Organizations in Extension Services

The National Agriculture Policy recognizes NGOs and community-based organizations as key partners in providing extension services to farmers. The policy establishes a clear framework in which organizations may initiate partnerships between smallholder farmers and off-takers (MINAGRI, 2018b).

Women Farmers in Extension Services

The National Agriculture Policy acknowledges the inequality between men and women in agriculture although women outnumber men in the agriculture workforce with a participation rate of 92 percent (MINAGRI, 2018b). This inequality is manifested in the limited decision-making powers women have that then undermine their control over and access to agriculture assets, extension services, financial services, inputs, opportunities to increase capacity, and production. Due to this inequality, the productivity of women is lower than the average (MINAGRI, 2018b), despite contributing immensely to the agriculture value chain by providing labor for planting, weeding, harvesting, and processing.

Cognizant of this challenge, the government has made a strong political commitment to gender equality, and to promoting it through agricultural policies. MINAGRI, guided by its agriculture

gender strategy, continues to make concerted efforts to mainstream gender and engage in gender-sensitive policy making and programming (MINAGRI, 2010a). Interventions under PSTA-4 will make specific gender-responsive provisions to target and include women and design solutions tailored to their needs and challenges. In addition to mainstreaming gender, specific policy actions are proposed to empower women economically and to engage them in agriculture decision-making processes.

Moreover, the development of skills and promotion of entrepreneurship is catered to empowering the youth in Rwanda to stimulate profitable engagement in agriculture and agribusinesses, especially in FLID. The policy states that there will be dedicated staff in MINAGRI's department for monitoring and evaluation to ensure that gender and youth agendas are mainstreamed (MINAGRI, 2018d).

CHAPTER 7

Challenges and Constraints of Farmer-Led Irrigation

Availability of Water Resources

Precipitation is the primary source of water for agriculture in Rwanda. It is the main force recharging Rwanda's groundwater aquifers and surface water bodies. Each year, the country averages 1,200 millimeters of precipitation. The amount of rainfall ranges from as low as 700 millimeters in Eastern Province to about 2,000 millimeters in the high altitudes of the north and west (MINIRENA, 2015). Annually, Rwanda's rainfall varies because of the El Niño—Southern Oscillation events, El Niño and La Niña. Due to which, the country experiences periodic floods and droughts.

A key to boosting Rwanda's sustainable agriculture production is by building a resilient system for agriculture production. Climate variability affects subsistence farmers the most, particularly for rainfed crops. In addition, climate change could exacerbate the effects of variable precipitation in Rwanda and lead to new risks (though it also could potentially have some benefits). For the past few years, Rwanda has recorded higher temperatures than the global average (MINIRENA, 2012), and climate change models project a jump in temperatures of about 1°C to 2.50°C by the middle of the twenty-first century, with more hot days and heavy precipitation (Future Climate for Africa, 2014). The uneven distribution of precipitation influences the availability of water and its uses in different seasons and regions.

Rwanda uses less than 2 percent of its available freshwater resources. Although Rwanda has potential renewable water resources (estimated at 6.80 billion cubic meters per year), water resource data show that Rwanda loses almost all its water resources through evaporation or runoff to other downstream countries. Government data show the following (MINAGRI and European Commission, 2016):

- The country annually loses 4.30 cubic kilometers of rainfall as runoff water.
- Inefficient water supply systems lose between 30 and 40 percent of water.
- Most surface or flood irrigation systems are inefficient because of damage, inadequate maintenance, and/or mismanagement of the irrigation infrastructure, as well as diversion of too much water, inadequate water supplies, lack of respect for the irrigation schedule, water theft, and water pollution.
- Water-related issues have triggered disputes between households at catchments and irrigation schemes. In 2015, an estimated 7 percent of FLID areas experienced water-related conflicts between upstream water users and either irrigation water users' associations (IWUAs) or producer cooperatives.

Planned developments in the agriculture, domestic supply, energy, infrastructure, and industry sectors indicate that water demand will increase in the next few years. Meeting both demand for internal use and transboundary needs is a key challenge for the government of Rwanda (GoR). The government is prioritizing the coordination of internal water usage and transboundary water cooperation for the following reasons:

(a) Limited capacity for water resource management in terms of human resources, infrastructure, and institutional systems;

(b) Severe decline of water resources, primarily because of land degradation leading to siltation of water bodies;

(c) Pollution from point and nonpoint sources, including agricultural chemicals, poorly planned human settlements, and poor urban and industrial waste management also adversely impacts the quality of water.

(d) Climate change, ecosystem degradation, and population growth, among other reasons impact the quantity and quality of water.

Land Availability

Rwanda is a small country, with arable land estimated to be 68 percent of the total area of 26,338 square kilometers (NISR, 2014). Land-related issues are multiple and varied in Rwanda. Some issues originate from the morphology and physiology of the land, while others are rooted in sociodemographic and socioeconomic situations.

As a densely populated country, Rwanda faces serious problems related to scarcity of land, development of human settlements, and protection of the environment. About 96 percent of rural households rely directly or indirectly on the land for their livelihoods.

With modernization of the agriculture sector, land resources have been poorly managed. (NISR, 2014). Rwanda is experiencing excessive pressure on land resources due to continuous cultivation, deforestation, settlements on agriculture land, lack of culture to adopt conservation agriculture practices, mismanagement of crop residues, and so on. These issues have accelerated land fragmentation and degradation as well as a decline in productivity and soil fertility due to erosion and suboptimal agriculture practices.

In Rwanda, most agriculture plots are small: the average plot size is 0.60 hectare, and it is often divided into three to four subplots. About 30 percent of households cultivate less than 0.20 hectare (accounting for about 5 percent of total arable land), while about 25 percent cultivate more than 0.70 hectare (accounting for 65 percent of national farmland). About 15 percent of rural households farm on less than 0.10 hectare. Many of these are female-headed households, farming on only 1.32 percent of the national cultivable land.

In FLID areas, more than 80 percent of irrigated land is fragmented, with an average plot size of 2.70 and 3.0 hectares. In marshlands, land fragmentation occurs primarily because of land distribution though cooperatives. On the other hand, land fragmentation in the hillsides occurs

because of inheritances and land purchases. Average and median farm sizes in FLID marshlands are about 0.16 and 0.10 hectare compared with 0.41 and 0.40 hectare on FLID hillsides. The majority of households (89 percent) practicing FLID have less than 0.25 hectare compared with 51 percent of households on FLID hillsides (MINAGRI and European Commission, 2016).

In Rwanda land disputes frequently occur because of the socio-economic importance of land in Rwandan culture. For most rural Rwandans, land serves as a traditional foundation. It provides a sense of belonging and symbolizes relationships between people more than it serves as a source of food production. Common reasons for disputes include boundary encroachment, inheritances, land transactions, and polygamy. The majority of disputes occur within extended families (Sagashya and English, 2009).

Policies and Institutions

Institutional capacity is critical to enhancing development of FLID areas with respect to design, development, implementation, maintenance, operation, and planning of irrigation systems. Institutional constraints in Rwanda's FLID projects include poor coordination between institutions dealing with irrigation development—this makes it difficult to differentiate the roles and responsibilities of stakeholders—and inadequacy of extension support for irrigation maintenance and management. In addition, the land tenure system, policies for subsidies and incentives, and the water fee system involving IWUAs require improvements to create an environment that is conducive to private sector investments in FLID.

Financial and Banking Services

Although GoR has made important strides toward helping farmers establish themselves financially, limited access to financial services still hinders the development and expansion of FLID. Purchasing of inputs—namely, fertilizers, improved seeds, and other irrigation equipment—requires financial capacity beyond the reach of small-scale farmers. Most FLID schemes are operated by farmers with small pieces of fragmented lands, so they cannot make collateral for long- and short-term credit provisions. This affects the efficiency of their FLID schemes. However, more affluent households benefit because they have more land, labor, and money to buy farm inputs, which allows them to take advantage of irrigation opportunities.

In Rwanda, the agriculture sector has specific financing needs, which differ from most commercial banking products that target urban real estate markets and the formal sector. Financing needs for agriculture follow a seasonal pattern, with peaks at the time for acquiring inputs and at the postharvest stage. Thus, the required amortization periods are shorter than in real estate and longer than for most microfinance products. Products matching these needs are still embryonic in most commercial banks in Rwanda, with collateral requirements that often go beyond the loan size and with interest rates as high as 21 percent (USAID-PSDAG, 2015).

Compared with men, women have limited access to formal financing opportunities, and they are more at risk of financial exclusion (MINECOFIN, 2016). Only 25.5 percent of loan beneficiaries are women, according to data from the Gender Monitoring Office (2017). The country needs

financial products addressing women's needs.

Output Markets and Pricing

The ability of farmers to access markets and marketing facilities (drying grounds, storage facilities, quality enhancing equipment, and so on) is a major driving force behind effective FLID schemes. In most irrigation areas, market problems are acute because of the perishability of irrigation-based agriculture commodities. Inadequate access to markets forces farmers to sell their products at lower prices to avoid spoilage. The markets are dominated by middlemen, and farmers do not have bargaining power due to lack of market information.

However, great variability exists in commodity pricing, often dictated by seasonality. Prices are low during harvest and high at other times. In addition, many irrigation areas have limited storage, which causes huge postharvest losses. Although there have been many attempts to organize markets in FLID areas by introducing contract farming models, this approach has not been efficient because these contracts are not legally enforceable.

Farmers try to sell to buyers outside their contracts to take advantage of market prices that are higher than contracted prices. Alternatively, they sell to other buyers to avoid repayment of inputs they received on credit. Conversely, buyers may import or purchase from other markets instead of from the contracted producers, or they impose strict quality standards on farmers to avoid purchasing from them at the agreed prices.

Input Markets and Pricing

In 2007, under the first strategic plan for agriculture transformation, the Rwanda Ministry of Agriculture and Animal Resources introduced the Crop Intensification Program (CIP). Initially launched as a pilot program to boost self-sufficiency,[3] ensure food security, and increase productivity in high-potential food crops (referred to as priority crops), the program subsequently became part of the government's agriculture policy (MINAGRI, 2018b).

CIP focuses on the transfer of knowledge and technology to farmers while improving access to inputs and markets. Three key goals exist, to increase access to inputs, improve availability of production technologies (extension services), and improve access to markets. The program entails a holistic approach to agriculture development, which addresses soil degradation and infertility, improved access to livestock (including the Girinka Program),[4] improved access to inputs (agrochemicals, fertilizers, and seeds), and links connecting farmers to markets. The aim of the program has been to increase farmers' use of quality seed and inorganic fertilizers. As a result, usage has multiplied five times over the past decade. This positive trend occurred not only because of subsidies on fertilizers and seeds, but also because of a shift in the GoR policy, from bulk procurement of fertilizer and seed to progressive privatization of importation and distribution.

