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RWANDA EARLY GENERATION SEED STUDY

COUNTRY REPORT

June 2016

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FOREWORD

The United States Agency for International Development (USAID) Bureau for Food Security (BFS) Early Generation Seeds (EGS) program, acting through Development Alternatives, Inc.'s (DAI) Africa Lead II project, will facilitate existing USAID Mission, BFS, and Bill & Melinda Gates Foundation (BMGF) partnerships to make significant seed system changes to break the bottlenecks on breeder and foundation seed, primarily in Africa. Many bottlenecks continue to hinder projects aiming to reach the great majority of small holder farmers in Sub-Saharan Africa, including the unsustainable supply of EGS. These include poorly functioning national variety release systems; policies, regulations, and misplaced subsidies that limit access to publicly developed improved varieties by private seed companies; and the continuing presence of obsolete varieties, as well as counterfeit seeds, in seed markets.

The overall EGS effort, which began in 2014 and will continue through 2017, is carried out in a complex, dynamic environment involving the USAID and BMGF partnership, several international and bilateral donors, as many as 12 African governments, several African regional organizations, and a plethora of public and private stakeholders. Over the past two years, the USAID and BMGF partnership has explored, with a large number of noted US, African, and international technical experts, how to address constraints in EGS systems. This exploration led to the Partnership's development of a methodology to analyze seed value chains, and to do this by specific market, crop, and economic dimensions. Applying this methodology leads to identifying actors and actions along the seed value chain that are required in order to produce an adequate supply of EGS on a sustainable basis. The methodology was vetted by technical experts from African regional organizations, research and technical agencies, and development partners.

USAID asked DAI through its Africa Lead Cooperative Agreement II to take this analytical methodology to the country level in selected Feed the Future countries, particularly in ways to change seed systems as they affect smallholders in the informal agriculture sectors. The lack of readily available and reasonably priced quality seed is the number one cause of poor agricultural productivity across much of the continent, particularly among smallholders. Africa Lead II selected and contracted with Context Network to execute EGS studies in Rwanda, Zambia, Kenya, and Nigeria as well as to lead a one-day EGS technical training on how to implement the study methodology with researchers from 11 countries in Addis Ababa, Ethiopia, on February 27, 2016.

With Africa Lead's guidance, the Context Network's work, both the technical training and the four country studies, requires careful consideration of appropriate private, public, donor, NGO, and informal sector roles in seed distribution to end users. In each country situation, the Context Network is identifying an inclusive set of stakeholders who stretch beyond a short "seed only" value chain (i.e., from breeder to foundation seed producers to producers of certified and Quality Declared seed) to end users, e.g., farmers in both the formal and informal agriculture sectors. Each study recognizes that needs and utilization will be shaped by gender differentiated roles in both crop production and trade (both formal and cross border). The Context Network country studies aim to better understand farmer requirements, i.e., demand, independent of the policy and technical parameters affecting EGS supplies.

The resulting EGS country studies are expected to have two additional medium-term impacts beyond the life of the Africa Lead contract with the Context Network. First, the studies will create incentives for greater government and private investment in the respective seed sectors, laying the basis for increased scale-up and adoption of more productive technologies. Second, and with some short-term increase in supply and quality of EGS, a number of policy or investment constraints will come into focus, coalescing stakeholders around the downstream changes required to address those constraints on seed quality and supply.

ACKNOWLEDGMENTS

This report was developed by a team at the Context Network led by Mark Nelson, a principal at the Context Network. Field research activities were conducted by Mark Walton, Evans Sikinyi, and Clement Urinzwenimana.

The team is grateful for the support of DAI including David Tardif-Douglin, Charles Johnson, and Sonja Lichtenstein as well as guidance from BFS Senior Food Policy Advisors, David Atwood and Mark Huisenga, and USAID Rwanda's, Malick Haidara and Patrice Hakizimana.

The team would also like to thank all key stakeholders in Rwanda who participated in interviews for this study. Through the course of the study, a number of challenges have been identified. The report research team recognizes the government of Rwanda is committed to improving EGS systems and addressing many of these recommendations. In interviews with government officials, the team repeatedly heard of the government's desire and focus to address many of these issues and recommendations, and thus the team looks forward to the Rwandan government's continued efforts.

ACRONYMS

Abbreviation	Definition
AFR	Access to Finance Rwanda
BFS	Bureau for Food Security (USAID)
BMGF	Bill and Melinda Gates Foundation
BTC	Belgium Technology Corporation
CAADP	Comprehensive African Agricultural Development Program
CAGR	Compound Annual Growth Rate
CGIAR	Consultative Group on International Agricultural Research
CIP	Rwanda Crop Intensification Program
COMESA	Common Market for Eastern and Southern Africa
DAI	Development Alternatives, Inc.
EAC	East African Community
EDPRS	Economic Development and Poverty Reduction Strategy
EGS	Early Generation Seed
EGS-PPP	Early Generation Seed Public Private Partnership
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
FTF	Feed The Future
GDP	Gross Domestic Product
GoR	Government of Rwanda
MINAGRI	Ministry of Agriculture (Rwanda)
MINILOC	Ministry of Local Affairs (Rwanda)
MFI	Micro-Finance Institution
NGO	Non-Governmental Organization
OPV	Open Pollinated Variety
PSTA	Strategic Plan for the Transformation of Agriculture in Rwanda
QDS	Quality Declared Seed
RAB	Rwanda Agricultural Board
RDB	Rwanda Development Board
RALICS	Rwanda Agriculture and Livestock Inspection and Certification Service
SACCO	Community Savings and Credit Cooperative
USAID	United States Agency for International Development
WDI	World Development Indicators

TERMINOLOGY

Breeder seed: Breeder seed is produced by or under the direction of the plant breeder who selected the variety. During breeder seed production the breeder or an official representative of the breeder selects individual plants to harvest based on the phenotype of the plants. Breeder seed is produced under the highest level of genetic control to ensure the seed is genetically pure and accurately represents the variety characteristics identified by the breeder during variety selection.

Pre-basic seed: Pre-basic seed is a step of seed multiplication between breeder and foundation or basic seed that is used to produce sufficient quantities of seed for foundation or basic seed production. It is the responsibility of the breeder to produce pre-basic seed and production should occur under very high levels of genetic control.

Foundation or basic seed: Foundation seed is the descendent of breeder or pre-basic seed and is produced under conditions that ensure maintaining genetic purity and identity. When foundation seed is produced by an individual or organization other than the plant breeder there must be a detailed and accurate description of the variety the foundation seed producer can use as a guide for eliminating impurities (“off types”) during production. Foundation and basic seed are different words for the same class of seed. Basic seed is the term used in Rwanda.

Certified seed: Certified seed is the descendent of breeder, pre-basic, or basic seed produced under conditions that ensure maintaining genetic purity and the identification of the variety and that meet certain minimum standards for purity defined by law and certified by the designated seed certification agency.

Quality Declared seed: In 1993 the Food and Agriculture Organization of the United Nations (FAO) produced and published specific crop guidelines as Plant Production and Protection Paper No. 117 Quality Declared Seed – Technical guidelines on standards and procedures. The Quality Declared Seed (QDS) system is a seed-producer implemented system for production of seed that meets at least a minimum standard of quality but does not entail a formal inspection by the official seed certification system. The intent behind the QDS system is to provide farmers with the assurance of seed quality while reducing the burden on government agencies responsible for seed certification. The QDS system is considered by FAO to be part of the informal seed system.

Quality seed: In this report the phrase quality seed is at times used in place of certified seed or QDS to describe a quality-assured seed source without specifying certified or QDS.

Commercial seed: Any class of seed acquired through purchase and used to plant farmer fields.

Improved versus landrace or local varieties: Improved varieties are the product of formal breeding programs that have gone through testing and a formal release process. A landrace is a local variety of a domesticated plant species which has developed over time largely through adaptation to the natural and cultural environment in which it is found. It differs from an

improved variety which has been selectively bred to conform to a particular standard of characteristics.

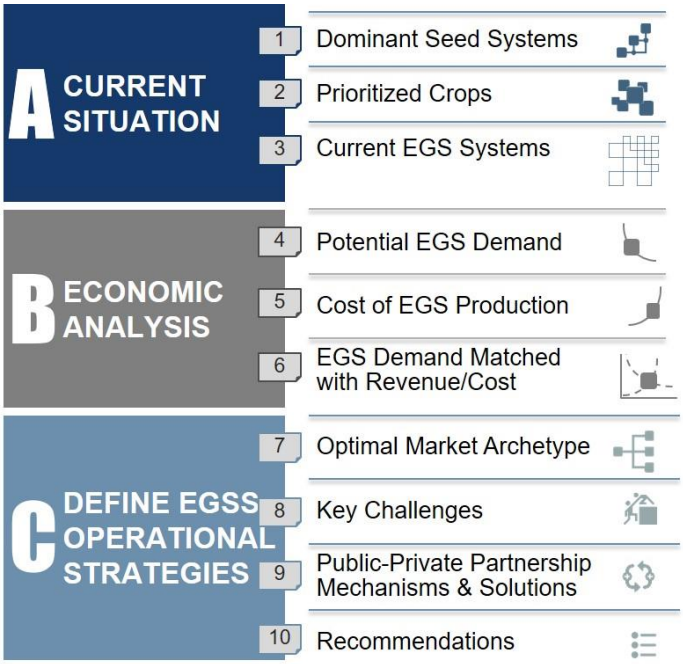
Formal seed system: The formal seed system is a deliberately constructed system that involves a chain of activities leading to genetically improved products: certified seed of verified varieties. The chain starts with plant breeding or a variety development program that includes a formal release and maintenance system. Guiding principles in the formal system are to maintain varietal identity and purity and to produce seed of optimal physical, physiological and sanitary quality. Certified seed marketing and distribution take place through a limited number of officially recognized seed outlets, usually for sale. The central premise of the formal system is that there is a clear distinction between "seed" and "grain." This distinction is less clear in the informal system.

Informal seed system: The informal system also referred to as a local seed system, is based on farmer saved seed or QDS. In Rwanda there is no use of QDS and the informal seed system is dominated by farmer saved seed where farmers themselves produce, disseminate, and access seed directly from their own harvest that otherwise would be sold as grain; through exchange and barter among friends, neighbors, and relatives; and sale in rural grain markets. Varieties in the informal system may be variants of improved varieties originally sourced from the formal system or they may be landrace varieties developed over time through farmer selection. There is no emphasis on variety identity, genetic purity, or quality seed. The same general steps or processes take place in the local system as in the formal sector (variety choice, variety testing, introduction, seed multiplication, selection, dissemination and storage) but they take place as integral parts of farmers' production systems rather than as discrete activities. While some farmers treat "seed" as special, there is not necessarily a distinction between "seed" and "grain." The steps do not flow in a linear sequence and are not monitored or controlled by government policies and regulations. Rather, they are guided by local technical knowledge and standards and by local social structures and norms.

METHODOLOGY

Building on previous studies and consultations with governments, private sector organizations, and partners, the USAID and BMGF partnership developed, tested, and widely vetted a methodology to identify country-specific and crop-specific options to overcome constraints in EGS supply (Monitor-Deloitte EGS Study sponsored by USAID and BMGF in 2015). As illustrated in Figure 1, this methodology includes ten-steps to define EGS systems, perform economic analysis, and develop EGS operational strategies.

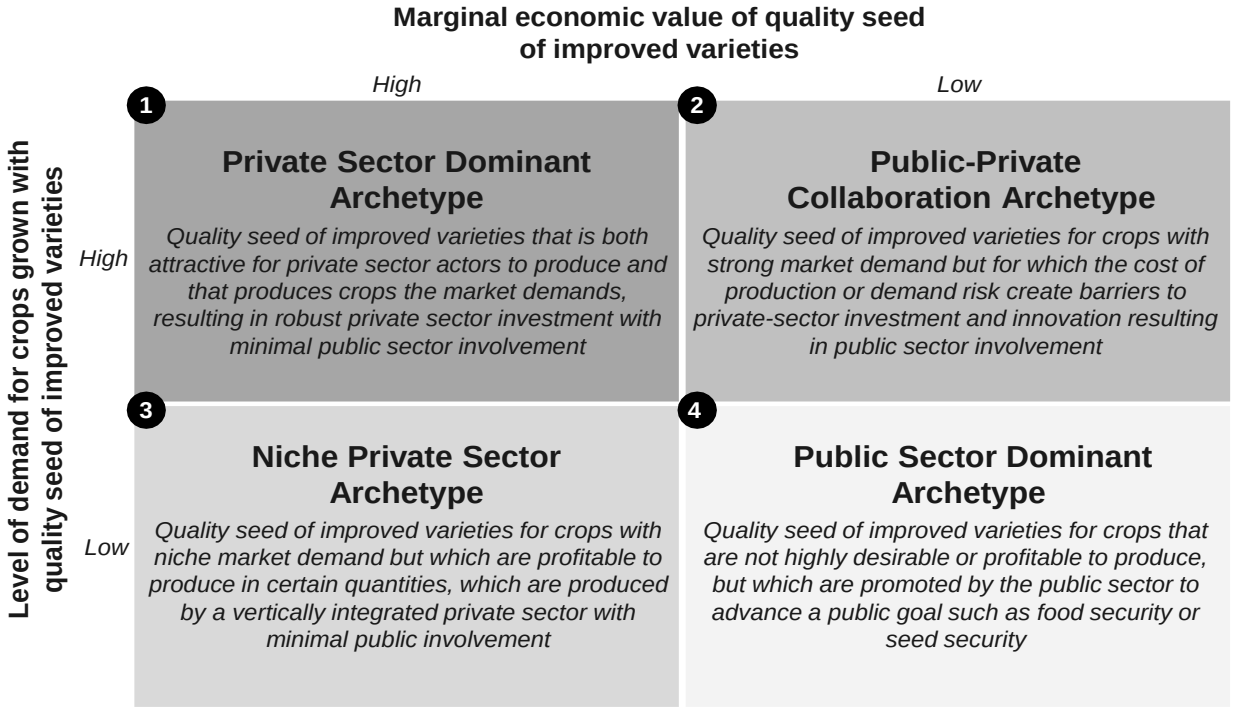
Figure 1: **EGS System ten-step process.**



Source: Ten steps based on process developed by Monitor Deloitte for EGS study prepared for USAID and BMGF (2015).

The first six steps of this ten-step process were used to analyze specific crops within Rwanda in order to inform step seven, development of the optimal market archetype. The study commissioned by the USAID and BMFG partnership utilized a common economic framework to define public and private goods and applied it to EGS systems, as shown in Figure 2. Once the optimal market archetype for each crop was developed, steps eight through ten identified the key challenges to achieving the optimal market archetype, possible public-private partnership mechanisms and solutions, and final recommendations.

Figure 2: **Market archetype framework.**



Source: Framework developed by Monitor Deloitte for EGS study prepared for USAID and BMGF (2015).

This framework categorizes EGS systems of crops and crop segments within a specific country, based on marginal economic value of the quality of improved varieties and the level of demand for crops grown with quality seed of improved varieties. Several variables, as represented in Table 1, inform these two factors.

Table 1: **Variables that inform market archetype framework.**

Key Variable	Description	Examples
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES		
Differential performance of improved varieties	Level with which improved varieties in the market have differential performance versus local varieties	Yield, quality, traits such as disease and drought tolerance
Frequency of seed replacement	Frequency with which quality seed must be bought to maintain performance and vigor of an improved variety	Yield degeneration, disease pressure, pipeline of new varieties being commercialized regularly
Differentiating characteristics	Existence of differentiating characteristics that command a price premium for improved varieties	Price premiums for processing, nutritional characteristics
Fragility of seed	Ability of seed to withstand storage and/or transport without significant performance loss	Hardiness/fragility of seed
Cost of quality seed production	Cost of producing quality seed	Multiplication rates, input costs, labor requirements, mechanization, macro and micro propagation technology
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES		
Total demand for seed	How much seed is required to meet the planting needs of a given crop	Area
Requirement for quality assurance	Requirement for quality assurance to realize variety benefits	Certification, Quality Declared, farm-saved seed
Farmer demand for specific varieties	Level of farmer demand for specific varieties	Mainly driven by agronomic performance
Market demand for specific varieties	Level of downstream demand for specific characteristics	Color, cooking quality, processing quality

Source: Based on variables developed by Monitor Deloitte for EGS study prepared for USAID and BMGF (2015).

STAKEHOLDER CONSULTATION

The selected crops for in-depth EGS system analysis were identified during a consultative process with BFS and USAID Rwanda. To support this endeavor, USAID Rwanda engaged key Rwandan stakeholders to provide input into the crops to be selected for the study. The field research team developed a matrix of key indicators crossed with ratings definitions as the basis for discussions. These indicators created a framework to prioritize crops that would have the largest impact on smallholder farmers and specifically women. To ensure that the EGS study encompassed both the formal and informal seed systems as well as the broader crop value chain, the field research team targeted a comprehensive set of stakeholders to be interviewed. Nearly forty stakeholders were interviewed representing public, private, NGOs, and donor actors.

PRIORITY CROPS

Within Rwanda, three crops were selected for analysis: Irish potato (referred to simply as potato throughout this report), common bean, and maize.

EXECUTIVE SUMMARY

SEED SYSTEMS IN RWANDA

There are four identified dominant seed systems in Rwanda, which include farmer-saved, public-private, public, and private. The farmer-saved and public seed systems represent the majority of seed volume. Farmer saved seed dominates the informal sector while the public-private and private seed systems represent the majority of EGS volume.