The National Fertilizer Policy was introduced in 2014. This policy aimed to increase fertilizer use to 45 kilograms per hectare (55,000 tons per year) by the end of the third phase of the strategic

plan in 2018 from an average of 20 kilograms per hectare (30,000 tons per year) over 2014 to 16 and 4 kilograms per hectare (8,000 tons) in 2006 (MINAGRI, 2014b).

Subsidized fertilizer is imported by eight approved importers, distributed by the Agro Processing Trust Corporation Ltd. and sold to farmers through a network of 750 agro-dealers. Overall, more than 1,000 agro-dealers operate in Rwanda. The intensive use of fertilizers and improved seed has significantly the productivity of Irish potatoes, maize, rice, and wheat. (MINAGRI, 2014b).

Infrastructure and Institutional Challenges

Similar to other eastern and central African countries, FLID has faced numerous challenges in Rwanda. Although some smallholder farmers have reported increases in income from commercial farming when using smallholder irrigation (FAO-Rwanda, 2017), adoption of various smallholder irrigation technologies has been low.

In Rwanda, most irrigation schemes are developed with government funding to support smallholder farmers. The government annually spends about 5.5 billion RF (US$ 7.86)[7] to ensure that irrigation infrastructures continues to support national agriculture production in a sustainable manner. Such financial burden is not sustainable because it will continue to increase the investment cost (USAID-Africa Lead, 2014).

In Rwanda, areas with medium to large FLID schemes typically suffer from at least some of the following:

- Depreciating infrastructure,
- Inefficient usage
- Low levels of cost recovery
- Poor or inadequate irrigation infrastructure
- Poor service delivery,
- Problems with land tenure and rights and
- Inefficient operation and maintenance of irrigation infrastructure because of the lack of availability and high cost of spare parts.

In addition to infrastructure challenges, some institutional challenges also exist. These include poor functioning of established associations for irrigation water user. They leads to ineffective control systems, inadequate monitoring, and ineffective enforcement of activities associated with FLID schemes. Water-related conflicts occur, due to poor and inefficient water management. Farmers with upstream plots in the scheme receive more water compared to the downstream farmers. In addition, other sectors also compete for the use of water. In the Eastern Province, for

[7] Exchange rate US$ 1 = RF 700

example, FLID water sources have multiple uses, including domestic use and livestock feeding. Often, planning for water resources often does not consider irrigation needs.

The government encourages the private sector to reduce imports of FLID equipment and accessories by developing local skills and technology that fit the Rwandan context. Local manufacturers and farmers should consider the development of skills through centers of excellence in FLID. In addition, the government should improve access to finances (at low interest rates), possibly by creating a FLID trust fund as a catalyst for an appropriatefinancial model. This would build confidence in both FLID suppliers and local manufacturers, and help farmers more easily acquire affordable equipment.

Moreover, the land tenure system characterized by small and fragmented plots limits private investors. The government aims to reform the Rwandan land tenure system in order to attract private investors to access land resources and fund FLID as private commercial farmers.

Notes

1. International Property Rights Index calculations, based on Integrated Household Living

Conditions Survey data (NISR, 2014).

2. For more information, go to http://www.minagri.gov.rw/index.php?id=618.

3. For more information, go to http://www.minagri.gov.rw/index.php?id=28.

CHAPTER 8

Assessment of Business and Financial Models

This chapter provides an overview of business and financial models used in Rwanda to access equipment for farmer-led irrigation (FLID). The chapter also presents an analysis of successful business and financial models with potential to be scaled up. This information will assist the government of Rwanda (GoR) in promoting appropriate business models in its policies for encouraging the use of FLID equipment. Such policies could help the country achieve its irrigation target by 2024 (MINAGRI, 2018d).

Existing Business Models in FLID

In Rwanda, several business models provide access to FLID equipment. The business models fall into one of three categories, small-scale farmers, medium-scale farmers, and large-scale farmers. Most smallholder farmers own small agriculture hand tools, such as hoes, knapsack sprayers, machetes or sickles, as well as small-scale irrigation (SSI) equipment. More than 300 local traders or small-scale suppliers operate across the country. Local village shops sell small hand tools, and seven midsize suppliers sell SSI equipment from their head offices in Kigali and the countryside (Figure 8.1.) (World Bank, 2017a).

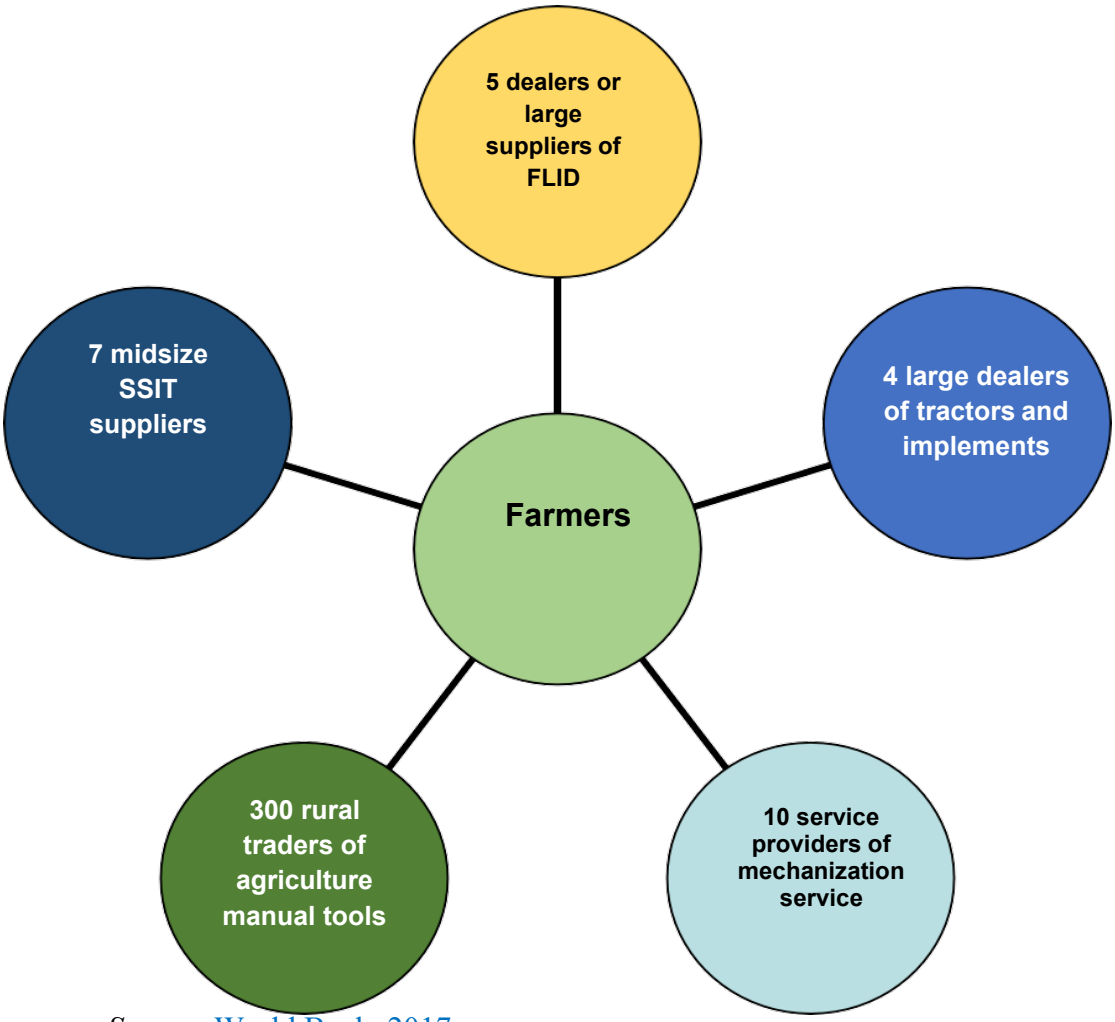
In addition to owning small agriculture tools and equipment, a number of smallholder farmers prefer to rent or borrow some of their SSI equipment from farmer cooperatives. In most cases, they rent or borrow diesel or petrol pumps and hoses. Some farmers also own larger equipment, such as power tillers with spraying or plowing equipment, but they usually prefer to rent farm machinery of larger capacity (such as tractors) from private service providers or the Rwanda Agriculture and Animal Resources development Board (RAB). Ten service providers rent out mechanization services in Rwanda, mainly for land preparation.

On marshlands and hillsides, medium- to large-scale farmers use FLID schemes developed with financial support from the Rwandan government or development partners (DPs) such as the African Development Bank, the International Fund for Agricultural Development, the Japan International Cooperation Agency (JICA), the Korea International Cooperation Agency (KOICA), and the World Bank. Since these farmers belong to cooperatives and irrigation water users' associations (IWUAs), they own these schemes only after signing transfer agreements[1] for operation and maintenance of the irrigation infrastructure.

FLID marshlands are state lands leased to smallholder farmers or cooperatives for 49 or 99 years (MINILAF, 2013). Hillside FLID schemes are developed on private land, but irrigation infrastructure (pressurized infrastructure such as drip, pivot, and sprinkler systems) is developed on their land is partially supported by the government. Established IWUAs collect fees from

smallholder users of irrigation water to ensure budgets for maintenance, management, and operation of irrigation infrastructure. Water fees are deducted from sales of crops to cooperatives after each harvest, which are deposited into bank accounts at nearby microfinance institutions (MFIs). Established IWUAs manage these accounts.

Figure 8.1: Business Models in FLID



Source: World Bank, 2017a

Note: FLID = farmer-led irrigation; SSIT = small-scale irrigation technology.

Most medium- to large-scale farmers use basic agriculture farm equipment recommended for small-scale producers. They manually operate knapsack sprayers to apply pesticides, so the demand for sprayers is consistently high. However, some medium- to large-scale farmers, such as those in the Coproriz-Mukunguri cooperative and Muvumba P8 Rice Growers Cooperative, own large farm machinery (such as tractors and implements). Other medium- to large-scale farmers, that are unable to use traditional tools, rent tractors from private service providers or RAB, mainly

for land preparation.

In Rwanda, Bramin farm, ProDev Bugesera, and Nyagatare Agro Ventures Rwanda Pvt. Ltd, are large irrigated commercial farms that are fully mechanized. These commercial farms usually have a full range of tractors and other equipment with established irrigation infrastructure.

Successful and Preferred Business and Financing Models

Table 8.1 summarizes the most common business models for farm mechanization.

Table 8.1: Business Models Used for FLID Equipment in Rwanda

Business Models	Clients	Products
Individual purchasing for private use	Individual smallholder farmers	SSIT equipment, manual or hand tools, spraying and plowing equipment, repairs and spare parts
	Commercial farms	Irrigation systems or infrastructure, tractors and implements, repairs and spare parts
Private service provider (irrigation systems)	Larger individual farmers, commercial farms, cooperatives	Irrigation systems and equipment, repairs and spare parts
Private service provider (tractors for rent)		Land clearing, planting, plowing, spraying
Government-funded	Individual smallholder farmers	SSIT equipment, knapsack sprayers
	Cooperative members	Irrigation systems, tractors, implements, power tillers with spraying or plowing equipment
Donor-funded	Individual farmers	SSIT equipment, knapsack sprayers
	Cooperative members	Irrigation systems, tractors and implements, power tillers with spraying or plowing equipment

Cooperative—shared purchasing for cooperative use	Cooperative members	Irrigation systems or equipment, tractors and implements, power tillers and accessories, repairs and spare parts

Source: World Bank, 2017a

Note: SSIT = small-scale irrigation technology.

Individual Farmers Purchasing FLID Equipment from the Private Sector

Farmer-Led Technology

Since 2015, the Rwandan government has offered a subsidy of up to 50 percent for farmers to scale up irrigation (MINAGRI, 2014a). The percentage of the subsidy depends on a farmer's status and the profitability of that farmer's project. Subsidized SSI equipment includes complete drip, rain gun, and sprinkler kits with pipes and portable diesel or petrol pumps, as well as equipment for rainwater harvesting, such as tanks (plastic and concrete), treadle pumps, and dam sheets. With a down payment of 50 percent, individual farmers, cooperative members, and other groups can apply for the subsidy and access equipment from the seven midsize SSI suppliers as individuals or as a group of farmers (Box 8.1.).

Box 8.1: Irish Potato Irrigation

- Farmer Gafaranga purchased Irish potato seeds at 350 RF (US$ 0.40)[8] per kilogram and applied 2 tons per hectare (700,000 RF, US$ 800).
- Irish potatoes take three to four months to mature.
- He was able to take advantage of a government irrigation rental scheme, costing him an additional 10 Rwf per kilogram.
- The farmer already had invested 110 RF (US$ 0.13) per kilogram in the crop (excluding irrigation costs), so the total cost was 120 RF (US$ 0.14).
- The use of irrigation doubles or triples the yield.

Source: World Bank, 2017a.

Most of the seven existing SSI suppliers have signed a memoranda of understanding (MoU) with the Ministry of Agriculture and Animal Resources (MINAGRI). This allows clients to receive subsidies of up to 50 percent for irrigation systems, which has helped increase demand (Box 8.1) (RAB, 2018). Suppliers also provide repairs, technical assistance, and other

[8] 2017 exchange rate US$ 1= 880 RF

maintenance services. Suppliers also provide spare parts, which they must import—a situation that can delay repairs and maintenance. In Rwanda, irrigation equipment is exempt from value-added taxes (VATs), but in 2017 the government began levying import taxes. Some companies have active marketing strategies. For example, one supplier conducts field demonstrations in rural areas, participates in trade fairs, and publicizes its services via radio spots and its website.

Investment Scenarios for Farmer-Led SSI

The investment cost for farmer-led SSI equipment depends mostly on a farmer's preference and financial capacity. Most Rwandan smallholder farmers prefer the following: (a) a drag hose system, (b) rain guns with flexible pipes, (c) rain guns with high-density polyethylene (HDPE) pipes, (d) a semi-permanent sprinkler system, or (e) a solar-powered irrigation system. All costs in the scenarios that follow represent total prices without subsidies.

Drag Hose System

The drag hose system consists of a diesel or petrol pump for water and a hose of 100 meters. Farmers may add more hoses to cover more area. About 85 percent of smallholder farmers prefer this FLID system (RAB, 2018).

Table 8.2: Investment Costs for a SSI Drag Hose System

Equipment	Quantity	Unit Price (RF)	Total Price (RF)[a]
Water pump[b] and fittings	1	250,000	250,000
Hose	1	100,000	100,000
Total			350,000

Source: RAB, 2018.

Note: SSI = small-scale irrigation.

a. Exchange rate: US$1 = RF 880.

b. Water pump specifications: (water pump flow (Q) = 30 cubic meter per hour; pressure head = 27 meters)

Rain Gun System

Many smallholder farmers prefer rain guns for irrigation because of their discharge capacity (10.50 cubic meters per hour). These systems require motorized or pressured water pumps to minimize water leakage. Farmers prefer flexible pipes—not HDPE pipes—that fit directly into rain guns to allow easy movement of rain gun stands.

Table 8.3: Investment Costs for an SSI Rain Gun System Connected to Flexible Pipes

Equipment	Quantity	Unit Price (RF)	Total Price (RF)[a]
Water pump[b] and fittings	1	1,600,000	1,600,000
Flexible pipe fittings with rain guns[c]	8	75,000	600,000
Rain guns	2	120,000	240,000
Rain gun stands with accessories	2	160,000	320,000

Source: RAB, 2018.

Note: SSI = small-scale irrigation.

a. Exchange rate: US$1 = RF 880.

b. Water pump specifications: Water pump flow (Q) = 45 cubic meter per hour; pressure head = 70 meters

c. Flexible pipe of 30 inches

Table 8.4: Investment Costs for an SSI Rain Gun System Connected to HDPE Pipes

Equipment	Quantity	Unit Price (RF)	Total Price (RF)[a]
Water pump and fittings	1	1,600,000	1,600,000
Quick-coupling of HDPE	40	38,000	1,520,000
Rain guns	2	120,000	240,000
Rain gun stands with accessories	2	160,000	320,000

Source: RAB, 2018.

Note: SSI = small-scale irrigation; HDPE = high-density polyethylene.

a. Exchange rate: US$1 = RF 880.

b. Water pump specifications: water pump flow (Q) = 45 cubic meter per hour; pressure head = 70 meters

c. Specifications of quick-coupling of HDPE pipes: 75 millimeters of diameter and PN (nominal pressure):

10.60 meters

Water Harvesting Facilities

This model harvests water from buildings, cowsheds, roads, etc., and stores it in small water reservoirs. Farmers use this water for growing food crops or vegetables during agriculture seasons A and B or during the dry period.

Water harvesting facilities can be constructed in two ways:

- *Water pond with an open dam sheet reservoir:* This system harvests water from either rainfall or runoff from roads and waterways. Water can also be pumped from rivers and lakes. The facility can serve as a type of water reservoir for farmers who own slightly more land.
- *Water pond with a covered dam sheet reservoir:* This design has two advantages. Firstly, it reduces the evaporation of water and, secondly, farmers can harvest rainwater directly from the roof.

Table 8.5: Investment Costs for FLID Water Harvesting Facilities with an Open Dam Sheet Reservoir

Equipment	Quantity	Unit Price (RF)	Total Price (RF)[a]
Dam sheet (250 cubic meters)	1	800,000	800,000
Excavation (250 cubic meters)	1	300,000	300,000
Construction of waterways and sedimentation chamber (10 cubic meters)	1	150,000	150,000
Fencing and grass protection	1	200,000	200,000

Source: RAB, 2018.

Note: FLID = farmer-led irrigation.

a. Exchange rate: US$1 = RF 880.

Table 8.6: Investment Costs for FLID Water Harvesting Facilities with a Covered Dam Sheet Reservoir

Equipment	Quantity	Unit Price (RF)	Total Price (RF)[a]
Dam sheet (250 cubic meters)	1	800,000	800,000
Excavation (250 cubic meters)	1	300,000	300,000
Construction of waterways and sedimentation chamber (10 cubic meters)	1	150,000	150,000
Roofing with iron sheets, supported by metallic tubes	1	4,500,000	4,500,000
Fencing and grass protection	1	200,000	200,000

Source: RAB, 2018.

Note: FLID = farmer-led irrigation.

a. Exchange rate: US$1 = RF 880.

Semi-permanent System

In a semi-permanent irrigation network, with rain guns, sprinklers, or drip kits, some equipment remains on the field, while other on-field equipment and materials, such as drag hoses, drip kits, and low-pressure sprinklers, can be taken home by the smallholder farmer. Each system consists of a small pumping station, a pipe network, and a water regulating reservoir. Farmers who use these systems usually own more than 5 hectares (Nzeyimana, personal communication).

Table 8.7: Investment Costs for an FLID Semi-permanent System

Equipment Description	Quantity	Unit Price (RF)	Total Price (RF)[a]
Water pump and accessories	1	1,500,000	1,500,000
Water supply to the reservoir network, HDPE pipes (90 millimeters)	200	9,800	1,960,000
On-field network, HDPE pipes (75 millimeters)	800	7200	5,760,000

Dam sheet (250 cubic meters)	1	800,000	800,000
Excavation (250 cubic meters)	1	300,000	300,000
Construction of waterways and sedimentation chamber (10 cubic meters)	1	150,000	150,000
Roofing with iron sheets and the structure supported by metallic tubes	1	4,500,000	4,500,000
Fencing and grass protection	1	200,000	200,000

Source: RAB, 2018.

Note: FLID = farmer-led irrigation.

a. Exchange rate: US$1 = RF 880.

Groundwater Drilling and Solar-Powered Irrigation Kit

Groundwater is an option for farmers whose land does not lie near sources of surface water. This model is mostly used in the Eastern Province by farmers who own land near marshlands and rivers. In most cases, drilling to access groundwater can go as far as 80 meters below the surface. A solar-powered pump is also part of the irrigation system. The unit cost per hectare is up to RF 5.50 million (US$ 6,250) (RAB, 2018).[2]

Tractors and Implements

The average cost of a tractor is RF 22.88 million (US$ 26,000) (World Bank, 2017a). This is a substantial amount for most farmers and typically requires a loan. Depending on the supplier, a bank loan or a loan through the supplier can be obtained (John Deere has its own financial company in Tanzania, for example). Banks require collateral if they are to provide loans for tractors, and repayment occurs in monthly installments.

The three dealers of tractors in Kigali have MoUs with the government and provide after-sale services, such as operator training (one or two days, depending on need) and technical problem solving and maintenance (this may be complementary if stipulated in the guarantee). The demand for tractors is low due to the small plot sizes across the country, which do not make it financially feasible to operate a tractor.

Private Service Provider Models

Farmer-Led SSI Technology

Some small-scale farmers purchase SSI mobile kits not only to irrigate their plots, but also to provide irrigation services for neighboring plots for a fee. In a private service model, the service

provider assesses the area's size, and the neighboring farmer only pays the operation costs. In most cases, the cost of operation is inexpensive, varying between RF 1,000 (US$ 1.14) and RF 2,000 (US$ 2.27) per hour[3]. The actual cost depends on the capacity of the diesel or petrol pump.

Tractor Hiring

Ten private service providers offer mechanization services for hire in Rwanda, mainly for land preparation. The service providers have bought most of the tractors from the GoR tractor fleet or from the four international tractor dealers that import Kubota, John Deere, Mahindra, and New Holland tractors. The providers have teams of drivers and technicians who operate the tractors and maintain them. They purchase spare parts from the four international tractor dealers (Box 8.2.).