Adoption of improved varieties is low across Rwanda. A 2009 Agra Baseline Study Survey estimated that adoption of improved varieties in Rwanda is only 7-13%. While improved variety adoption has likely increased since the 2009 study, adoption continues to be low across all crops in Rwanda, with the exception of hybrid maize. Informal seed systems dominate most crop value chains because in many cases the formal systems cannot meet demand, often because the formal system is under-resourced and Rwanda lacks a strong private seed sector to supplement or (where appropriate) replace public sector activities. As a result, farmers predominantly rely on saved seed and informal farmer-to-farmer exchanges.

EARLY GENERATION SEED SYSTEMS BY CROP

The Rwandan EGS systems fall under the responsibility of the Rwanda Agriculture Board (RAB). The breeding and variety development staff, housed in the RAB research department, is responsible for producing breeder and pre-basic seed. Basic seed is produced by the RAB seed production unit responsible for producing basic seed for seven crops: common bean, potato, maize, wheat, soybean, rice, and cassava.

Potato: It is estimated that only 3% of the potato planted area originates in the formal seed system, while 97% of potato area is planted with seed sourced by farmers through informal means. However, current EGS demand is estimated to be three times that of supply due to several supply capacity bottlenecks that are explained in the report. The formal system is public sector driven, but there is private sector participation, specifically from farmer groups and cooperatives.

Common bean: It is estimated that only 5% of the common bean planted area is sourced from the formal seed system, while 95% of common bean area is planted with seed sourced by farmers through informal means. While there are many reasons for the dominance of the informal system, the primary factor is that available supplies of quality seed are insufficient to meet the relatively limited demand for EGS.

Maize: 70% of the maize area is planted with hybrids and therefore serviced through a formal seed system. The remaining 30% is planted with open pollinated variety (OPV) seed, which is rapidly becoming an informal market. Although some private seed producers and local seed companies are attempting to produce certified OPV maize, it is clear from field team research for this study that RAB's decision to promote the use of hybrid maize is driving OPV maize out of the mainstream. The government has made evident its interest in hybrids by suspending production of OPV EGS and as a result there is a diminishing supply of quality OPV maize seed available to farmers. Recognizing the inherent performance advantage of hybrids over OPV

maize and in light of the government's focus on replacing OPV maize with hybrid maize, the research conducted for this study was focused primarily on issues impacting hybrid maize.

EARLY GENERATION SEED SYSTEM BOTTLENECKS/CONSTRAINTS BY CROP

Potato: EGS demand for potato is currently at least three times greater than supply, due to supply bottlenecks. These include:

Supply bottlenecks

- Inadequate *in vitro* production capacity.
- Low yields at all stages of seed potato production.
- Insufficient working capital for EGS producers.
- Limited availability of long term credit for EGS producers.
- Lack of storage for EGS and commercial seed.
- Small farm sizes of EGS and commercial producers.

Demand constraints

There are no significant constraints on demand for potato seed; the lack of new varieties with good disease resistance may limit total area in production but is not a particular constraint. If varieties selected for processing traits were available, total production might grow or processing types might displace some market production. There is, however, no specific data on the potential impact of processing potatoes, and the current potato processing industry is tiny and a non-factor in the larger potato production scheme.

Common bean: There are numerous EGS supply bottlenecks, as well as demand constraints in the common bean seed system. These include:

Supply bottlenecks

- Limited quantities of basic seed.
- Inconsistent quality of basic seed.
- Private seed sector not capable of delivering certified seed.
- Poorer than forecast seed yields.
- Seed producers divert seed for market or on-farm consumption.

Demand constraints

- Farmers are unconvinced improved varieties offer performance advantages.
- Performance of recent bush bean releases not compelling.
- Farmers unaware of the inherent advantages of quality seed.
- Farmers manage their operations based upon cash accounting.
- Smallholder farmers lack access to credit from the Community Savings and Credit Cooperatives (SACCOs).

Hybrid maize: The availability of hybrid maize seed is mainly driven by supply bottlenecks that stem from policy issues that constrain private sector supply growth and success. These include:

Supply bottlenecks

- Slow, cumbersome seed import process.
- Inadequate demand forecast system.
- Inequitable private sector exposure to risk.
- Unclear subsidy strategy.
- Inefficient and unclear registration process.

Demand constraints

- Suitability of hybrids for specific growing conditions and areas.
- Smallholder farmers lack access to credit from SACCOs.

PUBLIC-PRIVATE PARTNERSHIPS

Although the challenges and opportunities identified in common bean and potato are not identical, in both cases a public-private partnership (PPP) could be established as the foundation for building high-performance EGS systems. An effective EGS-PPP would significantly reduce or even eliminate government responsibility for production of EGS for certain crops and stimulate the development of a robust private seed sector. This would allow the government to redirect resources away from EGS production in favor of research and extension activities to ensure a steady supply of improved varieties that would enable farmers to realize more of the potential inherent in improved varieties.

An EGS-PPP would have three primary objectives:

- Produce enough EGS to meet current and future needs.
- Produce seed at the lowest possible cost while continuing to meet quality standards.
- Stimulate demand for quality seed at the farm level.

The EGS-PPP concept has merit for common bean and potato, but important differences between the two crops suggest that two such partnerships may be needed. RAB would be the public partner in both, but the nature of the crops and market opportunities for each may dictate different private partners.

Potato has greater potential to become economically interesting to the private sector than does common bean, and this difference will be key to attracting private partners. The economics of common bean and common bean seed are inherently less attractive than in potato and will likely make it difficult to attract seed or other industry partners to participate in the common bean PPP. Attracting significant levels of private support for the common bean PPP could be enhanced by incorporating other crops that have production and processing requirements similar to common bean, such as soybean and wheat.

RECOMMENDATIONS

Full and detailed recommendations for each crop can be found in section 5.4. It is recommended that there be a PPP established for potato and common bean with the specifications related to partners and position within the seed system developed according to the needs of the given crop. Additional high-level recommendations are listed below.

POTATO

The priority for potato is to expand and enhance EGS production capabilities to meet current and future demand. Rwanda has a robust domestic market for potato and is well positioned to become a regional supplier. Demand for potato EGS already exceeds supply by at least threefold. The primary need in early generation potato seed is a fully capable and scalable EGS system through a PPP. In addition, steps should be taken to increase the availability of new, improved potato varieties and to further enhance the economic value of potato.

COMMON BEAN

The priority objectives for common bean are to build on-farm demand for improved varieties and quality seed and to create a sustainable demand by increasing the marginal economic value of common bean. As these two objectives are realized, there will be a need for a robust and capable EGS system built as a PPP. In order to make this PPP attractive to the private sector, the government should consider including soybean and wheat with common bean.

HYBRID MAIZE

The priority for hybrid maize is to stimulate sustainable private sector growth by removing barriers to its participation, which will allow the public sector to exit the market. The government of Rwanda (GoR) has stimulated significant growth of maize production through its support and focus on replacing OPV maize with high-performance maize hybrids. The current program, including ongoing seed price subsidies, encourages farmers to adopt hybrid maize and use good agronomic practices. The Tubura experience has proven that smallholder farmers clearly benefit from using hybrids and that the lack of agricultural credit is the key bottleneck limiting further adoption. Maintaining an OPV EGS system props up an inferior product and is detrimental to smallholder farmer's interests.

Here following are specific recommendations:

- Develop and communicate a strategy to eliminate maize subsidies.
- Allow private maize seed companies to make seed production decisions, including what to produce and where to produce it, without government approval.
- Develop purpose-built agricultural lending products tailored for smallholder farmers.
- Harmonize Rwanda's registration and seed import process with EAC and COMESA procedures.
- Operationalize plant variety protection policies that have been embodied in the recently passed seed law.
- Focus RAB's hybrid maize program on conducting trials to provide farmers with unbiased data.

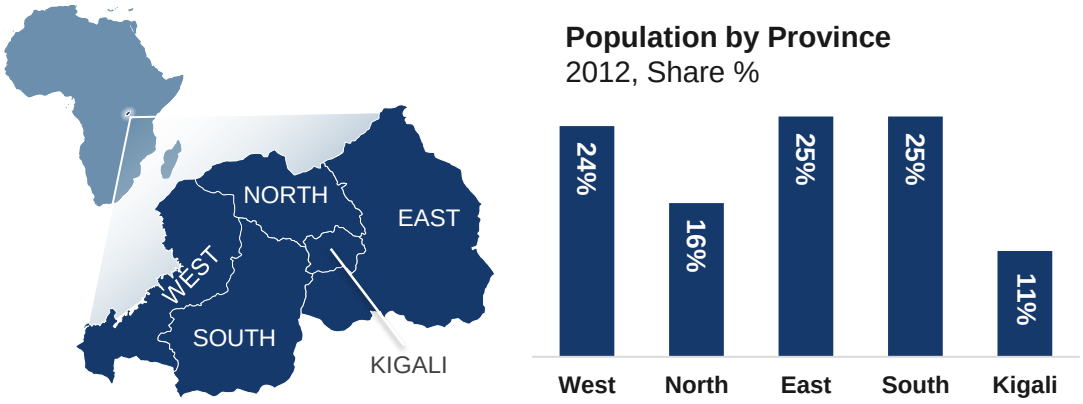
CHAPTER 1: CURRENT SITUATION – DOMINANT SEED SYSTEMS

1.1 COUNTRY OVERVIEW

Rwanda is a small landlocked country in eastern Africa sharing boundaries with Uganda to the north, Tanzania to the east, Burundi to the south, and the Democratic Republic of Congo (DRC) to the west. It is among the ten most densely populated countries in the world, of which 52% are women, living in 26,388 square kilometers (National Institute of Statistics of Rwanda, 2012). The demographic growth rate from 2002-2012 was 2.6% and total population in 2015 was estimated at 11.3 million inhabitants (Rwanda Country Stat, 2016).

As illustrated in Figure 3, Rwanda is divided administratively into five provinces and 30 districts. In 2012, 83% of the population was rural (National Institute of Statistics of Rwanda, 2012) despite an increasing trend for the youth (ages 15-24) to migrate to Kigali and provincial towns in search of employment (The East African, 2015).

Figure 3: **Map of Rwanda provinces and % population share.**

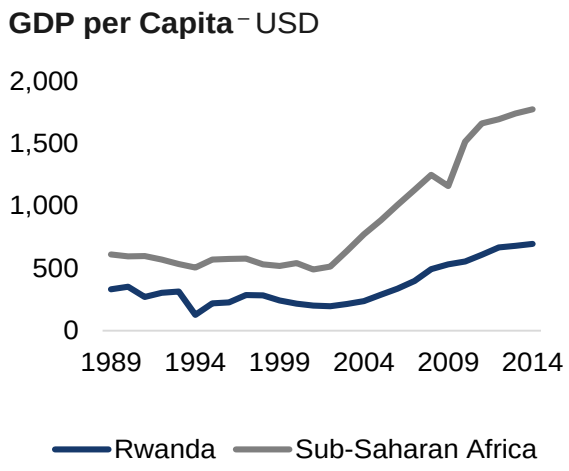


Source: National Institute of Statistics of Rwanda (2012).

According to the World Bank, the poverty rate dropped from 59% in 2001 to 45% in 2011 while inequality measured by the Gini coefficient decreased from 0.52 in 2006 to 0.49 in 2011 (World Bank, 2016). 70% of the population is literate, with women slightly less so (68%) as of 2015 (World Bank, 2016).

In 2012, real per capita gross domestic product (GDP) was $390, well below the Sub-Saharan Africa average of $1,522 (World Bank, 2015). Between 2001 and 2014, real GDP growth averaged about 8% per year (World Bank, 2016) as illustrated in Figure 4.

Figure 4: **Per capita GDP Rwanda compared to Sub-Saharan Africa.**



The government of Rwanda's long-term strategy (Vision 2020) is to transform the country from a low-income agriculture-based economy to a knowledge-based, service-oriented economy with a middle-income country status by 2020 (World Bank, 2016). To achieve its objectives, the government has developed a mid-term strategy for eradicating poverty, the Economic Development and Poverty Reduction Strategy 2 (EDPRS 2), which aims to raise domestic per capita GDP to $1000, have less than 30% of the population below the poverty line, and have less than 9% of the population living in extreme poverty by 2018.

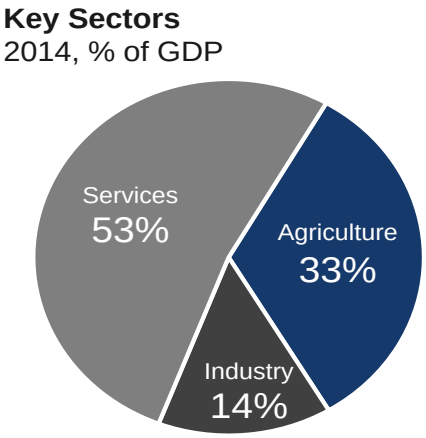
Source: World Bank (2016).

1.2 AGRICULTURE SECTOR

OVERVIEW

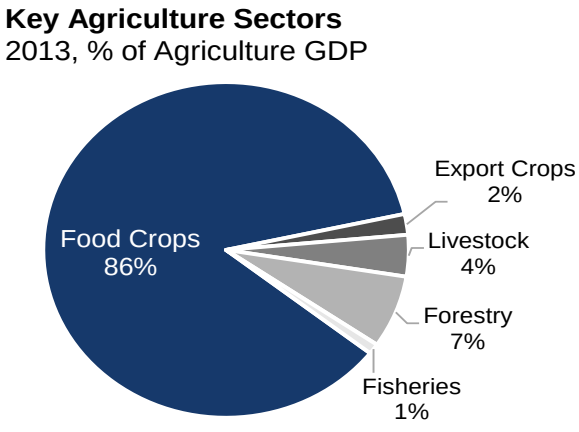
Currently, agriculture makes up 33% of the national GDP, more than in Kenya (30%) and in Nigeria (20%). Figure 5 shows the other two sectors contributing to GDP as Services and Industry. Nearly 50% of all exports come from agriculture, and 90% of the total labor force works in agriculture.

Figure 5: **Rwanda GDP composition (2014).**



Source: World Bank (2016).

Figure 6: **Rwanda agriculture GDP composition (2013).**



Source: World Bank (2015).

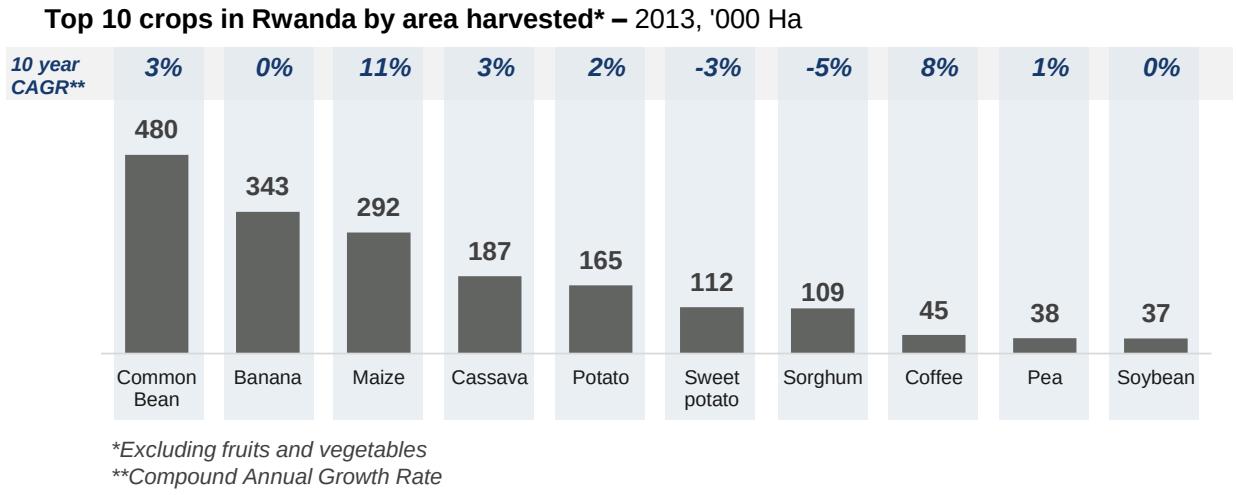
Within the agriculture sector, 86% of GDP is from the production of food crops, as shown in Figure 6. Tea and coffee, highly subject to international price fluctuations, were more than 80%

of agricultural exports from 2008-2010, with only small quantities of staple foods (e.g., common bean, potato) crossing the borders to neighboring countries (Uganda, DRC, Burundi) both formally and informally.

KEY CROPS

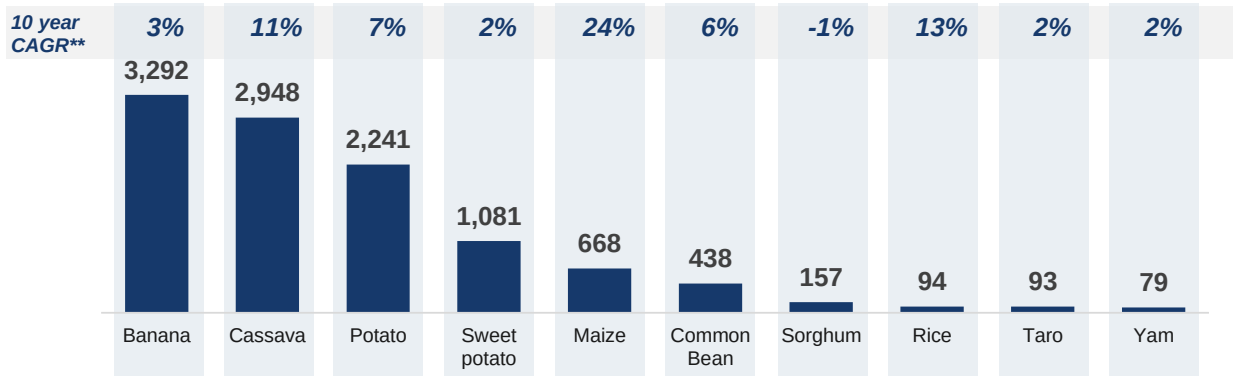
The top ten crops in Rwanda, based on area harvested and production, are presented in Figures 7 and 8. Common bean is the largest crop based on area harvested and is grown by 92% of rural households as an important source of protein and food security. Maize represents the fastest area growth, nearly tripling area in the last ten years. Maize and rice production are growing fastest, driven by the GoR's Crop Intensification Program (CIP). Of the key root, tuber, and banana crops, cassava and potato production are growing fastest, while banana and sweet potato production remains relatively flat.

***Figure 7*: Top 10 crops by area (2013).**



Source: Rwanda Country Stat (viewed in February 2016).

***Figure 8:* Top ten crops by production (2013).**



Source: Rwanda Country Stat (viewed in February 2016).

GROWING CONDITIONS

Although it is a small country, Rwanda has a hilly topography that creates a diverse set of growing conditions. Farms are scattered on hilltops, slopes, at the bottom of slopes, and in some of the inland valleys, as shown in Table 2.

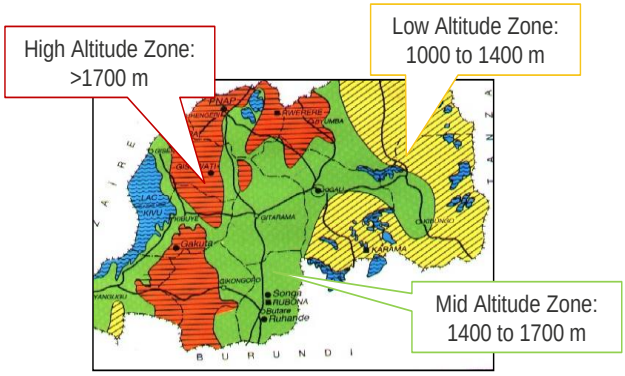
Furthermore, Figure 9 depicts Rwanda's three key altitude zones, with the lower altitude zones located in the eastern part of the country, the mid altitude zone mainly in the center, and the higher elevations in the north and west.

Table 2: **Topographic position of farms in Rwanda in 2010.**

TOPOGRAPHY	SHARE
TOP OF HILL	24%
SIDE OF HILL	46%
BOTTOM OF HILL	12%
PLAIN	16%
MARSH	2%
TOTAL	**100%**

Source: National Institute of Statistics of Rwanda (2010).

Figure 9: **Rwanda altitude zones.**



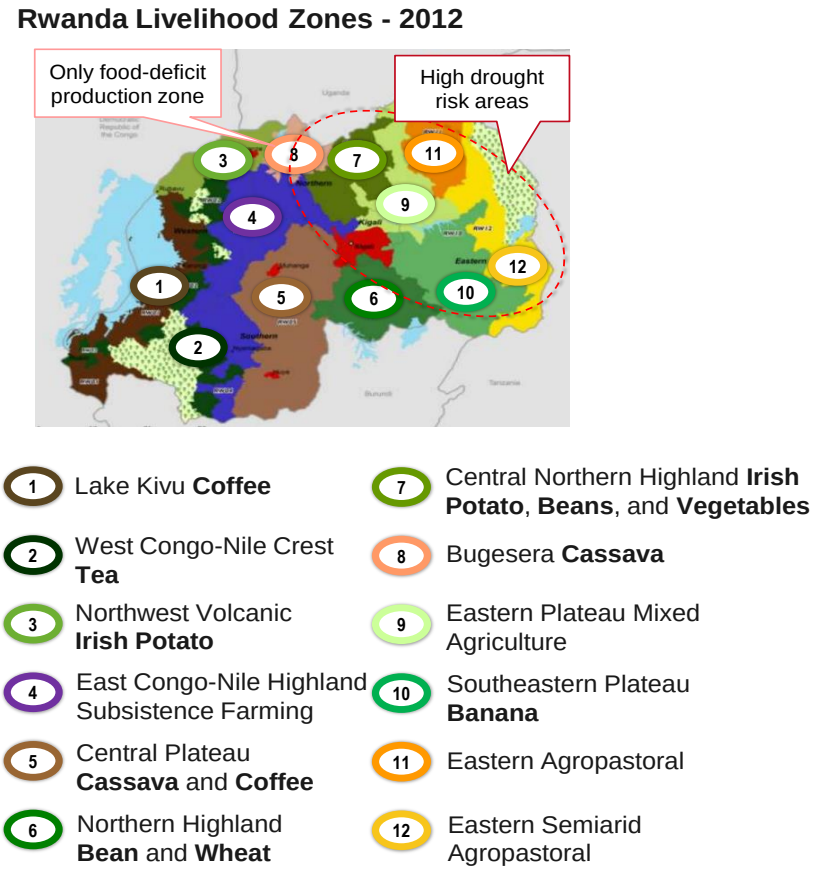
Source: Musoni (2013).

USAID's Famine Early Warning System has identified 12 distinct livelihood zones, shown in Figure 10, offering opportunities to both ensure food security and produce a surplus for processing and export, despite diverse agroclimatic challenges to production. There is one identified food-deficit zone in the north (Zone 8 – Bugesera Cassava) and multiple zones in the east at higher risk to drought. Among the agroclimatic challenges Rwanda faces are:

- Drought: Most common when rains start late or stop abruptly, particularly affecting the East Province; among the major staple food crops, maize and rice are most susceptible to drought, while cassava is the most drought tolerant.

- Flooding: Most common from March to June and from November to December, especially in inland valleys and on alluvial plains.
- Poor soil fertility: Nitrogen and phosphorus deficiencies affect maize (N, P), potato (N, P) and common bean (P).

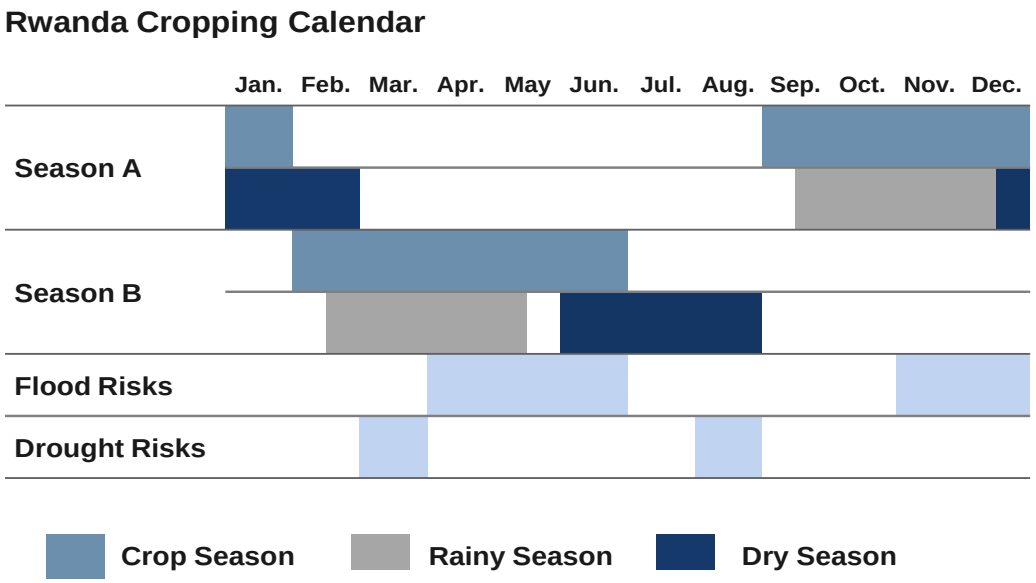
Figure 10: **Rwanda livelihood zones.**



Source: Famine Early Warning Systems Network (2012).

Rwanda benefits from two rainy seasons, the short rains from September/October to December (Season A) and the long rains from February/March to May (Season B), as depicted in Figure 11. Table 3 shows that most staple food crops are grown in both seasons. There is a third season (Season C), with cropping usually confined to the inland valleys, marshes, and alluvial plains where soil moisture is highest or where irrigation water is available. Crops such as rice, green maize, and vegetables, are grown in Season C in these areas.

Figure 11: **Typical year cropping season calendar.**



Source: MINAGRI (2010) sourced from World Bank (2015).

Overall, agricultural input use is higher in Season A than in Season B. For example, in a recent survey by the World Bank, 13.3% of households indicated that they use improved seeds in Season A, compared to 7.1% in Season B. This may be driven by the higher production of maize and potato in Season A, since farmers use more inputs (improved seed, fertilization, and crop protection chemicals) on these crops.

Table 3: **Principal crops' share of production by season (%).**

Season Share of Production

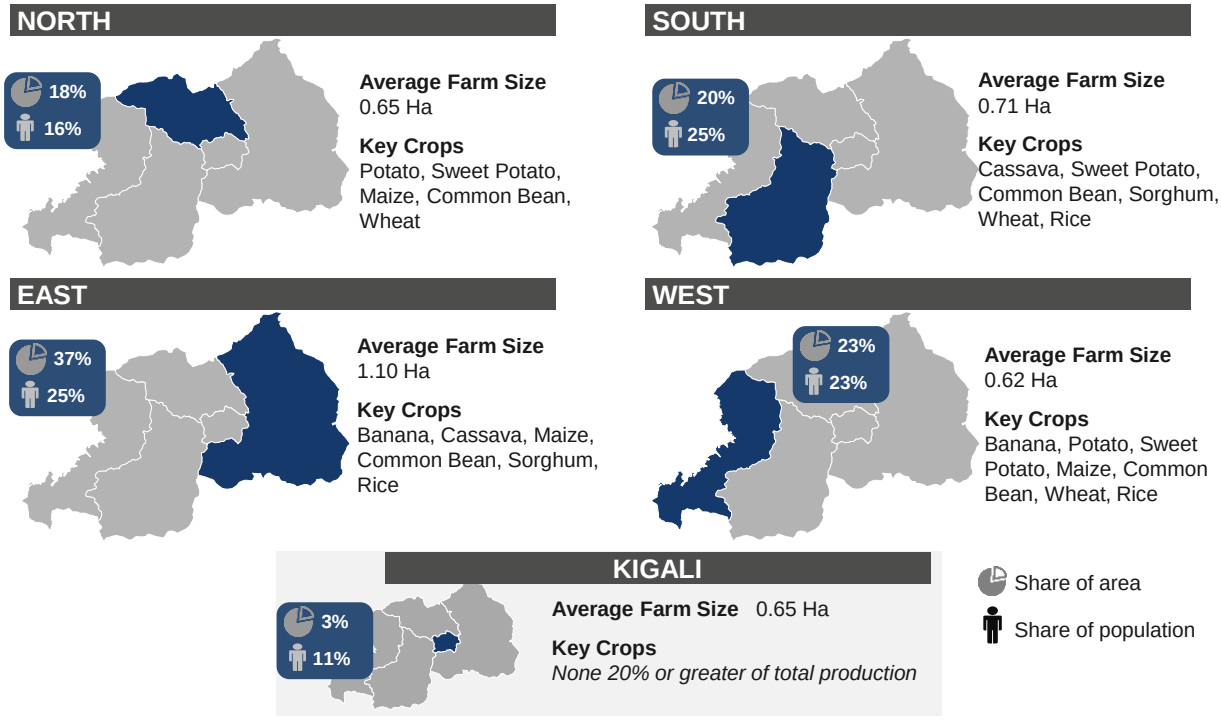
		Season A	Season B
Balanced Seasonal Production	Banana	49% ⟷	51%
	Cassava	44% ⟷	56%
	Common Bean	54% ⟷	46%
Season A Focus	Potato	**61%**	39%
	Maize	**65%**	35%
Season B Focus	Rice	40%	**61%**
	Sweet Potato	33%	**66%**
	Wheat	30%	**70%**
	Sorghum	5%	**95%**

Source: Japanese Ministry of Agriculture, Forestry, and Fisheries (2012).

PROVINCIAL CROP PRODUCTION

Most of the staple crops are produced throughout the country, but some regions have better yields because of more favorable conditions. Figure 12 presents the key crops (defined as having more than 20% share of the national production) by province. Kigali has no key crop identified because production is limited and it has an insignificant effect on national production statistics. Common bean is grown across the country, while maize production is more focused in the north, west, and east, and potato is concentrated in the north and west. Nearly all farmers in Rwanda could be classified as smallholder farmers, as 80% of them have less than 1 Ha, 94% have less than 2 Ha, and 99% have less than 4 Ha (National Institute of Statistics of Rwanda, 2010). The East province has the largest average farm size of 1.10 Ha, well above the four other provinces, where average farm sizes are ~0.6-0.7 Ha.

Figure 12: **Crop production and farm size by province.**



Source: MINAGRI (2011) sourced from Japanese Ministry of Agriculture (2012), National Institute of Statistics of Rwanda (2010) sourced from World Bank (2015).

As shown in Table 4, the division of labor in Rwandan agriculture is by task and by crop. Women are more active in the production of food security crops such as common bean, sweet potato, maize, and cassava at the subsistence level.

Table 4: **Gender roles in crop production by province.**

Gender roles in crop production by province

		North	South	East	West	Kigali	% of production sold	% of households growing
Food Security Crops	Common Bean	♀	♀	♀	♀	♀	12%	92%
	Sweet Potato		♀			♀	11%	45%
	Maize	♂♀		♀	♀	♀	22%	75%
	Cassava		♀			♀	23%	40%
Market-Oriented Crops	Potato	♂			♂		32%	53%
	Plantain			♂		♂	30%	28%
	Coffee		♂	♂		♂	*No data*	

Source: MINAGRI (2010) sourced from World Bank (2015), World Bank (2015).

Most of women's production is consumed on-farm, with small amounts sold locally. Women receive lower prices for their products and are underrepresented in agribusiness. Female-headed households (about 30%) are often very poor, with limited access to productive resources and assets. It is reported that women, especially female heads of households, have had limited access to government initiatives in Rwanda, such as CIP, because the inputs (chemicals, fertilizers, seeds) are too expensive and many of the technologies are labor intensive, restricting women's participation (World Bank, 2015).

In general, men are more involved in the production of marketed crops such potato, plantain, and coffee. They are more open to taking risks in order to increase income.

While research suggests (World Bank 2015) distinctions in gender roles by crop, field interviews reveal a more nuanced story, with both men and women often both involved in farm decisions. While women tend to manage day-to-day responsibilities because men hold additional off-farm jobs, responsibilities are highly dependent on the dynamics of specific households.

With respect to trade, women in Rwanda play a significant role in both informal and formal cross-border trade. A 2012 study by the Rwanda Ministry of Trade and Industry estimates women to represent 74% of informal cross-border traders. However, a 2013 USAID-Enabling Agriculture Trade study that conducted interviews with customs officials and National Bank data collectors contradicted this assertion and revealed "considerable variation according to the nature of the border post" with women participation being high in trade with the DRC, but closer

to 30% with respect to trade with Uganda. The study noted that women and men are both involved in cross-border trade, often working in collaboration depending on location and the commodity being traded. Men tend to manage transport, especially with bulkier commodities such as potato due to the physical requirements, while women often manage the stalls in which the commodity is sold (USAID-EAT 2013).

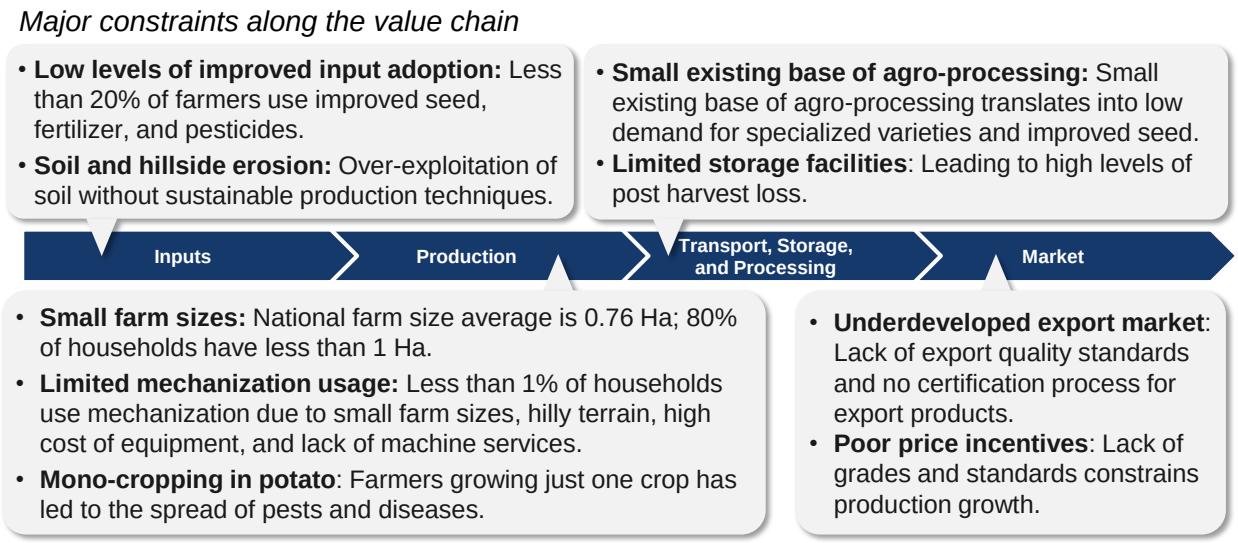
Gender related issues continue to be a priority for the GoR, and while challenges remain, the situation in Rwanda appears to be less serious of a problem compared to many neighboring countries. According to the World Economic Forum's Gender Gap Index[1], in 2015 Rwanda ranked 6th in the world, ahead of many developed countries including Germany, France, and the U.S. While this index is not agricultural specific and doesn't capture all the challenges for women in Rwandan agriculture, it supports the field interviews conducted in which women play critical roles in a variety of crops and functions, and those roles tend to vary by household.