MINAGRI helps service businesses by providing links with potential clients. It also invites service providers to participate in demonstrations, particularly during mechanization week and agriculture show events. Mechanization services are exempted from VATs, but no subsidy exists for mechanization options, except for irrigation equipment.

Box 8.2: Agrimec's Business Model for Land Preparation

- Agrimec uses John Deere tractors and charges RF 70,000 (US$ 80)[9] per hectare, excluding fuel tractor and plow and harrower.
- Fuel costs an additional RF 45,000 (US$ 51) for plowing and RF 15,000 (US$ 17) for harrowing per hectare.
- The total cost charged by Agrimec for plowing and harrowing is between RF 115,000 (US$ 131) and RF 130,000 (US$ 148) per hectare, depending on soil conditions.
- If the soil is not cleared, the costs are slightly higher; they range between RF 90,000 (US$ 102) and RF 100,000 (US$ 114) instead of RF 70,000 (US$ 80).

Source: World Bank, 2017a.

Government-Funded Model

The GoR has funded several community irrigation schemes, now operated and managed by cooperatives and IWUAs. The development cost of the marshland irrigation schemes averages RF 8.80 million (US$ 10,000) per hectare. On hillside pressurized irrigation schemes, the cost for center pivot systems is about RF 3.52 million (US$ 4,000) per hectare, RF 4.40 million (US$ 5,000) for sprinklers, and RF 6.16 million (US$ 7,000) drip systems. These figures do not include the cost of sourcing the water and of distributing it through pipes to the individual plots. The money for the electricity to run the pumps comes from the water fees collected by the IWUA of the irrigation scheme.

The marshland irrigation schemes are generally developed on state lands that can be leased to cooperatives or private investors. Several commercial farmers and cooperatives use the pubic

[9] Exchange rate: US$1 = RF 880

irrigation systems through a government leasing contract. The government envisions that private service providers will take over these irrigation schemes through land leasing or contract farming. The government has developed a lease-operate-transfer model, which seeks to attract private players into developed irrigation schemes.

In this model, the government (after an agreement with the concerned farmer-irrigators) will offer the large public irrigation infrastructure to private investors in the form of medium-term renewable leases (5 to 10 years) (World Bank, 2017a). The communities will have to lease land or make a contract farming agreement with the private service provider.

To pilot this model, in 2015, the government leased the Matimba Sector irrigation scheme to Clinton Development Initiative—an international nongovernment organization (NGO)—and landowners grouped under the Kooperative y'Abahinzi Borozi mu kibaya cy'Umuvumba (KABOKU)[4] leased approximately 200 hectares of their land at US$1,000 per hectare (CDI and KABOKU, 2015). This is a model that can be replicated across Rwanda on hillside private irrigated land developed using public funds.

Donor-Funded Model

In Rwanda, some medium to large marshland and hillside irrigated schemes were developed through financial grants from donors such as JICA, KOICA, NGOs, and the World Food Programme of the United Nations. Technical assistance is often part of the financial grants, and the farmers are trained in various modules to optimize developed irrigation schemes. Farmers are often grouped into cooperatives and IWUAs that will eventually own the irrigation infrastructure after signing transfer agreements[5] with the government for the operation and maintenance of the infrastructure.

In the long term, it is unclear who has responsibility to maintain such schemes. The lack of maintenance services, especially due to the lack of spare parts means that the life span of donor-funded equipment is often limited. There have been several cases where farmers were unable to cover operation and maintenance costs for irrigation schemes, and consequently were unable to use and optimize the irrigation schemes developed by the donors.

Cooperative Service Model

Cooperatives that are successful can save money and purchase equipment, which they can rent out to members. This model is especially suitable for larger machinery, such as agro-processing equipment, irrigation equipment, power tillers, and tractors. Cooperatives should be trained in financial administration, and it should be clear who is responsible for the equipment. Cooperative land preparation has been observed in some value chains, mostly cash crops, such as rice. Some Cooperatives invest in power tillers or tractors, and subsequently lend these to their farmers, who are responsible for the fuel costs. Most cooperatives own processing equipment, such as simple machines for direct postharvest handling activities, including dehulling, shelling, and threshing. Members usually can use these for a small fee per kilogram. Two examples appear in boxes 8.3 and 8.4 (World Bank, 2017a).

Box 8.3: Cooperative Business Model for Land Preparation—Maize

- A farmer has 6 hectares of farmland producing maize with a yield of 3 to 4 tons per hectare. The market price for maize is RF 150 (US$ 0.17) to RF 200 (US$ 0.23) per kilogram, producing an income of about RF 600,000 (US$ 682) per hectare.
- The farmer hires a tractor from a private service provider for RF 80,000 (US$ 91) per hectare, a price that includes an operator but does not include fuel. The job requires 40 liters of fuel per hectare, which amounts to RF 30,000 (US$ 34) per hectare.
- In terms of labor, land preparation for 1 hectare requires about 30 laborers for four days, and each laborer receives about RF 1,000 (US$ 1.14), so labor costs are about RF 120,000 (US$ 136) per hectare.

Source: World Bank, 2017a

Box 8.4: Example of Rice Cooperative Service Model

- The cooperative has 2,856 farmers with a total of 600 hectares.
- The farmers are cultivating rice in the marshland and growing other crops on their private land.
- Rice is harvested twice a year with a yield of 4 to 7 tons per hectare.
- Average farmland per farmer is 0.05 hectare (one plot); the largest farmer has 1 hectare.
- Farmers are cultivating paddy fields with only hand tools.
- There is no access road to the paddy fields.
- When a farmer joins the cooperative, a fee of RF 5,000 (US$ 6) is required. Furthermore, RF 25 (US$ 0.03) per kilogram of rice is paid as a rice-milling expense.

Source: World Bank, 2017a

Possible Sources of Financing

The agriculture sector in Rwanda is rapidly modernizing with a strong agenda of commercialization for national self-sufficiency and exporting. In order to achieve this, smallholder farmers, who constitute the majority of farmers in Rwanda, need to receive continuous assistance to professionalize and reduce their vulnerability, particularly their financial vulnerability.

The National Agriculture Policy recognizes the central role that financial institutions in the private sector will play in transforming Rwandan agriculture from a subsistence-based sector to a competitive, market-oriented, and wealth-creating sector. The policy confirms that the change needs to be driven by private investors ranging from smallholder farmers or cooperatives to larger investors. This is expected to be done from an agriculture value chain perspective. However,

financing the agriculture value chains is the key challenge for rural and agriculture finance in Rwanda, particularly for staple crops, such as maize, horticulture products, rice, and wheat. Only 5.20 percent of formal credit goes to agriculture, and formal agriculture financing is primarily supplied by nonbanking institutions, namely, savings and credit cooperatives (SACCOs) and mobile money providers (MINAGRI, 2018b).

Major identified bottlenecks to providing agriculture financial services include the following:

- Immature market for equity and debt instruments
- Inadequate market information mechanisms for responding to demand-side signals
- Inadequate rural banking infrastructure (branches)
- Insufficient skills for risk assessment and management in the sector
- Insufficient trust among actors across the value chain
- Lack of products to serve rural smallholders
- Low-value, bulky commodities that are difficult to finance
- Need for a transitional model to increase private sector involvement
- No warehouse receipt regulations
- Poor incentive structures for large off-takers for contract farming (MINAGRI and DFID Rwanda, 2011).

Due to the government's efforts to increase smallholder farmers access to financial services, different commercial banks, MFIs, and other financial service providers have instituted strategies to expand their financial services to low-income rural residents, especially smallholder farmers.

Development Bank of Rwanda

The Development Bank of Rwanda is a public financial institution that provides credit to agro-processing companies and producer organizations in cash crop value chains, such as coffee and tea. In 2016, agro-processing was the largest borrower in the bank's agriculture portfolio, accounting for 40 percent, followed by coffee or tea production at 22 percent and coffee or tea processing at 21 percent (World Bank, 2018).

Commercial Banks

Commercial banks are private financial institutions with a range of financial products covering preharvest and postharvest for select commodities, such as beans, coffee, dairy, horticulture products, Irish potatoes, maize, and rice. Some of these include Urwego Opportunity Bank, Kenya Commercial Bank, Banque Populaire du Rwanda, and the Compagnie Générale de Banque. Urwego Opportunity Bank provides loans for capital investment (dryers, irrigation equipment, trucks, and so on). Its primary targets have been individual farmers rather than cooperatives, based on thorough household financial assessments. The agriculture sector

accounted for 17 percent of its overall loan portfolio in 2016. Kenya Commercial Bank provides input financing, postharvest financing (including warehouse receipt financing), and investment financing.

Microfinance Institutions

MFIs provide financial services to low-income people, especially to their members, and many offer insurance, deposit, and other services. Rwanda's MFIs are divided into the following categories (MINECOFIN, 2013b):

- *Category 1.* informal MFIs that are tontines of any type. They operate only with contributions from members. They require no legal status or licensing from the central bank to conduct their activities. However, they must register with the nearest local administrative entity.
- *Category 2.* MFIs that have the legal status of savings and credit cooperatives. Their total deposits are less than RF 20 million. These institutions may not have more than one point of service or service outlet. This category has minimal supervision.
- *Category 3.* MFIs that collect deposits from the public. These MFIs have adopted the legal status of private limited companies or SACCOs. Total deposits exceed RF 20 million. They are required to observe all rules of management, prudential norms defined in the country's microfinance law, and the law's applicable regulations.
- *Category 4.* MFIs that do not take deposits. The minimum capital requirement for this category is RF 300 million.

Umurenge SACCOs are financial institutions under the cooperative form. As such, these cooperatives operate in the financial system, and their principal products are savings and credits. With these financial institutions, individual farmers or farmer organizations save money and acquire loans to invest in agriculture activities (MINECOFIN, 2014).

MFI loans increased from RF 8.20 billion (US$ 9.32 million) in 2012 to RF 20 billion (US$ 22.73 million) in 2016 (a compound growth rate of 25 percent). This represents about 22 percent of agriculture credit from all financial institutions and about 40 percent of credit for agriculture production. Given that MFI's have a wider rural outreach with a focus on lending to individuals, they are likely to finance a much larger number of farmers and micro- and small agro-enterprises than banks (MINECOFIN, 2014).

Institutional and Policy Support Needed

The GoR has been implementing institutional and policy reforms that concentrate on a few priority staple foods and horticultural commodities under the Crop Intensification Program. This is to help smallholder farmers access financial services and increase their leverage within agriculture value chains, In varying stages of development, these reforms do the following: (a) link formal and informal financial services, (b) establish collateral management and a warehouse receipt system

of international standard, (c) deal with information gaps, and (d) regulate remote banking. The need also exists for a regulatory and institutional infrastructure to cover medium- and long-term financing (MINAGRI and DFID Rwanda, 2011).