AGRICULTURE AND ENABLING ENVIRONMENT CONSTRAINTS

While this study focuses primarily on seed system related constraints, it's critical to review a more comprehensive set of constraints across multiple crop value chains to better inform the seed situation. Figures 13 and 14 provide a high-level but not exhaustive list of key constraints across the consolidated agricultural value chain and the enabling environment in Rwanda. Critical value chain constraints include small farm sizes (less than 1 Ha per household on average nationally) which makes farmer profitability difficult to achieve given farmers' inability to spread fixed costs across larger production areas. Limited storage facilities lead to high levels of post-harvest loss and limit the flexibility of smallholder farmers to store and sell grain when prices are high. There is a very small agro-processing sector which further limits the ability of smallholders to obtain premium prices for higher quality products.

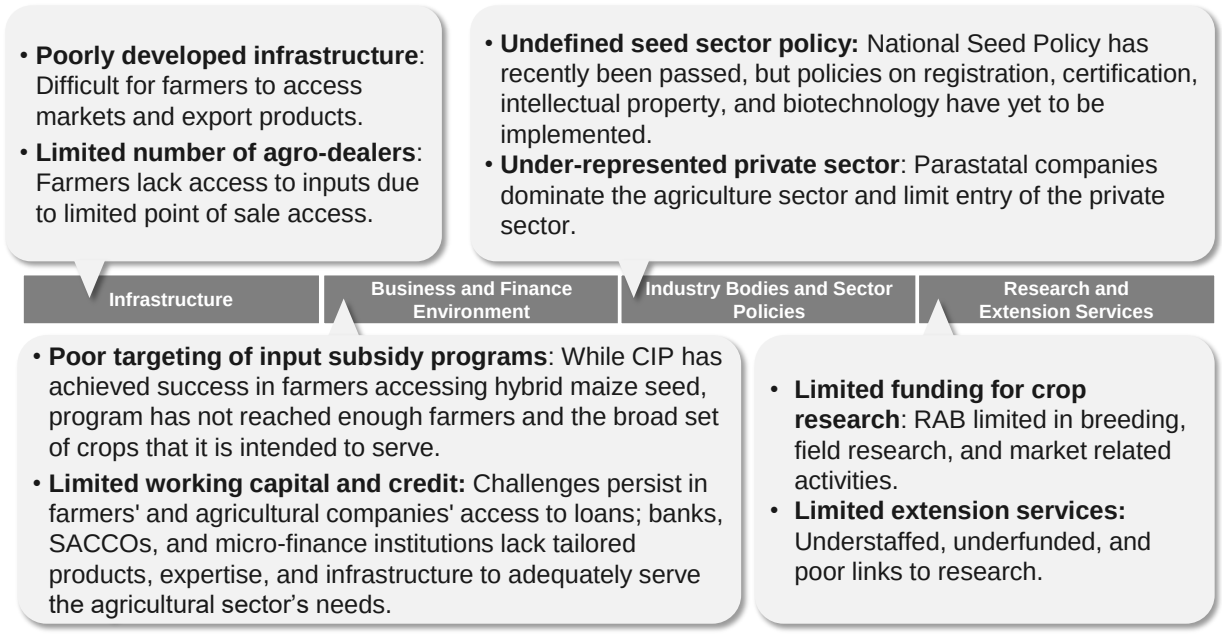
[1] The Global Gender Gap Index was first introduced by the World Economic Forum in 2006 as a framework for capturing the magnitude of gender-based disparities and tracking their progress. The Index benchmarks national gender gaps on economic, political, education and health criteria, and provides country rankings that allow for effective comparisons across regions and income groups.

Figure 13: **Major value chain constraints.**



Source: World Bank (2015), PSTA III (2013), field research team interviews (2016).

Figure 14: **Major Enabling Environment Constraints.**



Source: World Bank (2015), PSTA III (2013), field research team interviews (2016).

Rwanda's financial sector is dominated by commercial banks which account for 66.6% of the sector (AFR Rwanda MF Sector Assessment 2015). In 2014, commercial banks' target sectors included commerce, restaurants, hotels, public works, and manufacturing, which combined accounted for 73% of all bank loans. Agribusinesses have been under-represented and as a result they continue to be limited in accessing long term credit and working capital to invest in processing, distribution, and seed production infrastructure. A 2013 study commissioned by Access to Finance Rwanda (AFR) highlighted thirty-nine constraints across the agro-dealer

value chain which included high interest rates, financial products not fit for purpose, inadequate skills and know-how, and lengthy and inefficient processes and procedures (Access to Finance Rwanda, Agro Input Value Chain Financing Report in Rwanda 2013).

Access to credit is not only a constraint for agribusiness, but also a critical issue for smallholder farmers in Rwanda. While there is an emerging micro-finance sector including four micro-finance banks and twelve smaller micro-finance institutions (MFIs), these institutions have focused primarily on urban sectors including trade, hospitality, and real estate. Following a 2008 FinScope Survey that estimated 52% of Rwanda's population was completely excluded from financial services, the GoR launched the National Savings Mobilization Strategy which included the goal of creating at least one SACCO in every Umurenge (district) with the target of reaching 80% of Rwanda's population by 2017. As member based cooperatives, Umurenge SACCOs are considered to be better positioned to serve smallholder farmers as they are governed by members themselves, located in rural areas, and can focus on smaller sized loans. While the sector has grown rapidly with over 400 Umurenge SACCOs in Rwanda to date, they are underdeveloped institutions that are less than ten years old. Weak governance, poor internal control systems, low financial literacy of SACCO members, and a lack of infrastructure hamper efforts of SACCOs to provide loans to smallholder farmers on a large scale.

NATIONAL AGRICULTURAL STRATEGY

Rwanda was the first country to sign a Comprehensive Africa Agriculture Development Program (CAADP) agreement with the Organization of African Unity in 2007. The main goal of CAADP is to help African countries to design policies and initiatives to accelerate economic growth, eliminate hunger, reduce poverty, and improve food security. CAADP is a voluntary program placing agriculture at the center of the development agenda (MSI, 2012). It has been instrumental in increasing investment (both government and donors) in the agricultural sector in the countries with signed compacts.

Because the GoR had begun a rigorous process of strategic planning for long term development, Rwanda's goals and objectives were consistent with the four pillars of CAADP: Land and Water Management, Market Access, Food Supply and Hunger, and Agricultural Research.

The EDPRS is the operational strategy in the agricultural sector which led to the Strategic Program for the Transformation of Agriculture in Rwanda (PSTA). The PSTA concentrated on the commercialization of agriculture and the PSTA II concentrated on the intensification of agriculture. According to the World Bank, the PSTA II achieved 90% of the defined objectives. Those that were not achieved included:

- Inadequate quantities of maize and wheat seeds produced nationally, requiring importation.
- Poor quality of domestically produced seed.
- Poor seed sanitation and the prevalence of crop pests and diseases.
- Poor germination of seeds distributed under the CIP.
- Limited effective distribution of seed.

The PSTA II expired in 2014 and the GoR began stakeholder discussions to develop a new plan which will essentially encompass the PSTA III. The PSTA III has two main objectives; to

intensify, commercialize, and transform the Rwandan agriculture sector to enhance food security and nutrition, reduce poverty, and drive economic growth, and secondly to accelerate sustainable increases and an expanded private sector role in production, processing, and value-addition and commercialization of staple crops, export commodities, and livestock products.

To achieve these objectives, there are four key programs:

- Agriculture and animal resource intensification.
- Research, technology transfer and organization of farmers.
- Private sector-driven value chain development and expanded investments.
- Institutional results-focused development and agricultural crosscutting issues.

1.3 DOMINANT SEED SYSTEMS IN RWANDA

SEED SYSTEMS OVERVIEW

There are four identified dominant seed systems in Rwanda, as highlighted in Table 5, which include farmer-saved, public-private, public, and private. The farmer-saved and public seed systems represent the majority of seed volume. Farmer saved seed dominates the informal sector while public-private and private systems represent the majority of EGS volume.

Table 5: **Dominant seed systems in Rwanda.**

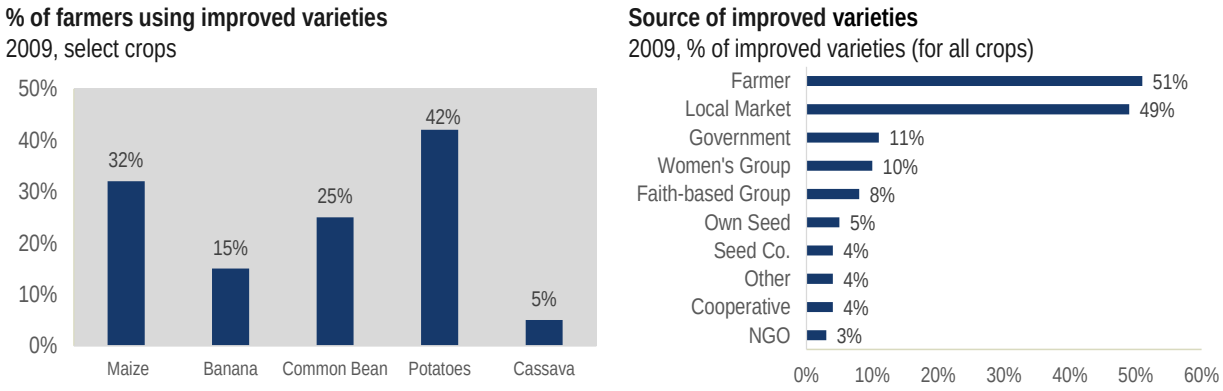
Seed Systems	Farmer-saved	Public – Private	Public	Private
Type of Crops	Local food crops	Food and cash crops	Major food and cash crops	High-value crops
Crops	• Common bean • Potato • Maize (OPV) • Banana • Sweet potato • Cassava	• Maize (OPV) • Potato • Common bean	• Maize (OPV) • Potato • Soybean • Wheat • Rice • Common bean • Cassava	• Maize (hybrid) • Soybean • Vegetable
Types of Varieties	Local and improved	Improved	Improved	Improved and hybrids
Quality Assurance System	Farmer-selected	Farmer-selected, certified emerging through private seed producers	Certified	Certified
Seed Distribution	Farmer-saved, farmer to farmer exchanges (trading, selling)	Local private seed companies, agro-dealers, farmer groups, cooperatives	Agro-dealers and NGOs	Regional private seed companies, NGOs, agro-dealers

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

Adoption of improved varieties is low across Rwanda. As depicted in Figure 15, a 2009 Agra Baseline Study Survey estimated that adoption of improved varieties in Rwanda is only 7-13%. While improved variety adoption has likely increased since the 2009 study, adoption continues

to be low across all crops in Rwanda, with the exception of hybrid maize. Informal seed systems dominate most crop value chains because in many cases the formal systems cannot meet demand, often because the formal system is under-resourced and Rwanda lacks a strong private seed sector to supplement or (where appropriate) replace public sector activities. As a result, farmers predominantly rely on saved seed and informal farmer-to-farmer exchanges.

Figure 15: Farmer use and source of improved varieties.[2]



Source: Alliance for a Green Revolution (AGRA) (2010).

1.4 KEY ACTORS IN THE SEED SYSTEM

PUBLIC SECTOR OVERVIEW

Ministry of Agriculture (MINAGRI)

MINAGRI's mission is to initiate, develop, and manage programs to transform and modernize agriculture and livestock to ensure food security and to contribute to the national economy. One Ministry organization, RAB, is at the center of the Rwanda seed sector. RALICS is the Ministry department responsible for protecting the health of Rwanda crops and livestock from foreign diseases and pests.

Rwanda Development Board (RDB)

RDB is an independent body that was formed in 2008 with the mission of accelerating economic development in Rwanda by enabling private sector growth. Key agencies responsible for business registration, investment promotion, environmental clearances, privatization, and priority sectors are represented in the RDB, which reports directly to the President and is guided by a Board that includes all key Ministers (e.g., finance, commerce, infrastructure, agriculture). RDB's scope of work includes all aspects related to the development of the private sector, which includes addressing the needs of large and small companies, and both local and foreign investors (RDB official website).

Rwanda Agriculture Board (RAB)

[2] Source of improved varieties percentage does not add up to 100% because the question was based on the number of farmers that accessed improved varieties from a specific source which could include multiple sources for a farmer.

RAB is an autonomous body whose mission is leading agriculture sector development into a knowledge-based; technology-driven, and market-oriented industry, using modern methods in crop, animal, fisheries, forestry, and soil and water management in food, fiber, and fuel wood production and processing.

RAB was formed in 2011 from three agriculture agencies, namely the Rwanda Animal Resources Development Authority, the Rwanda Agricultural Development Authority, and the Rwanda Agriculture Research Institute more commonly known by its French acronym, ISAR.

RAB is organized in five departments, two of which are focused on seed-related activities: (1) Research and (2) Crop Production and Food Security, which house crop breeding and extension, respectively.

Within RAB's Research department, the research directorate is responsible for overall coordination of countrywide agricultural research activities and for driving science-based technology generation for sustainable agriculture development. Crop research is conducted through commodity programs which cover Rwanda's key food and cash crops. Development and improvement of crop varieties is coordinated with Rwanda's CIP, with research being carried out on the development of improved varieties for crops including common bean, rice, wheat, maize, cassava, banana, Irish potato, and sweet potato.

Within RAB's Crop Production and Food Security department, the production of basic seed for priority food crops is the responsibility of the seed production unit. In addition, the seed certification unit - with 11 field inspectors and a seed laboratory with four employees - operates as a service that charges a small user's fee to issue certificates. This unit is only responsible for certified seed and has no oversight or responsibility for breeder or basic seed quality or standards.

Rwanda Agriculture and Livestock Inspection and Certification Service (RALICS)

RALICS enforces the Rwanda plant health law and related phytosanitary requirements for seed import and export. The department is responsible for activities that impact seed trade in several ways, including acting to enhance safe trade by limiting the introduction and spread of new pests; improving the quality of agricultural products for export; and resolving trade issues related to plant health. RALICS oversees plant pest and plant disease monitoring, surveillance, and diagnosis; pest risk analysis; inspections; and issuance of import and export certifications.

PROGRAMS AND NGOS

One Acre Fund (Tubura)

One Acre Fund is a non-profit organization that supplies smallholder farmers in East Africa with asset-based financing and agriculture training services to reduce hunger and poverty. The NGO began operations in Kenya in 2006 and entered Rwanda in 2007, with its African operations headquartered in Kigali, Rwanda. In addition, the organization works with farmers in Burundi, Tanzania, and Malawi. In Rwanda, the NGO is also known as "Tubura," a Kinyarwanda word which roughly translates to "multiply" or "multiplying."

Using a market-based approach, One Acre Fund facilitates activities and transactions at various levels of the farming value chain, including seed sourcing and market support. In 2014, farmers

who worked with One Acre Fund realized a 201% return on their investment and significantly increased farm income on every planted acre. The organization works with over 100,000 Rwandan farmers and has increased annual incomes by an average of $135.

Consultative Group on International Agricultural Research (CGIAR)

HarvestPlus is part of the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), which helps realize the potential of agricultural development to deliver gender-equitable health and nutritional benefits to the poor. The HarvestPlus mission is to improve nutrition and public health by developing and promoting biofortified food crops that are rich in vitamins and minerals and providing global leadership on biofortification evidence and technology.

HarvestPlus supports RAB in breeding, testing, and release of iron bean varieties developed in partnership with the International Center for Tropical Agriculture (CIAT). The organization works with private farmers, cooperatives, and nongovernmental partners to produce and multiply certified seed of released varieties for delivery to farmers.

HarvestPlus and its partners work in 25 districts of Rwanda to promote the availability, adoption, and consumption of biofortified bean. The goal is that more than one million Rwanda farming households will be growing biofortified bean by 2018.

In addition to HarvestPlus the International Potato Center is actively engaged in Rwanda in both Irish potato and sweet potato while the International Maize and Wheat Improvement Center is actively engaged in Rwanda in maize.

Access to Finance Rwanda (AFR)

AFR is a not-for-profit company founded in 2010 by the governments of the United Kingdom and Sweden and is currently funded by The Department for International Development, the government of Sweden, The MasterCard Foundation, and the KFW development bank of Germany. AFR's overall goal is to develop sustainable improvements in the livelihoods of poor people through reduced vulnerability to shocks, increased incomes, and employment creation promoting the development of increased access to financial services in Rwanda (AFR official website). AFR has five strategic priorities which include:

1. **Strengthening SACCOs**: AFR provides technical and financial assistance to Umurenge-SACCOs to develop management systems, automate operations, and develop services and products that meet the needs of rural people – particularly those engaged in agriculture. AFR leverages the potential of e-payments to reach customers and facilitate linkages with saving groups, commercial banks and MFIs.
2. **Smallholder farming**: AFR works with institutions and agents in the maize, coffee, tea, dairy, and Irish potato value chains to identify financial needs, facilitate engagement with financial service providers, and increase access to services.
3. **Promoting risk mitigation**: AFR promotes initiatives to increase the use of savings, pension, and insurance products by low-income people – especially women. This includes supporting the development of informal pensions and micro insurance products that could be delivered by Umurenge-SACCOs in association with specialized providers.
4. **Innovation**: AFR supports product development and demonstration with a focus on digitized financial services. AFR develops and implements market-driven projects that are unique,

innovative, and likely to result in high-impact, sustainable, and mass outreach. AFR invests in innovative ideas which are linked to satisfying a specific demand and to have the potential to dramatically increase financial inclusion.

5. **Knowledge sharing**: AFR promotes learning from AFR supported interventions and other interventions in the financial sector through improved coordination and dissemination nationally with the aim of promoting dialogue, learning and cooperation between stakeholders. AFR commissions market research and analyses, focusing on regulatory and market barriers to the uptake of financial services by low-income groups with a specific focus on women and youth.

PRIVATE SECTOR OVERVIEW

Private seed companies

The private sector, which remains underdeveloped, consists of both regional seed companies mainly focused on hybrid maize and a small number local seed companies that are more focused on OPV maize and legumes. Table 6 highlights the private seed companies active in Rwanda. Regional private seed producers face uncertain regulatory import and export policies, no government support for local hybrid production, and no intellectual property protection. Local private seed producers, on the other hand, face different problems which include lack of business and technical expertise and lack of land to maintain required isolation for seed production, which results in a high proportion of fields failing to meet certification requirements.

Table 6: **List of key private seed companies.**

Select private seed companies in Rwanda

Company	Origin Country	Regist-ration	Crop Seed Portfolio	Key Varieties
Kenya Seed Company Rwanda	Kenya	Yes	Hybrid maize, wheat, pasture, sunflower, sorghum, vegetables	• Maize: H628, H629, DH 04 • Wheat: KS Mwama
SEEDCO Rwanda	Zambia	Yes	Hybrid maize, soybean	• Maize: SC719, SC637, SC513, SC 403 Soybean: Sequire, Sequel
PANNAR	South Africa	No	Hybrid maize	• Maize: 691, 4M21, 53, 67, 628
Win Win	Rwanda	Yes	OPV maize, soybean, common bean	• Maize: ZM 607, M 101, M 103 • Common bean: bio-fortified bush and climbing
RESCO	Rwanda	Yes	OPV maize, common bean	• Maize: ZM 607, M 101, M 103 • Common bean: bio-fortified bush and climbing

Source: Research team analysis (2016).

Cooperatives and farmer groups

According to USAID, 2,400 agricultural cooperatives were registered in Rwanda in 2013. During this study, field interviews were conducted with representatives from approximately 20 seed production cooperatives from the North, East, and South provinces. These cooperatives appeared to be organized along traditional cooperative lines with members working together to produce certified seed of several crops.

The Belgium Technology Corporation (BTC), a long-time donor and partner of the Rwandan government, created a Seed Producer Training Program which was operated by RAB. The program was modelled on the approaches used in the Farmer Field School (FFS) which

provided farmers interested in seed production with training and mentoring in the production of wheat, rice, common bean, soybean, potato, cassava and OPV maize. In addition to basic seed production skills, the school introduced farmers to the concept of quality assurance. The program trained 653 private seed producer groups and was considered a successful, scalable program to train seed producers.

Agro-dealers

There are more than 1,000 agro-dealers active in Rwanda, delivering seed, fertilizer, and other agricultural products to farmers. Agro-dealers are an important link in the seed supply chain and provide Rwandan farmers with local access to agricultural inputs.

NATIONAL SEED SYSTEM STRATEGY

Within Rwanda's PSTA III are seven seed-specific focus areas, as well as specific seed-related activities for the selected priority crops. These focus areas include:

1. Increased public sector research and production of breeder, pre-basic, and basic seed.
2. Improved support for private seed multipliers through the provision of technical and business skills training and facilitated links to ensure access to inputs.
3. Reinforced internal and external quality control procedures and sensitization delivered on the importance of quality seed.
4. Revision and implementation of the national legislative framework for seed.
5. Expansion of the National Gene Bank.
6. Implementation of initiatives to encourage farmer demand, through demonstration plots and training.
7. Facilitation of improved links between farmers, small traders, and agro-dealers
8. Facilitation of seed imports and planting material.

Additionally, as shown in Table 7, there are specific seed activities within the prioritized crop value chains (within the PSTA strategy) of common bean, banana, maize, potato, soybean, wheat, and rice.

Table 7: **Seed-specific activities for government prioritized crops in PSTA III.**

Prioritized Crops*	Seed-specific Activities
Common Bean	• Continue and **strengthen R&D to introduce new common bean varieties** for each agroecological zone with **higher levels of micronutrients and iron**
Banana	• Provide better planting materials to banana growers
Maize	• Diffusion of **high-yielding**, **rapidly maturing hybrids**
Potato	• Capacity building of **seed multipliers in technical and business skills** • **Increase the number** of seed multipliers and seed dealers • Facilitate the involvement of **seed dealers / companies** in seed post-harvest operations, conditioning, and marketing • New construction and rehabilitation of **public** and **private aeroponic** screen houses, increased production of **in-vitro plants** • R&D of new varieties more **resistant to disease**
Soybean	• Strengthen R&D to introduce high-yielding and disease-resistant varieties • Promote soybean as a CIP crop – distribution of seeds
Wheat	• Improve and strengthen research into high-quality wheat
Rice	• Increase availability of high-yielding varieties

**PSTA III priority crop value chains classified as principle staple crops and value chains in which interventions are needed to remove critical bottlenecks in the chains*

Source: PSTA III (2013).

CHAPTER 2: CURRENT SITUATION – PRIORITY CROPS FOR EGS STUDY

2.1 SELECTING CROPS TO BE STUDIED

The selected crops for in-depth EGS system analysis were identified during a consultative process with BFS and USAID Rwanda. To support this endeavor, USAID Rwanda engaged key Rwandan stakeholders to provide input into the crops to be selected for the study. As Table 8 depicts, the field research team developed a matrix of key indicators crossed with ratings definitions as the basis for discussions. These indicators created a framework to select crops that would have the largest impact on smallholder farmers and specifically women. The field research team first identified the top ten crops by area and rated them based on current production and their ten-year historical compound annual growth rate (CAGR) to illuminate the potential growth prospects for the crop. The team then performed desk research to categorize the importance of the crop with respect to food security based on how many households grow the top crops and the percent of production used for household consumption. Next, the team assessed the importance of the crop to females based on participation in production as well as the importance of the crop to the government of Rwanda based on the review of the government's agricultural strategy. Smallholder farmers are not included in key indicators because all crops are considered smallholder farmer crops in Rwanda, given that 80% of farmers in Rwanda have less than 1 Ha and 94% have less than 2 Ha. Finally, the team consulted with BFS and USAID Rwanda to prioritize the crops for this EGS study based on selecting the crops that rate highest on these indicators and aligned with USAID's preference for focus crops, and input provided to USAID Rwanda from key stakeholders.

To ensure that the EGS study encompassed both the formal and informal seed systems as well as the broader crop value chain, the field research team targeted a comprehensive set of stakeholders to be interviewed. Nearly forty stakeholders were interviewed representing public, private, and donor actors. Public sector interviews included government officials from MINAGRI, breeders from RAB, and certification and inspection personnel, as well as Rwanda representatives from CGIARs. Private sector interviews included local and regional seed companies, agro-processors, and seed growers from keys regions in Rwanda. Twelve farmers were interviewed representing several farmer groups and cooperatives who play a critical role in seed production and distribution in the formal and informal seed sectors. The field team also conducted interviews with development groups and NGOs working specifically with seed growers, private seed companies, agro-dealers, smallholder farmers (specifically women), and MFIs.

Table 8: **Crop selection framework.**

KEY INDICATORS	RATINGS DEFINITIONS				
AREA	Largest crop area	Second and third largest crop area	Fourth and fifth largest crop area	Sixth and seventh largest crop area	Eighth, ninth, and tenth largest crop area
PRODUCTION		Second and third largest production volume	Fourth and fifth largest production volume	Sixth and seventh largest production volume	Eighth, ninth and tenth, etc. largest production volume
PRODUCTION GROWTH	>20% 10-year CAGR	10%-20% 10-year CAGR	5%-9.9% 10-year CAGR	0%-4.9% 10-year CAGR	<0% 10-year CAGR
FOOD SECURITY FOCUS	Grown by >70% of households, >70% consumed on-farm	Grown by >60% of households, >60% consumed on-farm	Grown by >50% of households, >50% consumed on-farm	Grown by >40% of households, >40% consumed on-farm	Grown by <40% of households, <40% consumed on-farm
GOVERNMENT STRATEGIC PRIORITY	Priority seed system and crop		Priority crop		No priority
KEY STAKEHOLDER PRIORITY	Priority seed system and crop		Priority crop		No priority
GENDER ROLES	Primarily grown by females		Grown by females and males		Primarily grown by males

CAGR: Compound Annual Growth Rate

Source: Research team analysis (2016).

2.2 SELECTED CROPS

As a result of this process (details of which are highlighted in Table 9), the field research team selected three crops for the analysis: potato, common bean, and maize. Below is a summary of the key reasons why each crop was selected for this EGS systems study.

Potato

- **Unmet EGS demand**: There is a significant unmet demand for EGS in potato for two key reasons. First, due to the high levels of disease pressure, farmers need to access clean seed regularly to ensure their fields do not become infected with disease. Second, there is a significant gap between yield potential in Rwanda's highly fertile potato growing regions and the yield farmers are actually achieving. While there are many factors that prevent farmers from increasing yields including poor agronomic practices and limited access to fertilizer, a lack of high-yielding improved varieties in the market is a critical issue constraining farmers from optimizing potato yields.
- **Export opportunity**: While Rwandan imports and exports are generally balanced, there's a significant opportunity to at least double potato exports, with price premiums to high-quality market segments such as the urban demand for crisps in Uganda and Tanzania (USAID-Enabling Agricultural Trade Project, 2013). While there are many value chain related factors such as storage limitations constraining exports, limited

access to improved high-quality EGS is a critical constraint to realizing actual export gains.

Common bean

- **Nutrition**: The critical issue of nutritional deficiency in Rwanda has led to the focus on development and dissemination of biofortified common bean varieties in Rwanda, led by HarvestPlus. However, these high-iron, improved varieties have reached farmers in limited scale. Developing a successful EGS system is critical to improving the health of Rwanda's population and achieving HarvestPlus' goal of more than one million Rwanda farming households growing iron beans by 2018.
- **Export demand**: While Rwanda is a net exporter of common bean through informal trade to the DRC and Uganda, there is a significant opportunity to grow beans for export if smallholder farmers were able to increase productivity. Disseminating higher yielding improved varieties through a functioning EGS system is an important part of increasing productivity.
- **Increase smallholder farm family income and food security**: Increased productivity driven by improved varieties also presents an opportunity for smallholder farmers to allocate less of their land to grow the same amount of common bean, providing farmers the opportunity to use the freed up land to grow higher value crops that can in turn improve their economic security.

Maize

- **Import competition:** As a net importer of maize, Rwanda cannot currently serve its growing demand for maize through local production without an increase in productivity. Continuing adoption of higher yielding hybrid maize is critical to increasing maize yields of smallholder farmers.
- **Government priority:** The government has a clear focus on increasing the adoption of hybrid maize and is advocating for private seed companies to produce hybrid seed in Rwanda, which has significant implications for how RAB allocates EGS resources in a highly resource constrained environment.

Subsequent chapters in this study will focus on the three selected crops.

Table 9: **Priority crop selection results in Rwanda.[3]**

KEY INDICATORS / TOP CROPS BY AREA	AREA	PRODUCTION	PRODUCTION GROWTH	FOOD SECURITY FOCUS	GOVERNMENT STRATEGIC PRIORITY	KEY STAKE-HOLDER PRIORITY	GENDER ROLES	Comments
COMMON BEAN	●	◔	◑	●	◑	◕	●	Critical nutrition, food, and economic security crop grown >90% of households
BANANA	◕	●	◔	●	●	○	◔	Key food security crop, limited private sector interest
MAIZE	◕	◑	●	◑	●	●	◕	Government priority to increase yields and reduce reliance on imports
CASSAVA	◑	◕	◕	◕	●	●	●	Priority for food security led by public sector
IRISH POTATO	◑	◕	◑	◑	●	●	◑	Key government target for seed system improvement; significant private sector interest
SWEET POTATO	◔	◕	◔	◑	○	◔	◕	NGO-led initiatives underway but low priority to government of Rwanda
SORGHUM	◔	◔	○	○	○	○	◑	Minor crop area
PEA	○	○	◔	○	○	○	◑	Minor crop area
SOYBEAN	○	○	◔	○	◑	◑	◑	Government priority arising from donor initiatives but still small area
WHEAT	○	○	◕	○	●	◔	◑	High growth potential and government focus, but minor crop area to date

Low ○ ◔ ◑ ◕ ● High

Source: Research team analysis based on consultation with key stakeholders (2016).

[3] While desk research (World Bank 2015) identified specific distinctions in gender roles by crop, the field team (as stated in earlier sections) found that gender roles seemed to be more equal in practice. As such, the priority crop selection analysis specific to gender is a combination of both desk research and field interviews.

CHAPTER 3: CURRENT SITUATION – EARLY GENERATION SEED SYSTEMS

3.1 EARLY GENERATION SEED SYSTEMS

The Rwandan early generation seed EGS system falls under the responsibility and control of RAB. The breeding and variety development staff, housed in the RAB Research department, is responsible for producing breeder and pre-basic seed. Basic seed is produced by the RAB seed production unit which is responsible for producing basic seed of seven crops: common bean, potato, maize, wheat, soybean, rice, and cassava. The unit has four full-time employees and works with the RAB station managers at eight locations who have responsibility for on-station seed production activities. Each station has one employee with responsibility for seed production, reporting to the local station manager.

3.2 POTATO

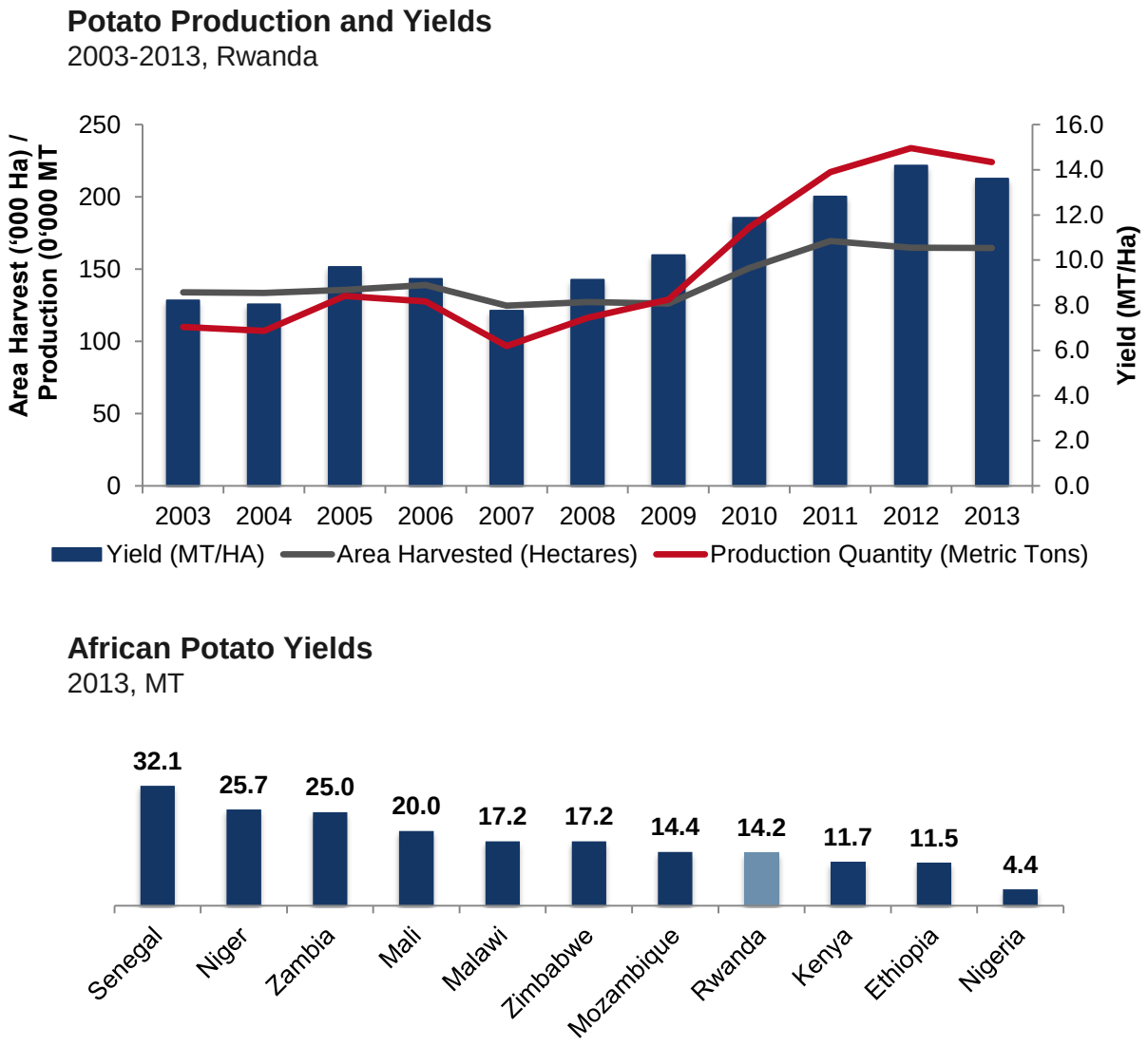
SUPPLY

Rwanda is the largest producer of potato (*Solanum tuberosum*) in the East African Community, and third-largest in Sub-Saharan Africa. Potato is an important staple food in Rwanda. The rich volcanic soils and high altitude present favorable growing conditions in the North and West provinces where the majority of potato production occurs. Almost all of potato production is for local consumption, with minimal exports.