Links between Formal and Informal Financial Services

The GoR recognizes the need for policies and strategies to cover informal financial providers, such as village savings and loan groups (tontines and *Ikimina*) established in most areas of the country. These informal financial providers develop efficient links between themselves and larger, more formal financial institutions, including commercial banks and MFIs. These links benefit both formal and informal financial institutions and actors outside the financial arena. The links allow institutions to overcome geographic limitations, asymmetric information with low-income clients in rural areas, and to serve those who otherwise are unable to access institutions in a cost-effective manner.

The main role of the government and the National Bank of Rwanda is to establish a policy and regulatory framework that encourages, facilitates, and promotes these links. There is also a need to explore innovative products and services with potential to increase access to financial services in rural areas. These services include asset financing (through leasing and matched savings), factoring, microinsurance, and business development services linked to financial services.

Collateral Management and Warehouse Receipts

The GoR recognizes the need for a collateral management and warehouse receipt system of international standard to improve access to financial services for Rwanda's smallholder farmers. For this, the GoR is establishing the necessary legal and regulatory framework and the warehouse receipt regulatory body. It also has been developing specific mechanisms for value chains and implementing intensive capacity building.

Information Gaps

Information gaps produce bottlenecks for agriculture financing. These gaps include lack of information about agriculture finance, supply and demand, and asymmetry of information between value chain actors. The GoR has been implementing strategies to mitigate these bottlenecks. The development of a credit information bureau to cover rural smallholders and the development of an extended commodity information exchange system.

Remote Access Banking

The increasing use of mobile phones throughout Rwanda has expanded opportunities for mobile money transfers and other forms of meters-banking. The technology has opened access to financial services in rural areas, using techniques that are essential components in link banking and other product innovations. Meters-banking is a sector-wide issue that goes well beyond the requirements of rural and agriculture finance. The National Bank of Rwanda has put in place an appropriate regulatory environment for meter-banking.

Longer Terms for Financing

The value chain analysis reveals a need for medium- to long-term financing instruments, particularly to finance postharvest handling and processing. Leasing would be an appropriate mechanism for medium-term financing. In order to expand leasing in Rwanda, the country would need regulatory and institutional infrastructure. The same need applies to the main sources of long-term financing, capital markets, and public-private partnerships.

Notes

1. Irrigation management transfer agreements.
2. Exchange rate: US$1 = RF 880.
3. Exchange rate: US$1 = RF 880.
4. KABOKU is a cooperative of maize, soybean, bean, and vegetable growers in Kagitumba Cell, Matimba Sector of the Nyagatare District in Eastern Province.
5. Irrigation management transfer agreements.

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Appendix A: Water Resources

Table hd>Table 1: Characteristics of Nine Water Catchments, Rwanda

Water Catchment	Surface (km^2)	Basin	Description
Lake Kivu	2,425	Congo	A lake transboundary with Congo, Dem. Rep. It includes several smaller catchments draining into Lake Kivu.
Rusizi	1,005	Congo	The catchment that comprises the Rusizi, Rubyiro, and Ruhwa Rivers. It is transboundary with Congo, Dem. Rep. and Burundi.
Upper Nyabarongo	3,348	Nile	An inland headwater catchment of the Nyabarongo River and its tributaries springing from the Nyungwe Forest.
Mukungwa	1,887	Nile	An inland headwater catchment that drains the volcano region, the Ruhondo and Burera Lakes, and the Rugezi wetland.
Lower Nyabarongo	3,305	Nile	An inland downstream catchment that drains the area from the confluence of the Nyabarongo and Mukungwa Rivers down to the confluence of the Nyabarongo and Akanyaru Rivers.
Akanyaru	3,402	Nile	A transboundary (with Burundi) upstream catchment that springs in the Nyungwe Forest and features a long, flat, and wide wetland that drains the Cyohoha south lake along with a series of lakes in Burundi.
Upper Akagera	3,053	Nile	A transboundary (with Burundi and Tanzania) downstream catchment that drains the area from the confluence of the Nyabarongo and Akanyaru Rivers down to the Rusumo Falls. It features numerous lakes with significant evaporation losses and a confluence with the Ruvubu

			River.
Lower Akagera	4,288	Nile	A transboundary (with Tanzania) downstream catchment that drains the area downstream of Rusumo Falls up to the confluence of the Akagera and Muvumba Rivers. It features numerous lakes and two tributaries that run dry in dry season.
Muvumba	1,565	Nile	An intricate transboundary (with Uganda) upstream catchment. The Muvumba catchment drains the Mulindi River that runs into Uganda to enter Rwanda after a 50-kilometer detour as the Muvumba River, which eventually forms the border with Uganda.

<Table source>*Source:* MINIRENA, 2015.

<Table hd>Table 2: Lakes and Their Estimated Volumes, Rwanda

Lake	Surface Area (m^2)	Volume (m^3)
Bilira	6,558,084	84,959,933
Burera	51,916,704	3,115,816,667
Cyohoha north	8,424,334	241,771,067
Cyohoha south	19,226,403	182,696,100
Gaharwa	4,691,529	40,304,233
Gashanga	2,019,200	19,940,933
Hago	25,272,265	294,013,500
Ihema	18,820,546	705,915,633
Kilimbi	2,875,802	19,230,400
Kivu	1,068,600,981	181,560,657,400
Kwumba	36,800,706	289,711,400
Mirayi	2,645,833	17,143,700
Mugesera	21,228,700	253,190,033
Muhazi	34,442,452	454,233,033

Muhindi	123,519,823	1,859,406,867
Nasho, Kagese, Cyambwe, Rwampanga	77,935,096	960,109,767
Ruhondo	27,580,052	868,250,500
Rumira, Kidogo	4,459,255	25,428,367
Rwakibare	32,422,599	2,603,505,900
Rwanyakizinga	7,405,171	47,737,533
Rweru	33,832,572	422,571,133
Sake	58,291,101	595,059,300
Total	**1,668,969,208**	**194,661,653,400**

Source: MINAGRI, 2010**b**

Table 3 Water Uses in the Nine Water Catchments, Rwanda

Water Catchment	Surface Area Level 1 Catchment (km^2)	Renewable Resource ('000 m^3)	Potable Water Supply Use (x1,000 m^3)	Irrigation Water Use (x1,000 m^3)	Total Water Use (x1,000 m^3)	Total Water Use (%)	Total Water Use Over Renewable Resource (%)
Akanyaru	3,265	798,000	10,815	21,195	32,010	**26.87**	**4.01**
Lake Kivu	2,180	898,000	5,917	440	6,357	**5.34**	**0.71**
Lower Akagera	3,223	907,000	880	8,404	9,284	**7.79**	**1.02**
Lower Nyabarongo	3,269	899,000	11,983	7,983	19,967	**16.76**	**2.22**
Mukungwa	1,586	905,000	3,659	0	3,659	**3.07**	**0.40**

Muvumba	3,223	193,000	875	9,742	10,617	**8.91**	**5.50**
Rusizi	504	432,000	954	890	1,844	**1.55**	**0.43**
Upper Akagera	2,939	504,000	9,776	16,034	25,809	**21.66**	**5.12**
Upper Nyabarongo	3,162	1,290,000	8,400	1,193	9,593	**8.05**	**0.74**
Total	**23,351**	**6,826,000**	**53,259**	**65,881**	**119,140**	**100.00**	

<Table source>*Source:* MINIRENA, 2015.

Appendix B: Service Providers of SSIT Equipment

Table 4: Service Providers of SSIT Equipment, FY 2017/18

Company Name	Contact Details
Africa Drilling & Exploration Ltd.	Tel: (+250) 788 309 495 P.O. Box 4059, Kigali E-mail: aderwanda@afridrillers.com
Enterprise de Construction Mixte	Tel: (+250) 788 416 746, (+250) 781 199 330 P.O. Box 3741, Kigali E-mail: ecmrda@gmail.com
General Consultancy & Trading Company Ltd.	Tel: (+250) 784 737 426, +250 788 664 238 E-mail: nsanzi2001@yahoo.fr
Innovatech Ltd.	Tel: (+250) 785 981 943 P.O. Box 1998, Kigali
Open Construction & Related Services Ltd.	Tel: (+250) 788 660 161 E-mail: opencompany2014@gmail.com, infos@openconstructionltd.com

Pro Water Rwanda Ltd.	Tel: (+250) 788 351 338, (+250) 788 985 337 P.O. Box 1220, Kigali E-mail: prowaterrwanda@gmail.com
Socose Ltd.	Tel: (+250) 788 642 042 P.O. Box 773, Kigali E-mail: socoserwanda@yahoo.fr

<Table source>*Source:* RAB, 2018.

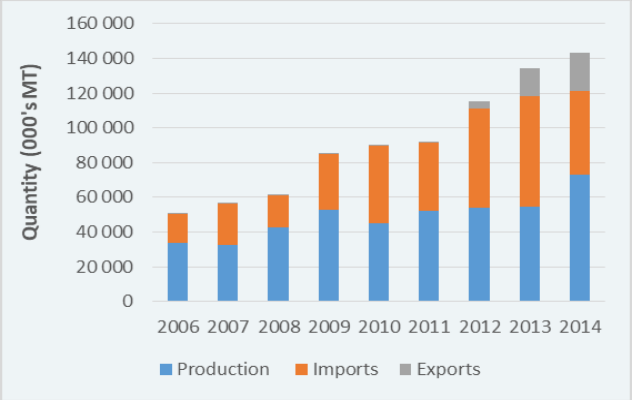
Appendix C: Agricultural Products

Rice

Locally produced rice is categorized into long-grain and short-grain rice. The domestic market for long-grain rice consists of middle-income urban consumers, while the domestic markets for short-grain rice include low-income urban households, rural consumers, and large buyers, such as boarding schools. Domestic demand for rice is met at 51 percent by local production and 49 percent by imports, especially from Tanzania (90 percent) and from the Asian countries of India, Pakistan, and Thailand (Cambridge Resources International, 2017).

In 2006, rice imports were about 17,000 tons; by 2014, rice imports had tripled to reach 49,000 tons. In the nine years between 2006 and 2014, Rwanda spent about US$ 141 million in rice imports; the quantity of rice imported during this period was about 344,000 tons, as shown in figure 3.1 (Cambridge Resources International, 2017). Imported rice mainly consists of long-grain fragrant rice purchased by high-income urban consumers, as well as hotels and restaurants.

Rice production is projected to increase by 2 percent in the short term, 12 percent in the midterm, and 18 percent in the long term, as shown in figure 3.2 (Cambridge Resources International, 2017). Despite this increase, the current potential rice production will still be insufficient to meet the domestic demand at 100 percent unless the GoR develops additional land for irrigation to support rice production.