Although potato is a priority crop under Rwanda's CIP, production improvement has been limited and yield levels are low relative to other countries in Africa (Figure 16). However, potato yields have increased in the past ten years likely as a result of improved fertilization both in terms of types used and quantities applied. Yields vary by province, with some yields reaching up to 20 MT/Ha in the North. Key factors limiting potato yields:

- Late Blight: Is a fungal disease caused by *Phytophthora infestans* and the cool wet conditions combined with poor agronomic practices (poor crop hygiene, reduced rotation periods, planting infected seed because of limited clean planting material) can result in up to 100% crop loss.
- Suboptimal use of fertilizer: Recommended use for optimal yields for nitrogen (N): 150-210 Kg/Ha, phosphorus (P): 250 Kg/Ha, and potassium (K): 360 Kg/Ha, average use of NPK in Rwanda ~12 Kg/Ha for each nutrient element.
- Lack of storage and processing: Leading to price volatility and subsequent early harvesting to take advantage of high prices.

Figure 16: **Potato area, production, and yield.**



Source: Rwanda Country Stat (viewed in February 2016), FAO Stat (viewed in February 2016).

As shown in Figure 17, potato is grown on a commercial basis in North and West provinces, where 90% of national production is concentrated (Figure 3.2).

Figure 17: **Potato production by province, 2011.**

Potato Production
By province, 2011

- 800K+ tons
- 400-800K tons
- 100-400K tons
- <100K tons

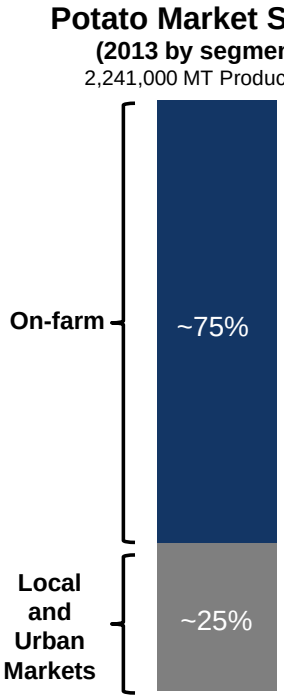
	NORTH & WEST	SOUTH, EAST, & KIGALI
Share of Potato Production	**~90%**	**~10%**
Average yields	17-18 MT/Ha	3-5 MT/Ha
Farmer varietal needs	• Short seed dormancy, short vegetative cycle, late blight resistance, bacterial wilt tolerance, large tubers, short cooking times, marketability	• Bacterial wilt tolerance, high yields on acidic soil

Source: MINAGRI (2011) sourced from Japanese Ministry (2012), World Bank (2015), USAID (2002).

DEMAND

The majority of potato is sold in rural and urban markets across Rwanda, as can be observed in Figure 18's illustration of potato demand segments. The industrial processing sector is nascent, with only one processor identified currently processing small volumes. While there appears to be demand from neighboring countries, exports are minimal, representing less than 1% of total production. Consumers are willing to pay differentially for varieties that have desirable features (e.g., size, boiling quality, etc.).

Figure 18: **Comparison of potato demand segments.**

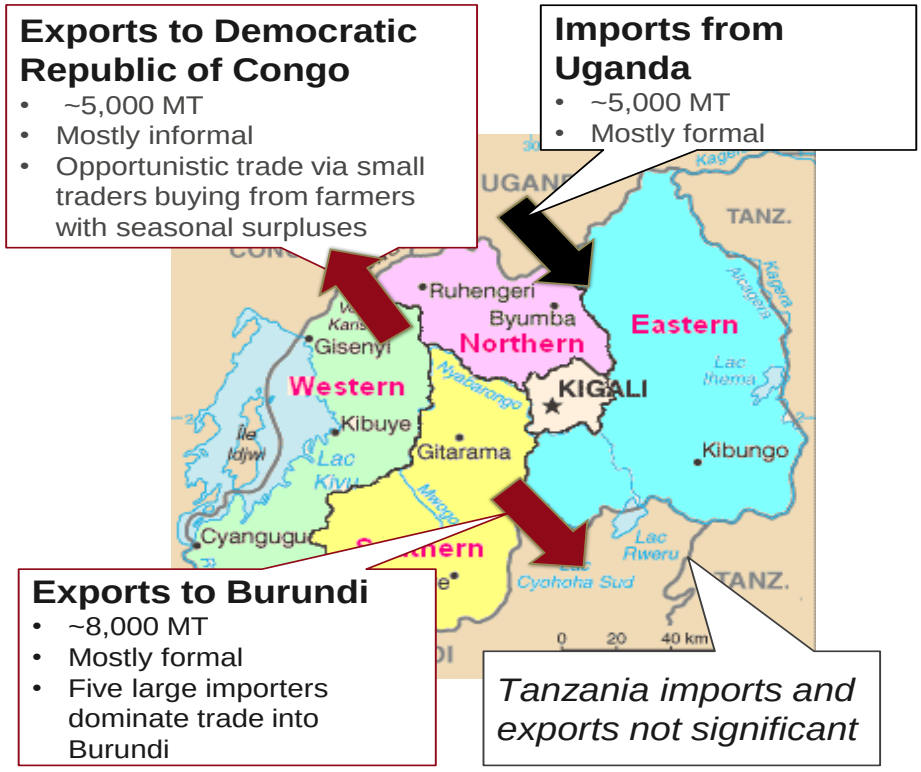


	Segment Description	Segment Needs
On-farm consum.	• Including on-farm consumption and seed production	• Cooking quality for boiled potato demands "floury" characteristics over "watery"
Local markets	• Traders buy tubers from growers and either transport to local markets in lower production provinces in South and East or urban markets in Kigali • Two informal wholesale markets in Nyabugo (sourced from Northwest and serving the East) and Giticyinyoni (serving urban markets) • One central market in Kigali that feeds retail markets in urban areas	• Urban consumers prefer large tubers and modest eye size for crisps, storability, long seed dormancy, high dry matter content, red or pink skin, oblong tuber shape • Currently no grades but small price premiums for larger tubers
Industrial Processing ***<1%***	• *One small chip processor currently operating in Rwanda (Holland Fire Food) with capacity of ~50 MT/yr, looking to grow to 3,000-4,000 MT/yr*	• *Currently processing Kinigi, the most popular potato variety in Rwanda*
Exports ***<1%***	• *Net exports (formal and informal) are minor, however significant opportunity exists to increase exports to Uganda, Tanzania, and Burundi if production increased*	• *Uganda and Tanzania urban demand for crisps and chips growing rapidly*

Source: Rwanda Country Stat (viewed in February 2016), USAID (2002), expert analysis (2016).

Rwanda trade is generally balanced with a slight weighting toward being a net exporter, as shown in Figure 19. Trade with Uganda and Burundi is mainly through formal channels, while exports to the DRC are mainly through informal channels. Formal trade to Burundi is organized by five large traders who use assemblers and agents to collect potatoes which are then transported in 20 MT trucks. Informal export to the DRC is conducted opportunistically based on smallholder farmers located near the border due to the bulkiness of potatoes which limits the volumes that can be sold informally. Experts suggest that Rwandan potatoes can be produced at a price that is competitive in neighboring counties (USAID-Enabling Agricultural Trade Project, 2013). The two key factors limiting increased exports are lack of storage which means production spoils and early harvesting to capture price spikes which leads to lower yields. With improved storage and higher yielding varieties, there's a significant opportunity to at least double potato exports, with price premiums being paid, e.g. the urban demand for crisps in Uganda and Tanzania. This will only be achieved by developing efficient trade networks with Uganda and Tanzania by utilizing the significant hauling capacity that is currently returning empty from Kampala and Mwanza (USAID-Enabling Agricultural Trade Project, 2013).

Figure 19: **Potato imports and exports (2013).**



Source: USAID (2013).

IMPROVED VARIETIES

There are 12 disseminated varieties in Rwanda, all developed by RAB and CIP. A list of the varieties available in Rwanda along with some information about each is presented in Table 10. All of the currently available varieties were released in the 1980s and 1990s. During field interviews it was learned that RAB plans on releasing 16 new, improved varieties in the near future. Farmers are knowledgeable about the characteristics they require in a variety and the characteristics of the varieties on the market. Currently there is limited downstream demand from processors, but interviews suggest there is an emerging opportunity, requiring coordination of the R&D and private processor communities, to develop the right varieties for downstream demand.

Table 10: Key potato varieties.

Key potato varieties
Listed in order of popularity

Variety Name	Developer	Year of Release	Varietal Strengths	Varietal Weaknesses
Kinigi	RAB/CIP	1983	Yield, dry matter content, marketability, late blight tolerance, tuber size, round shape	Bacterial wilt susceptible
Sangema	RAB/CIP	1980	Tuber size, floury, boiling cooking quality, oblong shape	
Kirundo	RAB/CIP	1983	Yield, dry matter content, marketability, late blight tolerance, tuber size, round shape	Bacterial wilt susceptible
Mahondo	RAB/CIP	1989	Yield, dry matter content, marketability, late blight tolerance, tuber size, round shape	Bacterial wilt susceptible
Gikungu	RAB/CIP	1992		
Victoria	RAB/CIP	1989	Yield, tuber size, round shape, early maturity	Disease susceptible, low dry matter content
Kigega	RAB/CIP	1992		
Mizero	RAB/CIP	1992		
Ngunda	RAB/CIP	1992		
Nderera	RAB/CIP	1992		
Kuruseke	RAB/CIP			
Cruza	RAB/CIP	1985	Yield, disease tolerance, acidic soil tolerance	Low dry matter content, small-medium tuber size, late maturity

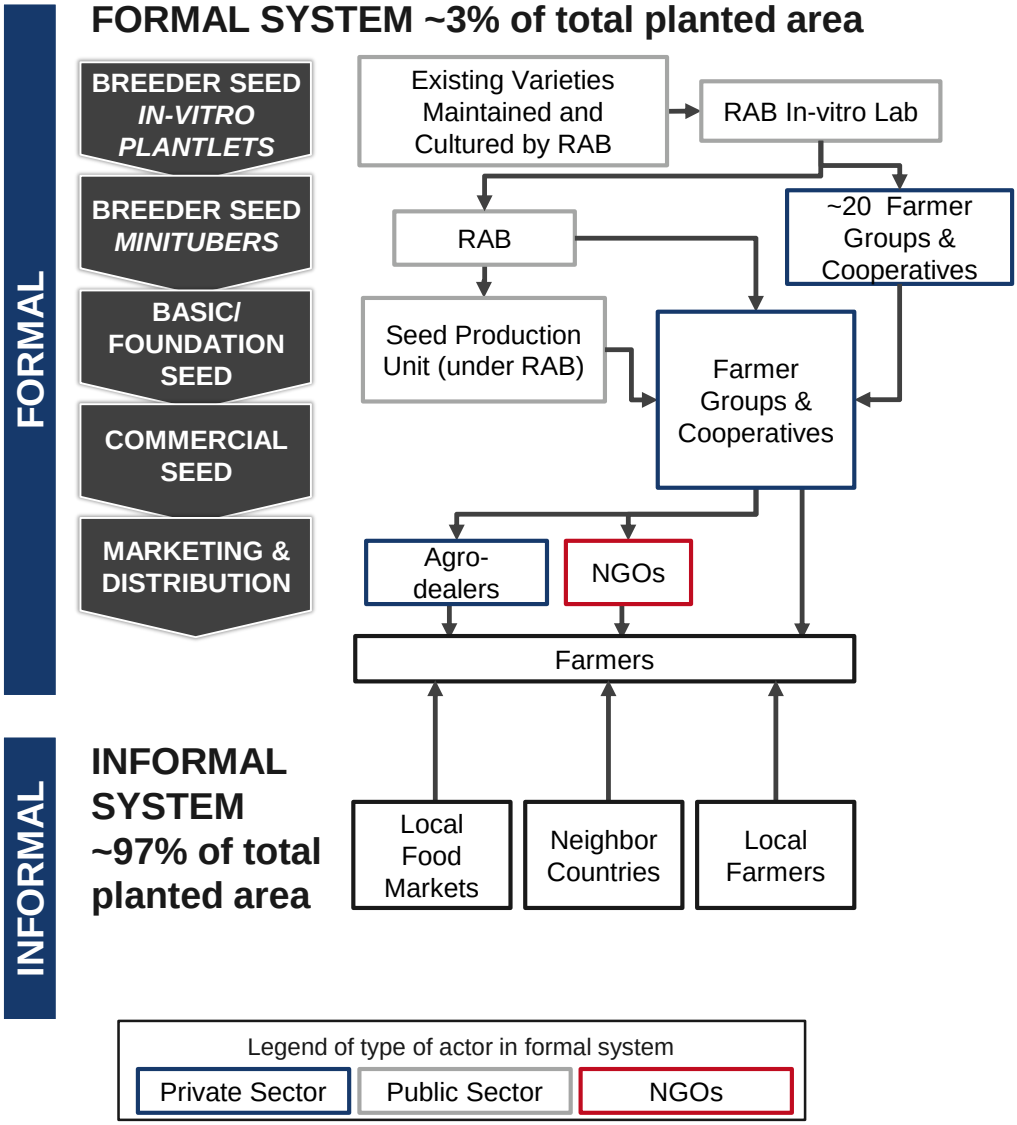
**Table partially completed due to lack of data*

Source: Field research team interviews (2016).

STRUCTURE OF EGS VALUE CHAIN

It is estimated that only 3% of the potato planted area is provisioned by the formal seed system, while 97% of potato area is planted with seed sourced by farmers through informal means, as shown in Figure 20. However, current EGS demand is estimated to be three times that of supply due to several supply capacity bottlenecks that will be further explained in the following section. The formal system is public sector driven, but there is private sector participation, specifically from farmer groups and cooperatives.

Figure 20: **Structure of potato seed system.**



Source: Expert analysis (2016).

FORMAL SYSTEM

RAB evaluates and selects potato varieties from public germplasm, much of it originating from CIP, and releases varieties for use. The potato program is part of the RAB Research department which is also responsible for maintaining varieties and producing breeder seed.

Production of breeder seed involves two distinct steps: producing *in vitro* plantlets from the mother plants maintained by RAB and production of mini-tubers from *in vitro* plantlets. RAB is currently the primary source of *in vitro* plantlets, and is attempting to expand production through a collaborative agreement with a local university. There are also a small number of private tissue culture labs entering the market.

Unlike the other crops included in this study and in response to the high demand for quality potato seed, RAB involves private sector seed producers in the production of mini-tubers, pre-

basic seed, and basic seed. *In vitro* plantlets are used by RAB for mini-tuber production and sold to private mini-tuber producers. According to RAB, approximately 20 private producers are in engaged in mini-tuber production.

RAB produces approximately 20% of all basic seed, with the balance produced by private growers and cooperatives. Certified seed is then produced by farmer groups and cooperatives, with marketing and distribution led by farmer groups, cooperatives, agro-dealers, and NGOs.

INFORMAL SYSTEM

Because the formal system cannot meet the existing demand for EGS and certified seed, the informal market plays a large and important role in potato. The majority of seed from the informal system is sourced from production that is saved from the previous harvest which farmers then replant for the next season. However, due to high disease pressure, farmers cannot re-use their own seed indefinitely and must either replace it through purchasing seed from the formal system or, more often, from the other informal sources which include neighboring farmers, local food markets, and through cross-border trade with Uganda. When sourcing seed from neighbors, farmers will often observe neighbors who have had high yielding harvests from the previous season and opportunistically buy potatoes from that farmer if the farmer happens to have excess production to sell. Farmers selling potato to be used for seed vary by season based on performance of the previous season and availability of potato for sale and thus are generally not considered seed producers who will provide a reliable supply of high quality seed. Another informal source of seed for farmers is local markets where ware potatoes (potatoes sold for food consumption rather than specifically for seed) are marketed. Farmers typically prefer to buy smaller ware potatoes for seed purposes as the price of potatoes is calculated based on weight. In some cases, farmers will separate the smaller potatoes from their harvest and sell them as seed. Potato seed is also sourced through cross-border trade with Uganda for ware potatoes. A group of certified potato producers from the North province estimated that up to 15% of all potato seed came into Rwanda from Uganda as market tubers.

Although improved varieties are well known and highly prized in the market, there are local varieties of potato as well. No data was collected during this study to quantify the number or prevalence of local varieties compared to informal sources of known and officially released varieties.

KEY EGS SYSTEM BOTTLENECKS AND CONSTRAINTS

As mentioned previously, EGS potato demand is currently at least three times greater than supply due to supply bottlenecks that include:

Supply bottlenecks

- **Inadequate *in vitro* production capacity:** The RAB *in vitro* lab has a fixed capacity of 160,000 plantlets per year (two 80,000 cycles per year); RAB estimates that current demand is at least three-fold greater than the maximum supply that can be produced.

- **Low yields at all stages of seed potato production:** Disease pressure and lack of integration of more productive mini-tuber technologies (e.g., aeroponics[4]) are among the most important factors limiting current seed availability.
- **Insufficient working capital for EGS producers**: EGS potato producers are faced with a long period of cash outflow before any income is generated. Farmer groups and cooperatives producing mini-tubers, basic seed, and commercial seed do not have sufficient financing to fund production activities before getting paid. Although Rwanda has many SACCOs and MFIs well positioned to service EGS producers, these lenders have yet to develop specific products tailored to EGS producers that take into account the unique timelines of EGS potato production.
- **Limited availability of long term credit for EGS producers**: EGS potato seed production requires significant capital investment in infrastructure such as mini-tuber technologies and facilities. SACCOs and MFIs are not big enough to service loans of this size which requires larger financial institutions such as commercial banks. However, banks in Rwanda traditionally have not done much agricultural lending and as such, accessing loans with a competitive interest rate and in a timely manner are significant challenges.
- **Lack of storage for EGS and commercial seed**: Absence of storage requires just-in-time seed production, which significantly increases risk to seed producers. As a result, seed producers often use their harvest for on-farm consumption or to sell as ware potato when market prices are high.
- **Small farm sizes of EGS and commercial producers**: Small farm size exacerbates the problem of maintaining rotational requirements for seed producers. There has been progress in increasing farm sizes through a requirement that farmer's accessing inputs through CIP must also adopt land consolidation measures. While total area under consolidated land use has increased from 28,788 Ha in 2007 to 502,916 Ha in 2012, challenges remain for potato seed producers to further consolidate in order to ramp up EGS and commercial seed supply.

Demand constraints

- There are no significant constraints on demand for potato seed; the lack of new varieties with good disease resistance may limit total area in production but is not a particular constraint.
- If varieties selected for processing traits were available, total production might grow or processing types might displace some market production. There is, however, no specific data on the potential impact of processing potatoes, and the current potato processing industry is tiny and a non-factor in the larger potato production scheme.

[4] Aeroponics is a plant culture technique in which mechanically supported plant roots are either continuously or periodically misted with nutrient solution (Barak et al., 1996).

3.3 COMMON BEAN

SUPPLY

Common bean (*Phaseolus vulgaris)* is the most important crop in Rwanda in terms of national consumption, food security, geographical coverage, and the percentage of households producing it (92%). With 56% fiber and 25% protein content, common bean is an important nutritional complement to starchy cereal and tuber-based diets (World Bank, 2015).

Two types of common bean, bush and climbing, are grown in both Season A and Season B. Climbing types have higher yield potential and are well adapted to the cooler highland zones in the north and central regions. Bush types dominate in the lowland zones of the east and central regions, and occupy approximately 2/3 of the total bean area, as shown in Figure 21.

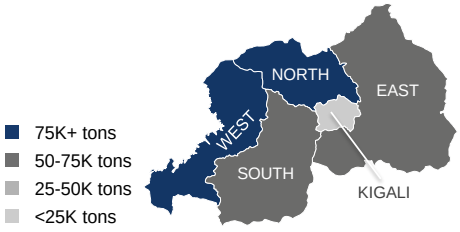
Farmers generally plant varietal mixtures, and their proportions are chosen to suit family preferences for taste and cooking quality and to minimize risk of crop loss. Common bean is often grown in multi-crop situations, e.g., in conjunction with maize, and only rarely as a single variety. Fields planted to a single variety are usually in response to market demand for certain characteristics such as color and size.

Figure 21: Common bean subsegments.

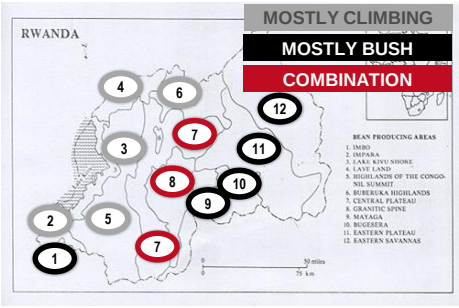
Common Bean Subsegments

	Bush Bean	Climbing Bean
		
Estimated Share of Total Bean Area	**~2/3**	**~1/3**
Yield Potential (Improved Varieties)	1.5-2.5 MT/Ha	3.0-5.0 MT/Ha
# of Improved Varieties Recently Released	7	17
Location	• Mostly grown in the **lowland** zones in **Central and East**	• **Northern Highlands** and parts of the **Central** midlands
Characteristics	• **Shorter maturity** and therefore **higher tolerance** to **limited rain** and **warmer weather**	• **Longer maturity**, **requiring wet** and **colder climates** as well as **fertile** environments • **Staking requirements limit area growth**

Common Bean Production
By province, 2011



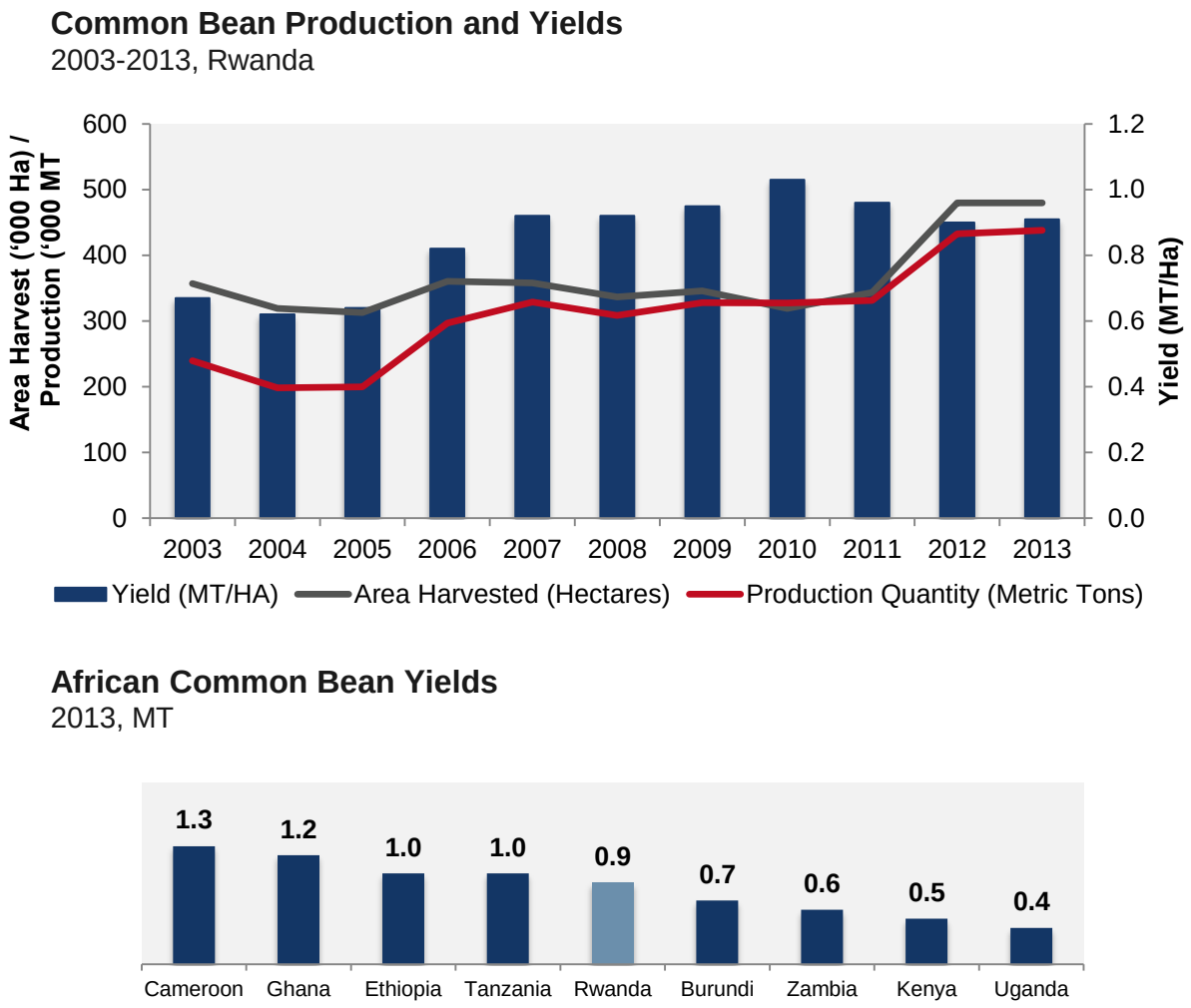
Common Bean Focus
By twelve agroclimatic zones



Source: Musoni (2012), MINAGRI (2011) sourced from Japanese Ministry (2012).

As seen in Figure 22, common bean production growth over the past ten years has been low, driven by modest area and yield increases. Since common bean is susceptible to moisture stress, particularly during flowering, pod initiation, and pod filling, drought during these critical periods will reduce yields, which occurred in 2004 in the East and South provinces.

Figure 22: Common bean area, production, and yield.



Source: Rwanda Country Stat (viewed in February 2016), USAID (2002), expert analysis (2016).

Common bean yields in Rwanda are comparable to average yields in Africa, as Figure 22 illustrates. Yields are primarily limited by low levels of fertilizer and low use of improved varieties due to financial constraints, as well as limited access to training in agronomic best practices.

Table 11 shows the significant gap between the yield potential of crops grown in optimal conditions of both bush and climbing beans and the yields obtained on farms. Closing the gap would have a significant impact on food security in Rwanda. Climbing types have much higher yield potential than bush types but are not well adapted to the warmer and dryer regions of the country. They are also more labor intensive and costly to produce than the bush type due to the need for poles to support the plant and the resulting crop.

***Table 11:* Comparison of yield potential and on-farm productivity of common bean types.**

Table 1. Productivity (kg/ha) of beans in Rwanda

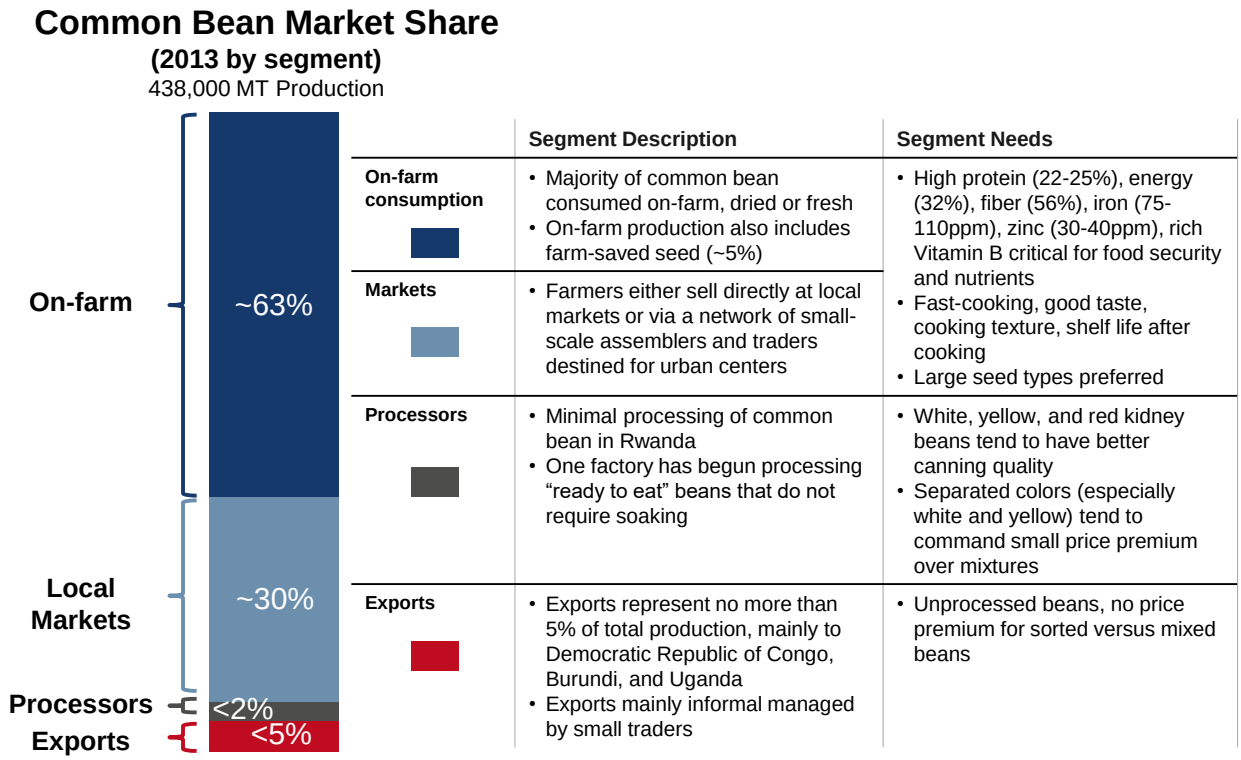
Type	Potential (kg/ha)	On farm (kg/ha)	Mean on-farm (kg/ha)
Bush	1,500 -2,000	700 – 800	800 – 1,000
Semi-climbing	2,000 – 2,500	800 – 900	
Climbing	3,000 – 5,000	1,500 – 3,000	

Source: Musoni (2012).

DEMAND

Common bean is the most important staple food crop in Rwanda and is primarily consumed on-farm. According to various estimates, on-farm consumption ranges from just over 60% (USAID-EAT, 2013) to as high as 88% (World Bank, 2015) with the balance going to local and urban markets and a very small proportion for commercial processing or exported, as illustrated in Figure 23. Although farmers have clear varietal preferences, they do not translate into a material price differential based on variety.

***Figure 23:* Comparison of common bean demand segments.**



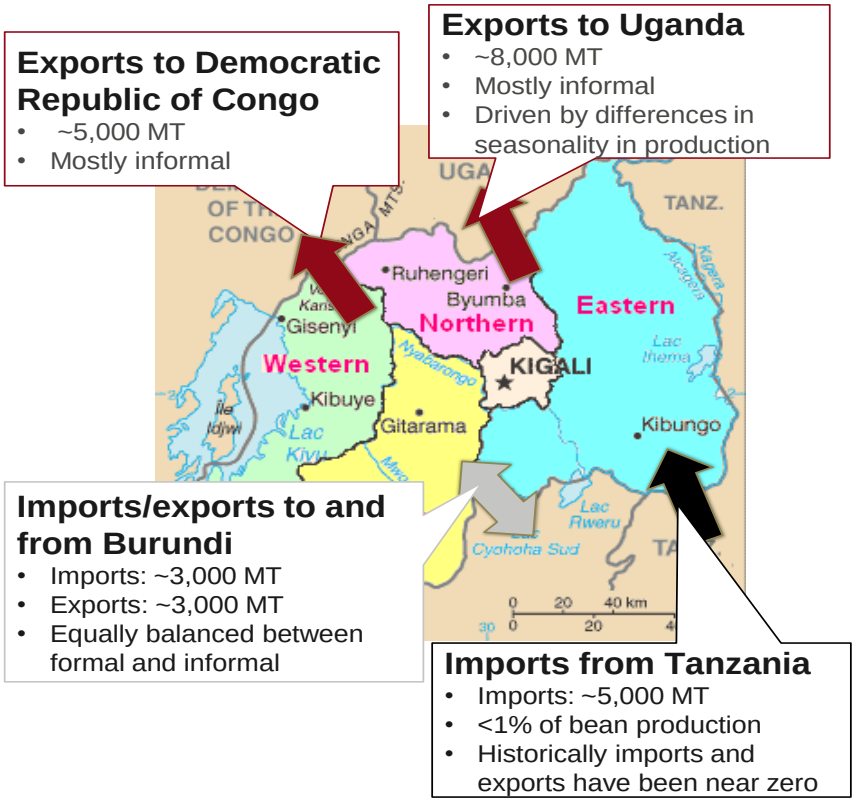
Source: Rwanda Country Stat (viewed in February 2016), Musoni (2012), USAID (2013), World Bank (2015), expert analysis (2016).

There is a very small formal processing industry led by Rwanda Agribusiness Processing Industries which prefers beans that have better canning quality, usually white, yellow, and red

kidney beans. Separated colors (especially white and yellow) tend to command premium prices over bean mixtures. Less than 5% of production is processed.

Rwanda is a net exporter of common bean, but common bean exports are not significant. Less than 10,000 MT were exported in 2012, which is less than 5% of total production, as Figure 24 shows. Traders typically carry small amounts of production on bicycles across borders, then small trucks transport common bean to market centers. Although East African Community duty-free arrangements provide no major advantage for informal trade beyond customs clearance charges and a refundable withholding tax, informal trade is the primary export channel for common bean. This is due to the fact that smallholder farmers are the main producers of common bean, and they opportunistically sell surplus crop, which varies by season. Furthermore, while Rwanda produces common beans at competitive prices, traders suggest it is costly to accumulate large volumes of common beans with consistent quality which limits the growth of formal trade. While there is no specific data on demand from countries in the region, experts suggest exports could double in the short term, with further increases in the long term if the Rwandan common bean yields increase (USAID-Enabling Agricultural Trade Project, 2013).

Figure 24: **Common bean imports and exports.**



Source: USAID (2013).

ADOPTION OF IMPROVED VARIETIES AND QUALITY SEED

Over 1,000 common bean varieties, most being landrace varieties, have been identified in Rwanda (Gapusi, J., et al, 2012). Rwanda has an active common bean breeding program based in RAB's Research department. The breeding program has historically focused on yield and

improved nutritional quality. The yield potential of climbing beans has pushed the breeding program to a heavy emphasis on breeding climbing types.

In 2010, RAB and the common bean program began to collaborate with HarvestPlus to develop biofortified varieties. The first varieties, based on germplasm already under development by RAB, were released in 2012. Over the last ten years, RAB's program has released more than 20 varieties, with about half being biofortified and half conventional. Approximately 80% of the releases have been climbing beans.

Research data gives clear evidence of the yield potential of the RAB varieties, but as previously noted, on-farm yields are about 50% of potential yield, as outlined in Table 12. Given the potential of these varieties, one must wonder why these new varieties are not widely demanded by farmers.