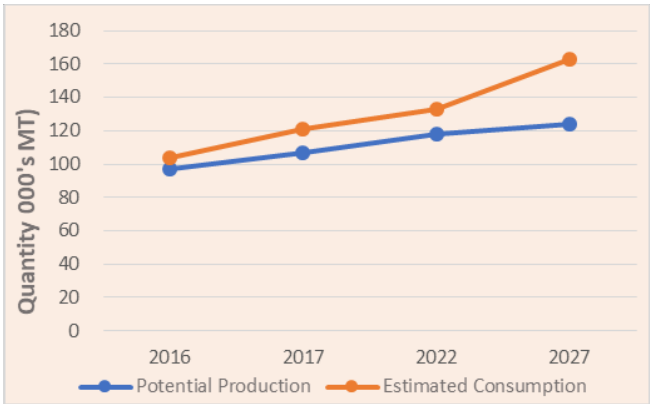


Fig title>Figure 3.1: Rice Production and Trade, Rwanda, 2006–14

<Figure source>*Source:* Cambridge Resources International, 2017

[[TS: Create y-axis. Place figure 3.1 underneath first paragraph in rice section. Replace spaces with commas in y-axis labels, for example, 20,000, 40,000, and so on. Titles for both need to be above the figures.]]

<Fig title>Figure 3.2: Potential for Rice Production and Estimated Consumption, Rwanda

<Figure source>*Source:* Cambridge Resources International, 2017

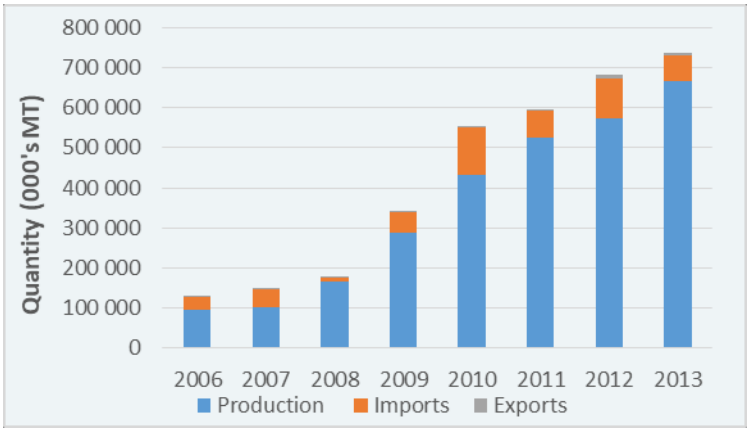
[[TS: Create y-axis. Set key labels in initial caps. Title should go above figure.]]

<C head>Maize

From 2006 to 2013, locally produced maize satisfied the domestic market at 83 percent, while the remaining 17 percent of domestic demand was met by imports from Uganda (65 percent) followed by Tanzania (30 percent) and Kenya and Zambia (5 percent), as shown in figure 3.3. Maize imports increased by an annual average of 11 percent, or from 29,000 tons in 2006 to 63,000 tons in 2013; imports during the same period reached 484,000 tons (Cambridge Resources International, 2017).

<Fig title>Figure 3.3: Maize Production and Trade, Rwanda, 2006–13

[[TS: Create y-axis. Replace spaces with commas in y-axis labels, for example, 100,000, 200,000, and so on]]



<Figure source>*Source:* Cambridge Resources International, 2017

Domestic markets for maize are rural and urban consumers and maize-processing millers. About 74 percent of the bulk maize produced in Rwanda is consumed on the farm; an additional 18 percent is sold for processing into flour, with 115 millers processing about 100,000 tons of maize per year. The remaining 8 percent of total maize production may be used for farm rent, bartering, seed, or gifts. It also may be damaged (Cambridge Resources International, 2017).

Maize production is expected to increase and meet domestic demand, although a deficit will be registered in the short term. In the long term, significant production surplus is expected (figure 3.4). This surplus will reduce imports from Uganda, Tanzania, Kenya, and Zambia. With the demand for maize products in urban areas in the Kivu region of the Democratic Republic of Congo, Rwanda can export its surplus maize to that region and explore new markets (such as animal feed for livestock). However, to achieve this level of production, the GoR needs to commit itself to a heavy investment in irrigation infrastructure.

<Fig title>Figure 3.4: Maize Potential Production and Estimated Consumption, Rwanda

[[TS: Create y-axis. Replace spaces with commas in y-axis labels, for example, 1,000, 1,200, and so on]]

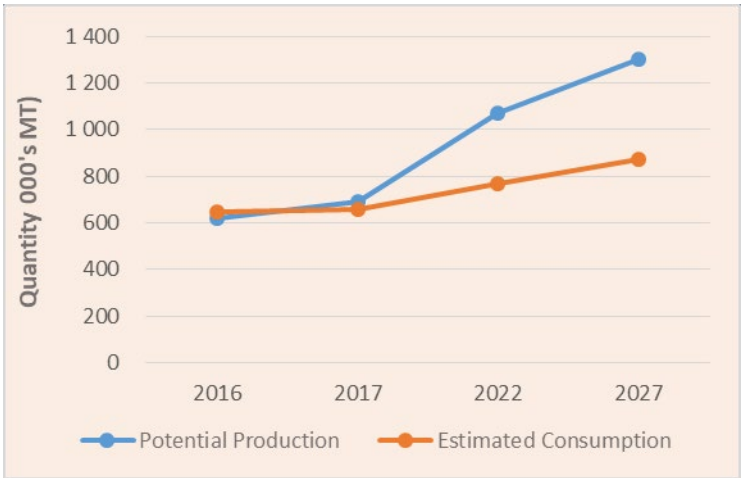


Figure source>*Source:* Cambridge Resources International, 2017

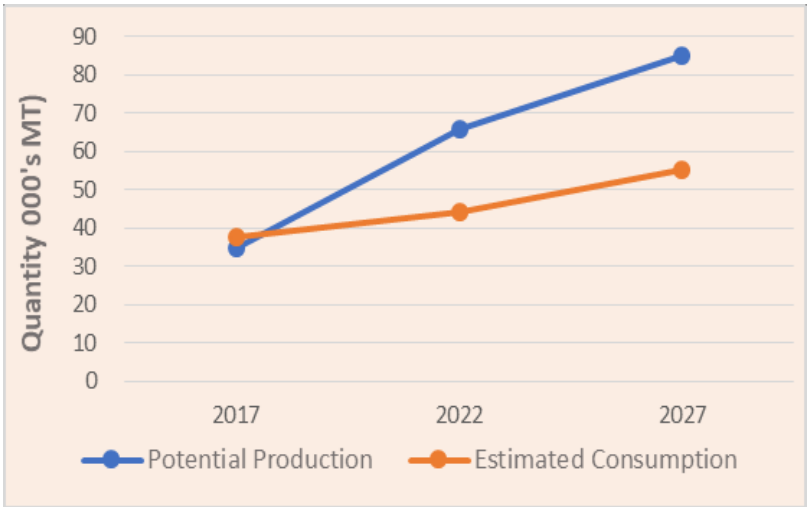
<C head>Soybeans

Since 2012, soybeans have been a priority crop. Soybean production increased by 4 percent from 16,500 tons in 2013 to 17,100 tons in 2014. The domestic market for soybeans is still small, but the demand is increasing. Domestic markets for soybeans include agro-processing plants and low-income rural households that consume soybeans mostly in times of food scarcity. Agro-processing plants boosted the demand for soybeans from 40,000 metric tons per year in 2014 to 70,000 metric tons per year in 2016 (Cambridge Resources International, 2017). Key processing plants include Africa Improved Foods, Gorilla Feed Co., Mount Meru Soycof Ltd., Poultry East Africa Ltd., Premier Animal Feeds Industries Ltd., and Zamura Feeds, along with many other small-scale processing facilities.

Because local soybean production is still too low to meet domestic demand, Rwanda relies on imports, mostly from Uganda and the Democratic Republic of Congo, to supplement feedstock needed by local processing plants. However, soybean imports remain modest, averaging 719 tons per year; they amounted to 6,470 tons between 2006 and 2014 (Cambridge Resources International, 2017). As shown in figure 3.5, soybean production is projected to increase in the medium term and long term to reach 66,064 and 84,834 metric tons, respectively, thus allowing the country to satisfy its domestic needs and realize a surplus for the export market.

Fig title>Figure 3.5: Soybean Potential Production and Estimated Consumption, Rwanda

[[TS: Set initial caps throughout; create y-axis.]]



<Figure source>*Source:* Cambridge Resources International, 2017

<C head>Horticulture High-Value Crops

In Rwanda, horticulture farming is mainly practiced through private organizations dispersed across all provinces. On average, about 231 horticulture farming organizations per province are engaged in production of horticulture crops and products. The Western Province has the highest number of horticulture-oriented organizations (294), followed by the Eastern Province (278), Southern Province (267), Northern Province (206), and Kigali city with 110 horticulture farming organizations (NAEB, 2014a). These organizations include associations, cooperatives, and private companies engaged in production, processing, and marketing activities related to horticulture.

In Rwanda, the horticulture crops sold the most are vegetables (77.30 percent) and fruits (20.30 percent); the remaining 2.40 percent consist of chilies, flowers, nuts, and spices. The vegetable market is dominated by cabbages, carrots, eggplants, onions, and tomatoes. As of 2014, the horticulture gross sales were estimated at 5.33 billion RF (US$ 76.15 million) (NAEB, 2014a).

The high value of horticulture crops is not equally distributed across the country. Smallholder FLID growers of vegetables are more concentrated in Southern, Northern, and Western Provinces, while fruits are the most produced in the Eastern Province. The Western Province has the most balanced production of horticulture crops. The volume of major horticulture crops (that is, vegetables and fruits) varies by seasons, with a positive trend over time. National statistics show that the annual volume of vegetables reached a top record of around 32,000 MT in fiscal year 2013/14 but decreased to 19,000 MT by the end of fiscal year 2016/17. In contrast, the

annual volume for fruits increased to about 6,000 MT by end of fiscal year 2016/17 (NISR, 2017b).

Because of limited productivity and the lack of diversified products, horticulture production does not meet local demand. The Rwandan Horticulture Baseline Survey of 2014 indicated that Rwanda imported about 82 percent of its total volume of vegetables, leaving a gap deficit of about 64 percent to meet national and international demands. The survey also indicated that Rwanda imported about 99 percent of its total volume of fruits to meet national demands. The survey indicated that about 72 percent of horticulture products never left the district in which they were produced (NAEB, 2014a). This means that horticulture in Rwanda is mainly oriented toward local consumption. FLID organizations are looking for potential markets beyond their respective districts.

Appendix D: FLID Laws and Policies

Fourth Strategic Plan for Agriculture Transformation

The Ministry of Agriculture and Animal Resources (MINAGRI) has been implementing a series of Strategic Plan for Agriculture Transformation (PSTAs) since 2004. The first phase (PSTA I) ran from fiscal year (FY) 2004 to 2008, the second phase (PSTA II) ran from FY2008 to 2012, and the third phase (PSTA III) ran from FY2013/14 to FY2017/18. PSTA-4 builds on the achievements of previous PSTAs within the perspective of transforming agriculture from a subsistence sector to a knowledge-based, value-creating sector that contributes to national economic growth and ensures food and nutrition security (MINAGRI, 2018d).

PSTA-4 is the implementation instrument of the NAP. It constitutes the agriculture sector's strategic plan under the first phase of the country's NST 1. PSTA-4 seeks to build a resilient agriculture sector responsive to climate change. Rwanda's agriculture sector is dominated by small-scale subsistence rainfed farms that rely on traditional technologies and practices and thus make the sector vulnerable to variability in rainfall. The plan promotes development of affordable and sustainable irrigation technologies through the scaling up of SSITs for improved crop and land productivity and commercial farming.

Irrigation Master Plan

Inaugurated in 2010, the Rwanda Irrigation Master Plan provides the country with a tool to plan appropriate use of its natural resources, especially soil and water. The plan indicates that the country has a national irrigation potential of 589,713 hectares distributed across six domains: groundwater resources, lake water resources, marshlands, rivers and flood water, runoff from dams, and runoff from small reservoirs. The plan supports initiatives in areas identified as

favorable for irrigation infrastructure, and it requires investments in small, medium, and large irrigation projects on hillsides and marshlands to enhance and upgrade the agricultural value chain for increased food security and enhanced growth of exports (MINAGRI, 2010b).

National Irrigation Policy

Since 2014, the National Irrigation Policy has supported implementation of programs for soil and water conservation management in Rwanda. The Rwanda Irrigation Master Plan acknowledges the need for a policy to create an environment for implementing irrigation schemes. The National Irrigation Policy sets up a framework to bridge fundamental gaps in the irrigation subsector; it proposes key reforms to structure a highly modern and productive irrigation subsector that contributes effectively to the national economy (MINAGRI, 2014c). A key constraint to development of an irrigation subsector in Rwanda is the high cost of irrigation development, especially for hillside projects; thus, the National Irrigation Policy creates an environment that supports the development and expansion of efficient and cost-effective irrigation systems.

Small-Scale Irrigation Strategy

The National Irrigation Policy of 2014 identified the high cost of irrigation equipment (especially pumped schemes) as the foremost challenge limiting growth of the irrigation subsector (MINAGRI, 2014a). Irrigation investment averages US$14,000 per hectare for sprinkler technologies, the same amount for center pivotal technologies, and US$4,000 per hectare for drip technologies. The significantly high cost of irrigation development in Rwanda is explained by the country's hilly topography, which requires relatively bigger pumping systems. Consequently, individual farmers, especially the small-scale farmers who currently dominate the agriculture sector, tend to be discouraged from participating in irrigation development. In response to this challenge, MINAGRI developed in 2014 its small-scale irrigation strategy to promote low-cost and sustainable farmer-led investments in irrigation to support the country's vision of rural poverty alleviation. The strategy promotes widespread use of affordable, demand-driven assembled SSITs locally made for about US$1,500 per hectare (MINAGRI, 2014a).

National Policy for Water Resources Management

Rwanda developed its National Policy for Water Resources Management in 2011 in response to challenges from rapidly changing demographic patterns, demands of intensified socioeconomic development, degradation from unsustainable and inappropriate land use practices, and uncertainties created by climate change, among other reasons. The policy provides the GoR with a comprehensive framework for equitable and sustainable allocation of water resources across different sectors to meet the social and economic needs of present and future generations (MINIRENA, 2011). As far as agriculture sector development is concerned, the policy acknowledges that the increasing demand for water resources to intensify irrigation is unavoidable

as the country aspires to move from rainfed agriculture to competitive, high-producing, and market-oriented irrigated agriculture. The policy sets up an environment that supports the agriculture sector to efficiently and productively use the scarce water resources in a sustainable and environmentally friendly manner.

National Water Resources Master Plan

Following recommendations in the National Policy for Water Resources Management, the GoR adopted in 2015 a plan to ensure development, use, and management of sustainable water resources. The *Rwanda National Water Resources Master Plan* supports decision making to quantify available water resources and each sector's water demand and to propose a management plan for optimal and rational use of water. The plan indicates the need for investigation of irrigation types and their effects on water resources, water quality, and sediment transport. Irrigation practices need to be improved and adapted in ways that sustain Rwanda's water supply to ensure sustainable land and crop productivity (MINIRENA, 2015).

National Land Use and Development Master Plan

The National Land Use and Development Master Plan adopted in 2010 guides better management, usage, and zoning of natural land resources (MINIRENA, 2010). Steady growth of both population and economy puts pressure on arable land, a key factor for agricultural production. Because of increasing demand for land resources, agricultural productivity will experience negative effects in the absence of appropriate measures. The plan provides integrative solutions across the environmental, political, and socioeconomic sectors critical for development of effective FLID in Rwanda.

National Land Policy

The National Land Policy adopted in 2004 serves as the framework to establish a land tenure system guaranteeing tenure security for all Rwandans and to guide necessary land reforms to ensure good management and rational and sustainable use of national land resources. As far as irrigation development is concerned, the policy stipulates that marshlands intended for agriculture development should be cultivated after sufficient planning and assessment of environmental effects. In addition, the policy recommends maintaining marshlands on the country's private land and establishing clear regulations for their sustainable use to avoid disorderly farming with negative environmental consequences (MINITERE, 2004).

Energy Policy

The energy sector plays a fundamental role in supporting socioeconomic transformation, and it has

a systemic link to the growth of other economic sectors. Ensuring access to affordable, modern, and sustainable energy is integral to Rwanda's economic development, poverty eradication, and socioeconomic transformation as stipulated in Vision 2050. The GoR adopted the Rwanda Energy Policy in 2015 to guide provision of cost-effective and environmentally appropriate energy that is also efficient, reliable, safe, and sufficient for households and all economic sectors on a sustainable basis (MININFRA, 2015b).

The energy sector in Rwanda consists of four components: biomass, electricity, gas, and petroleum. Each plays a key role in Rwanda's transition to a middle-income country as envisioned in the NST 1. As Rwanda aspires to expand areas under irrigation through the scaling up of cost-effective marshlands and SSITs, energy demands to expand FLID will undoubtedly increase.

One of the key constraints to updating FLID technologies is the high cost of energy. The price for water treatment plants and water pumping station stands at 126 RF (US$ 0.15) per kilowatt hour[10]. This rate is relatively high compared with other countries in the region, and the supply of energy is still unreliable, which discourages stronger industrial growth and business expansion. The government's planned structural shift from conventional farming to agro-processing and the increasing use of irrigation will require an affordable and sufficient energy supply to power machines and pump water through expansion of energy generation and diversification (MININFRA, 2013).

Health Sector Policy

The Health Sector Policy of 2015 sets up a framework for providing and continually improving affordable health care, including curative, preventive, promotive, and rehabilitative services of the highest quality, thereby contributing to the reduction of poverty and enhancing the well-being of the population (MINISANTE, 2015). This policy can establish interventions associated with the development and implementation of irrigation projects to address any potentially harmful health effects ahead of time while promoting environmental safety, proper sanitation, and access to safe water for all uses, including irrigation.

National Housing Policy

One of the key objectives of the National Housing Policy adopted in 2015 is to maintain food security and support rural-urban links by addressing efficient use and protection of rural agricultural resources, including land, water, and the environment (MININFRA, 2015a). The policy serves as a guiding tool when developing irrigation projects, especially in assessing dynamics of the markets for FLID products.

Laws and Regulations

[10] Exchange rate US$ 1= 850 RF

Law Governing Land

The GoR enacted law 43/2013 on June 6, 2013, governing land in Rwanda to set up modalities for proper and rational management of land. To optimize agricultural productivity, the law prohibits subdivision of land reserved for agriculture and animal resources if such subdivision would lead to parcels of less than a hectare in size. The law stipulates that although land is part of the common heritage of all Rwandans, the government is the sole authority to accord rights of occupation and use of land. The government also has the right to order expropriation in the public interest; in addition, this law talks about the right to an emphyteutic lease, which cannot exceed 99 years (MINILAF, 2013).

Law 43/2013 stipulates that swampland, or marshland, belongs to the State. It should not definitively be allocated to individuals; it can be lent to a person or group of people based on an agreement between parties for the benefit of Rwandans. The law provides for a prime minister's order, which should determine modalities of the use, development, and management of swampland. This implies that all farmer-led irrigated marshlands must comply with provisions of the law. Allocation and acquisition of land for investment should be based on a business plan approved by a competent authority in accordance with the importance and value of the investment (MINILAF, 2013).

Law Regulating the Conservation, Management, Protection, and Use of Water Resources

Law 62/2008 of October 2008 regulating the conservation, management, protection, and use of water resources defines applicable rules and modalities (MINIRENA, 2008). Some aspects of irrigation development projects fall under provisions of this law.

Government Incentives and Subsidies

The GoR's commitment to agriculture transformation is the driving force behind the implementation of subsidy and incentive policies. Because of limited land resources, demographic pressure, high competition for arable land, and the unpredictability of climate change, intensifying production systems is imperative for increasing food production and agriculture export growth in the country.

Yields of several crops are less than half their potential because inputs are low (MINAGRI, 2016a). To address this gap, the GoR has implemented since 2007 the Crop Intensification Program to expand access and use of modern inputs such as fertilizers, improved seeds, irrigation, mechanization, postharvest handling technologies, and storage mechanisms, as well as access to financial services, markets, and extension and advisory services. The program covers crops grown across the country, namely, bananas, beans, cassava, fruits, maize, Irish potatoes, rice, soybeans, wheat, and vegetables (MINAGRI, 2016a).

According to ministerial order 0003/2016 of January 2016, governing agricultural subsidies for

2017 seasons A and B,[3] subsidized fertilizers include macrofertilizers (subsidized between 15 and 36 percent), micronutrients (subsidized at 50 percent), and compound or blend fertilizers (subsidized between 5 and 20 percent). Other agricultural subsidies include small-scale irrigation equipment countrywide (subsidized at 50 percent). Subsidized seeds include imported hybrid maize (subsidized between 75 and 85 percent), imported soybean seeds (subsidized at 85 percent), locally produced soybean seeds (subsidized at 68 percent), and open-pollinated varieties of maize and wheat (subsidized 58 to 59 percent) (MINAGRI, 2016d).

Findings from the agricultural surveys of 2017 and 2018 produced by the National Institute of Statistics of Rwanda (NISR) indicate that these efforts have increased crop yields, use of improved seeds and fertilizers, and updates to irrigation technologies. For example, the yield for maize increased from 1.11 metric tons per hectare in 2017 season A to 1.53 metric tons per hectare in 2018 season A. The agricultural survey report of 2018 also indicates a 6 percent increase in total maize production in 2018 season A compared with 2017 season A. The use of improved seeds increased from 6 percent in 2017 season A to 11 percent in 2018 season A for small-scale farmers and from 52 to 53.80 percent for large-scale farmers during the same period (NISR, 2018a).

Fiscal Incentives for Imported Inputs and Equipment, Import Duties, and Taxes

To help expand farmers' access and use of agricultural inputs and other agricultural and livestock materials and equipment, law 37/2012 of September 2012, establishing the value added tax as modified, provides that all agricultural and livestock products, services of agriculture insurance, agricultural inputs, and other agricultural and livestock materials and equipment are exempted. Irrigation equipment and farm machinery are on the list of tax-exempted goods established by the minister in charge of agriculture and animal resources and approved by the minister in charge of taxes as provided for by the law on value added tax (MINECOFIN, 2012b).

Appendix E: Value-Chain Suppliers

Suppliers and Distributors of Hand Tools and Agriculture Machinery

Farmers usually purchase their hand tools in rural city centers from local dealers or traders. For agriculture machinery, four international dealerships offer tractors and ploughing implements in Rwanda: (a) LonAgro (imports John Deere), (b) ETC Agro Tractors and Implements Ltd. (imports Mahindra), (c) Car and General (imports Hisaki & Kubota), and (d) Machines & Tractors Rwanda (imports New Holland). The RAB signed a memorandum of understanding with these four suppliers to provide maintenance and repair services as well.

Ten suppliers of mechanization services exist; farmers use them mostly to rent tractors for land preparation. They are (a) Voluntous Agricon Rwanda (VAC) Ltd., (b) S.B.T.C. Trading & Construction Pvt. Ltd., (c) KNU, (d) R.M.F. Cooperative, (e) Renaissance Ltd., (f) Nagrico Ltd.,

(g) Agressol Ltd., (h) Agrimec Ltd., (i) Coproriz Mukunguli, and (j) Muvumba P8 Rice Growers Cooperative. Some of these, like VAC, also sell agriculture machinery and equipment.

Suppliers and Distributors of Seeds and Mineral Fertilizers

In 2007, the GoR introduced the Crop Intensification Program (CIP) to teach agriculture and technology concepts to farmers while improving their access to inputs and markets. The CIP also aims to increase farmers' access to quality seed and inorganic fertilizers through government subsidies[11].

Suppliers of Maize, Rice, and Soybean Seeds

From 2007 to 2016, Rwandan farmers received improved maize and soybean seeds for free, courtesy of a government subsidy of 100 percent.[2] From 2016 to date (2019), smallholder farmers can access imported hybrid maize seeds and soybean seeds with a government subsidy of 75 to 85 percent, respectively, mainly from Kenya Seed Company Rwanda Ltd., Seed Co. International Rwanda Ltd., and Murphy Chemical/Pannar Seed Company. Table 5.3 contains details of seed varieties sold to farmers.

Table 5.3: Suppliers of Maize and Soybean Seeds

Company Name	Contact Details	Crop	Seed Varieties
Murphy Chemical/Pannar Seed Company	Tel: (+250) 788 305 462, (+250) 788 480 403 P.O. Box 598, Kigali E-mail: omugire@yahoo.com	Maize	PAN-691, PAN-4M21, PAN-63, PAN-67
Kenya Seed Company Rwanda Ltd	Tel: (+250) 786 870 213 P.O. Box 6312, Kigali E-mail: james.osore@yahoo.com	Maize	H-629, H-628, DH-04

[11] http://www.minagri.gov.rw/index.php?id=618

Seed Co. International Rwanda Ltd.	Tel: (+250) 787 318 642 P.O. Box 525, Kigali E-mail: kasaijab@seedco.co.rw, kasaija.banage@gmail.com	Wheat	KS Njoro, KS Chozi
		Soybeans	Sequel, Squire, Safari

Source: MINAGRI, 2016a

The three seed companies are from the region. They signed a contract with the Rwandan government to import and distribute hybrid maize seeds and improved soybean seeds. These companies produce the improved soybean seeds locally and sell them at a government subsidy of 66 percent (MINAGRI, 2016a). In addition, the RAB produces and sells open-pollinated variety (OPV) maize seeds (ZM-607, Pool-9A, M-101, and M-103) and soybean seeds (Peka-6 and SB-24)[4] with a government subsidy of 58 to 59 percent (NISR, 2018a).

The RAB produces also improved variety seeds of paddy rice; these rice seeds include Chinese varieties such as Xinan, Yun keng, Yun yin, and Zhong geng; Indian varieties such as Basmati and Nerica; and local varieties such as Buryohe, Facagro, Gakire, Intsinzi, Intsindagirabigega, Kigori, Muturage, and Tebuka. The RAB supplied about 46 percent of improved seeds to the small-scale farmers, while between 54 and 58 percent of the paddy rice seeds came other sources, that is, mainly rice farmers themselves (NISR, 2018a). In fact, by using improved basic rice seeds purchased from the RAB, small-scale farmers used to keep rice seeds from harvests and produce their own rice seedlings, which they later transplanted in their rice plots in marshlands. Over time, this behavior influenced the degeneration of existing rice seeds. According to the agricultural survey compiled by the National Institute of Statistics of Rwanda (NISR) about 2017 seasons A, B, and C, the majority (between 70 and 80 percent) of large-scale farmers obtained their improved paddy rice seeds from other suppliers or nongovernmental organizations (NGOs).

Table 5.4 illustrates total land cultivated by small-scale farmers and large-scale farmers in the three seasons. Based on total cultivated area per season, in seasons A and B of 2017, small-scale farmers used on average 95 percent local maize and soybean seeds (that is, traditional seeds), while 5 percent used improved seeds in both seasons. Data from the two seasons also indicated that about 17 percent (average of both seasons) of the small-scale farmers used improved seeds in the marshlands, dominated by maize (16 percent), paddy rice production (57 percent), and vegetables (27 percent). However, large-scale farmers used improved seeds for 56 percent of their planted areas in both seasons (NISR, 2018a).

<Table hd>Table 5.4: Land Cultivated by Small- and Large-Scale Farmers, Seasons A, B, and C, 2017

Category	Season A (ha)	Season B (ha)	Season C (ha)
Large-scale farmers	16,749	18,097	—
Small-scale farmers	889,784	897,029	22,404
Total cultivated land (ha)	**906,533**	**915,126**	**22,404**

<Table source>*Source:* NISR, 2018a.

<Table note>*Note:* — = not available.

To access improved seeds, small-scale farmers rely mainly on three sources: the RAB at 35 percent (the average of 2017 seasons A and B), NGOs and similar suppliers at 20 percent, and seed dealers at 32 percent. Other sources contributed an average of 13 percent. Survey results also indicated that 50 percent of soybean seeds were purchased from the RAB by small-scale farmers, while about 65 percent (on average) of large-scale farmers purchased OPV maize seeds from the board (NISR, 2018a).

<C head>Vegetable Seeds and Pesticide Suppliers

In Rwanda, registered companies that supply and sell vegetable seeds also supply and sell pesticides and insecticides. These companies include Agribelico Ltd.,[5] Agrotech Ltd., Amiran Kenya Ltd., Balton Rwanda, Holland Greentech Rwanda, HoReCo Rwanda,[6] Kenya Seed Company, OMNI Agriculture Ltd., and Victoria Seeds Ltd. Between 80 and 90 percent of the vegetable seeds planted by small- and large-scale farmers come from these dealers (NISR, 2018a).

The 2017 agricultural survey indicated that vegetables constituted the largest group of crops grown in season C, in addition to tubers (that is, Irish potato) and roots (that is, sweet potato). Farmers also grew vegetables in seasons A and B, mainly in marshlands and hillside areas, using FLID equipment. About 11 percent of small-scale farmers versus 35 percent of large-scale farmers used pesticides in their farming activities in both seasons A and B of 2017 (NISR, 2018a).

Farmers used pesticides a great deal in season C—about 42 percent of small-scale farmers and 72 percent of large-scale ones. Small-scale producers used pesticides mostly on paddy rice (41 percent), vegetables (36 percent), and Irish potatoes (23 percent); for other crops, this number was less than 10 percent. For large-scale farming, the use of pesticides was high for wheat (90 percent), paddy rice (88 percent), vegetables (77 percent), peas (83 percent), and Irish potatoes (80 percent). In addition, Cypermethrin (pyrethroid; between 35 and 45 percent of use) and

Dithane (mancozeb; between 20 and 40 percent of use) were highly used compared with other types of pesticides by both small- and large-scale farmers. These pesticides were largely used on hillside lands rather than marshlands (NISR, 2018a).

Mineral Fertilizer Suppliers and Distributors

The GoR subsidizes mineral fertilizers, and it has authorized eight companies to import them (table 5.5). According to the RAB, Rwanda annually imports 30,000 metric tons of fertilizers: 8,000 metric tons of urea and 10,000 metric tons of diammonium phosphate (both intended for wheat and maize production), as well as 12,000 metric tons of nitrogen, phosphorus, and potassium compound (used primarily in the production of rice and Irish potatoes) (MINAGRI, 2018c).

The Agro-Processing Trust Corporation Ltd. is the only authorized company to distribute government- subsidized mineral fertilizers; it sells them to farmers through a network of about 1,000 agro-dealers in the country (MINAGRI, 2018c).

The 2017 agricultural survey indicated that about 19 percent of small-scale producers used inorganic fertilizers during season A, 15 percent used them during season B, and 38 percent used them during season C. The survey estimated inorganic fertilizer use in marshlands (mainly for paddy rice) at 49, 36, and 28 percent for seasons A, B, and C, respectively. However, although an estimated 44 percent of large-scale farmers used inorganic fertilizers during season A, that figure dropped to 33 percent during season B (NISR, 2018a).

<Table hd>Table 5.5: Government-Approved Importers of Mineral Fertilizers, Fiscal Year 2017/18[a]

Company Name	Mobile Phone No.	E-mail
Cooperative pour la promotion du commerce des intrants agricoles de Rubavu (COOPCIAR)	(+250) 788 767 333	hsansmentir@yahoo.com
Export Trading Group	(+250) 782 899 556	Santosh.shukla@etgworld.com
Ets Nkubili Alfred	(+250) 788 300 760, (+250) 788 301 967	alfrednkubili@yahoo.fr
Koperative y'Abacuruzi b'Inyongeramusaruro Nyabihu (KOAINYA)	(+250) 788 995 268	koainya2017@gmail.com
Murenzi Supply Company	(+250) 788 300 759	murenzisupplycompany@yahoo.fr
One Acre Fund (Known as Tubura in Rwanda)	(+250) 788 741 343,	Info.rwanda@oneacrefund.org

	(+250) 786 561 265	
World Business Alliance	(+250) 782 329 537	info@wba.rw
Yara Rwanda Ltd.	(+250) 788 303 702, (+250) 735 518 740	Peter.ngugi@yara.com

Table source>*Source:* MINAGRI, 2016a

GWSP
GLOBAL WATER
SECURITY & SANITATION
PARTNERSHIP

IFC | International Finance Corporation
WORLD BANK GROUP

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

W19083