Table 12: **Examples of recent releases of improved varieties.**

Improved Climbing and Bush Bean Varieties
Select Examples of Recently Released Varieties

	Pedigree Code	Maturity *day*	Potential Yield *MT/Ha*	Size	Color	Key Characteristics
Climbing	RWV 3006	110	3.8	Large	White	Bio-fortified, export market
	RWV 2872	108	4.2	Large	Sugar	Regional market, income
	RWV 3316	115	4.0	Large	Red	Bio-fortified, nutrition
	Gasirida	100	5.0	Large	Purple	Popular markets, culinary traits
	CAB 2	115	5.0	Medium	Navy	Bio-fortified, fast cooking
	RWV 2070	105	5.0	Large	Khaki	Marketable, taste
	RWV 1129	102	4.0	Large	M/moja	Bio-fortified, early, marketable
	Gasirida	100	5.0	Large	Purple	Popular markets, culinary traits
	MAC 9	85	3.7	Medium	Calima	Marketable
	MAC 44	84	3.8	Medium	Calima	Bio-fortified, marketable
Bush	RWR 2245	75	2.0	Medium	Calima	Bio-fortified, marketable
	SER 16	75	2.5	Small	Red	Drought tolerant

Source: Musoni (2012).

Four factors appear to play roles in stifling demand for certified seed of improved varieties:

1. Farmers are not convinced of the high yield potential of improved varieties because their experience says otherwise.
2. Farmers are not aware of the inherent advantages that come from planting quality seed compared to farmer-saved seed.
3. Farm household planting decisions are driven by cash availability (or lack thereof) rather than potential or theoretical returns.
4. Inadequate access to credit for smallholder farmers and a lack of agricultural lending expertise by SACCOs.

The first two factors are closely related and are rooted in the need for a strong extension service focused on translating agricultural research into on-farm trials. Based on the interviews conducted with farmers and seed producers for this study, the variety trials conducted by the extension service are not seen as providing compelling evidence that improved varieties used in conjunction with good agronomic practices will provide superior returns to farmers. While many common bean farmers also grow hybrid maize which demonstrates their willingness to adopt improved varieties, they don't necessarily equate hybrids to improved varieties and as such aren't necessarily aware of the benefits of improved common bean varieties.

Despite repeated questioning of all stakeholders, no evidence was found of RAB or any other party conducting trials specifically designed to compare performance of quality seed with the performance of farmer-saved seed. It is essential to conduct such trials, as long as they are designed to distinguish between the effects of seed quality and variety. In the absence of such visual experiences, it will not be clear to farmers that the additional cost of certified seed is justified, as Figure 25 outlines.

Figure 25: **Formal versus informal variable cost basis – Bush bean.[5]**

Formal vs. Informal Market on Variable Cost Basis: Bush Beans

Formal Market Cost/Ha **Certified Seed**		**Informal Market Cost/Ha** **Informal Seed**		**Informal Market Cost/Ha** **Saved Seed**	
Seed Cost (Basic)	$43	Seed Cost (Open Market)	$26	Recycled Seed	$0
Fertilizer	$329	Fertilizer	$298	Fertilizer	$267
Pesticide	$13	Pesticide	$0	Pesticide	$0
Planting & Harvesting	$173	Planting & Harvesting	$173	Planting & Harvesting	$67
Labor General	$429	Labor General	$164	Labor General	$0
Transportation	-	Transportation	-	Transportation	$0
Inspection/Lab/ Germination Fees	$3	Inspection/Lab/ Germination Fees	$0	No Inspection	$0
Other Variables	$38	Other Variables	$13	Other Variables	$9
Total Variable Cost	**$1029**		**$674**		**$342**
Estimated Yield MT/Ha	*1.2*		*1.0*		*0.8*
Estimated Cost USD/Kg	**$0.86**		**$0.67**		**$0.42**

Perceived Cost Difference = ~2x

Source: Research team analysis (2016).

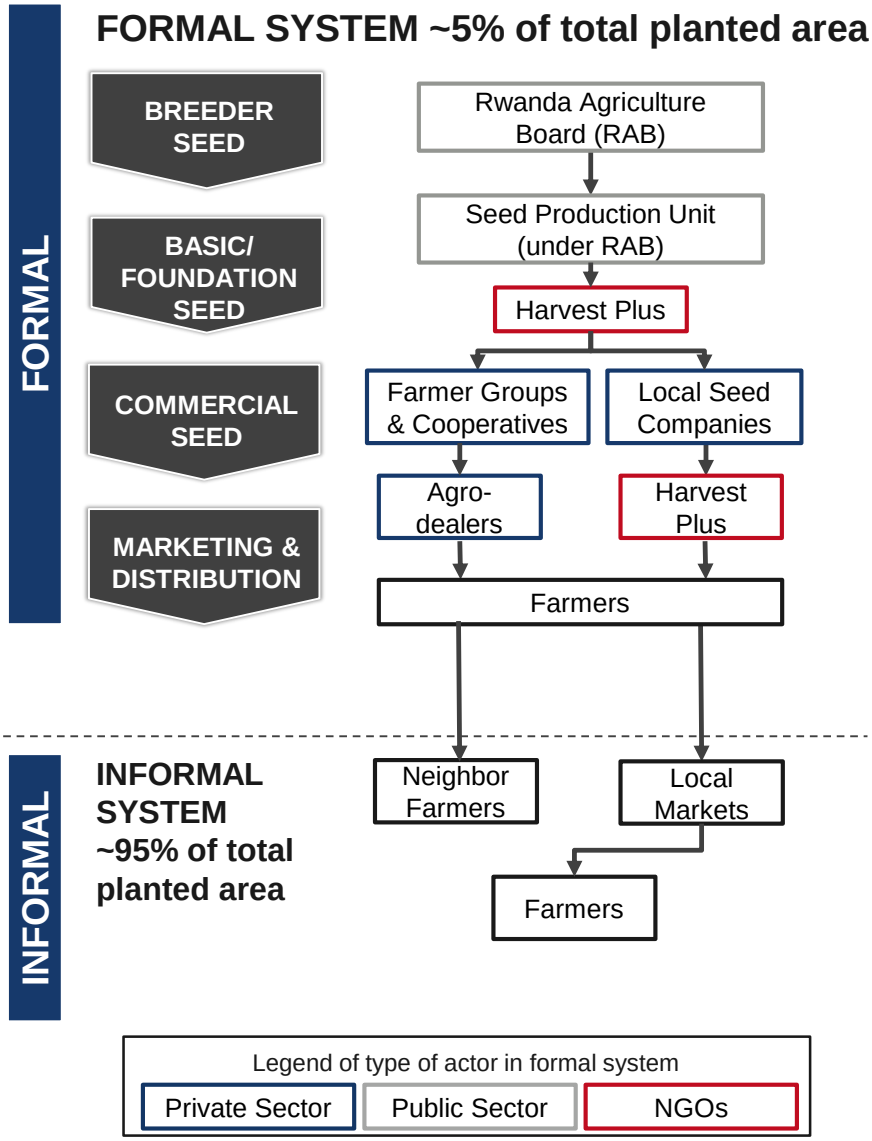
[5] Labor costs are estimated to be higher in the formal production system because labor is assumed to be hired and paid for while the informal sector assumptions were made that less labor would be hired and fewer operations conducted (e.g., one plowing rather than two plowings). For the farmer saved seed calculation, no labor costs were assumed because in interviews with farmers, they consistently mentioned that they do not count their own labor as a cost. While there is clearly a cost to time, the purpose of this calculation was to show how the farmer perceives the cost of seed.

The remaining factors stifling demand for certified seed of improved varieties reflect the economic challenges faced by Rwanda's smallholder farmers. The absence of a robust agricultural lending system necessitates a cash-based outlook and makes it hard, perhaps impossible, for farmers to look beyond their immediate cash needs and adopt practices that would produce more income and thus more economic and food security for the country as a whole.

STRUCTURE OF EARLY GENERATION SEED VALUE CHAIN

It is estimated that only 5% of the common bean planted area is supported by the formal seed system, while 95% of common bean area is planted with seed sourced by farmers through informal means, as illustrated in Figure 26. While there are many reasons for the dominance of the informal system, the primary factor is that available supplies of quality seed are insufficient to meet the relatively limited demand for EGS.

Figure 26: **Structure of common bean seed system.**



Source: Research team analysis (2016).

FORMAL SYSTEM

Common bean breeding in Rwanda is the responsibility of the RAB Research department. The common bean breeding program is responsible for producing breeder and pre-basic seed. At this point in time, the program also has a grant from HarvestPlus to produce basic seed of biofortified varieties to supplement RAB seed production activities in common bean.

Basic seed is produced by the RAB seed production unit. Although the official government recommendation to farmers is to purchase new seed every fourth season, the RAB seed production plan assumes that farmers are purchasing seed every tenth season, and decisions on quantities of basic seed to produce are taken accordingly.

The formal market in common bean is driven by HarvestPlus, which buys EGS for production of certified seed by local seed companies, farmer groups, and cooperatives and sells certified seed to farmers at a subsidized price. It is unclear what the true demand for biofortified varieties would be if HarvestPlus exited the market and subsidized seed was not available. Even in the absence of direct subsidies, RAB dictates seed pricing in the marketplace and has set prices low to stimulate demand. The low price may be a boon to farmers, but it is a disincentive to seed producers. In the absence of a guaranteed buyer (HarvestPlus), it is likely that seed producers would look for higher value alternatives to common bean.

INFORMAL SYSTEM

The informal seed system includes farmer-saved seed, seed acquired through trading with neighbors, and seed purchased from neighbors, agro-dealers, or in food markets. Farmer-saved seed makes up the bulk of the informal system, with other channels used when on-farm yields were too low to justify saving grain for seed or when a farmer learns of a new variety that piques his or her interest. In interviews with farmers, it became clear that purchasing certified common bean seed does not happen often and is not a top-of-mind option.

Very few farmers plant only one variety of common bean choosing instead to plant mixtures of varieties. Interviews for this study revealed that unless farmers are acquiring seed to fill a planting shortage, a farmer would typically introduce a new variety by planting 1 Kg of seed and evaluating the variety's performance. That is apparently the case regardless of the market channel through which the seed is obtained. If the new variety performs satisfactorily, some of the first crop is retained for seed, and the variety is introduced into the farmer's mix of varieties.

KEY EGS SYSTEM BOTTLENECKS AND CONSTRAINTS

There are numerous EGS supply bottlenecks as well as demand constraints identified in the common bean seed system value chain. These include:

Supply bottlenecks

- **Limited quantities of basic seed:** The RAB seed production unit is significantly understaffed and generally under-resourced for the size of its crop portfolio.
- **Inconsistent quality of basic seed:** Some seed growers reported receiving seed labelled as "basic" that did not meet basic seed quality parameters, which led to planted fields failing to meet standards required for certified seed.
- **Private seed sector not capable of delivering certified seed:** Local seed producers, including seed companies, farmer groups, and cooperatives, have limited seed production expertise or experience which results in relatively large numbers of seed fields failing to meet certification requirements.
- **Poorer than forecast seed yields:** Seed yield of common bean achieved by producers is routinely below estimated yield potential which results in less seed available to be certified. This is most pronounced in the south where fungal diseases are prevalent.
- **Seed producers divert seed for market or on-farm consumption:** There are occasions when seed producers will use their harvest for on-farm consumption or to sell as grain when market prices are high.

Demand constraints

- **Farmers are not convinced improved varieties offer performance advantages**: On-farm yields are significantly below research yields and extension service support to help farmers realize yield potential are either nonexistent or inadequate.
- **Performance of recent bush bean releases is not compelling**: New bush bean varieties reported to suffer from disease susceptibility and yield below that of local varieties.
- **Farmers are unaware of the inherent advantages of quality seed:** No evidence of research to compare performance of quality seed with performance of farm-saved seed. Demonstrations are critical to not only showing farmers the advantages, but also generating the data required to support the investment case.
- **Farmers manage based on cash accounting**: Farm household decisions are driven by cash availability (or lack thereof) more so than potential returns which are further away in cash flow terms.
- **Smallholder farmers lack access to credit from SACCOs:** There is inadequate access to loans for farmers to invest in inputs such as improved seed and fertilizer.

Lack of demand is the primary issue constraining adoption of quality seed and improved varieties by farmers. The lack of demand for certified seed ripples through the EGS system and signals a lack of need for basic common bean seed. In the chronically constrained RAB seed production unit, it is very likely that these signals affect resource allocation and the prioritization of activities.

If Rwanda is to gain the full benefit from the resources invested in developing improved varieties of common bean, including nutritional benefits of the biofortification program, it must first convince farmers that spending the additional money required to purchase quality seed of improved varieties will create tangible economic benefits for them and their families.

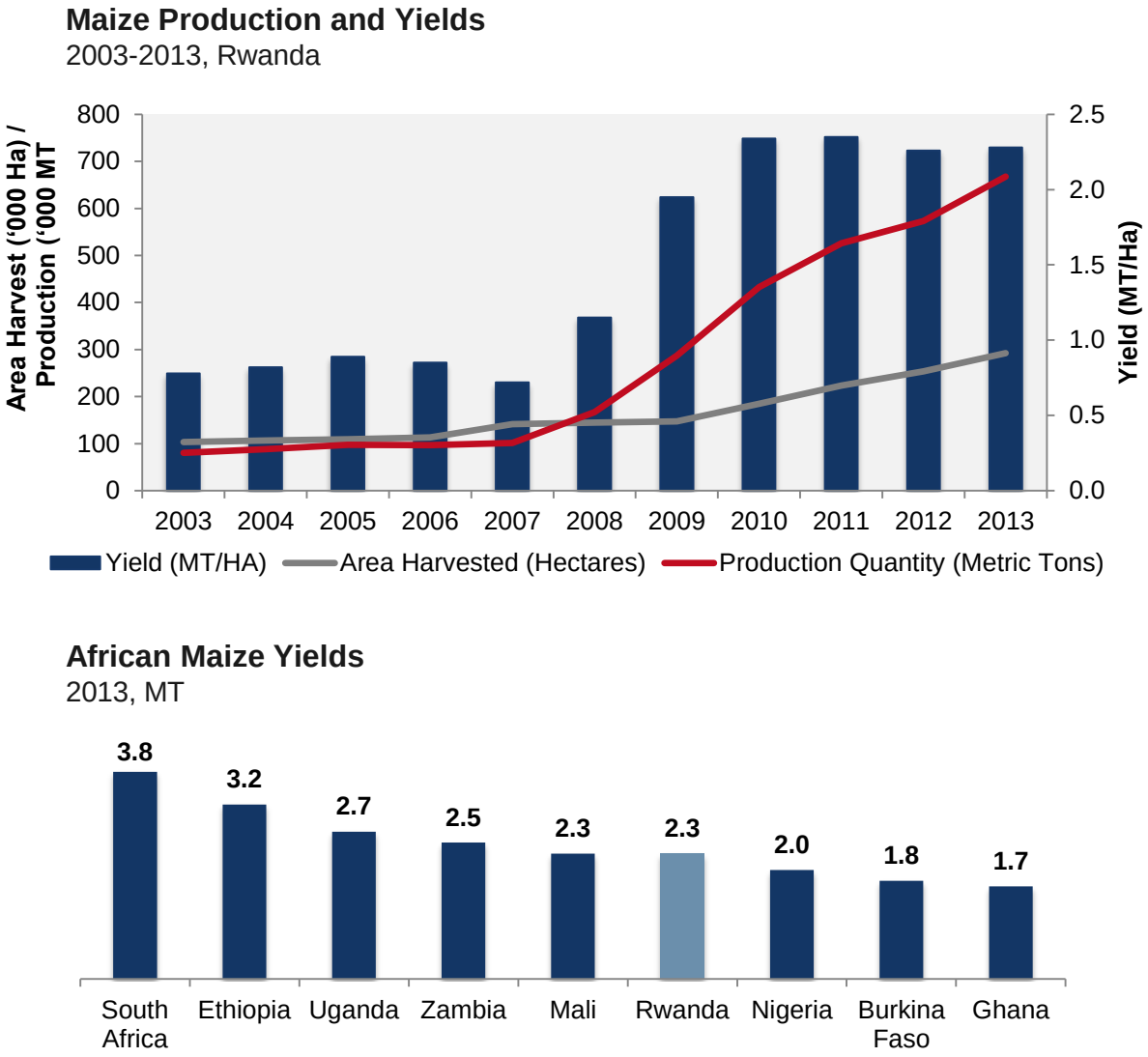
Additionally, the Rwanda common bean breeding program should reevaluate its priorities and look again at ways to increase yield and disease resistance in bush-type varieties. Although bush beans have inherently lower yield potential than climbing beans, they are grown on a much larger area and even a small yield increase will have a positive impact on national production. Some farmers in areas well suited to climbing beans are reluctant to plant them because of the additional labor and cost required to produce the crop. Spending breeding time and resources to increase bush bean yields and to eliminate major disease problems should continue to be a high priority for the common bean breeding program.

3.4 MAIZE

SUPPLY

Maize (*Zea mays*) is the third-largest crop area in Rwanda and the fastest growing in area and production terms, as Figure 27 represents. Production has more than tripled since 2003 to serve increased demand, as consumption trends have evolved from a purely subsistence to a successful commercial crop. The single greatest impact on maize production has been the introduction and adoption of hybrid maize. The government has used seed and fertilizer subsidies to encourage adoption of hybrid maize, and since 2009 the maize area under cultivation has doubled.

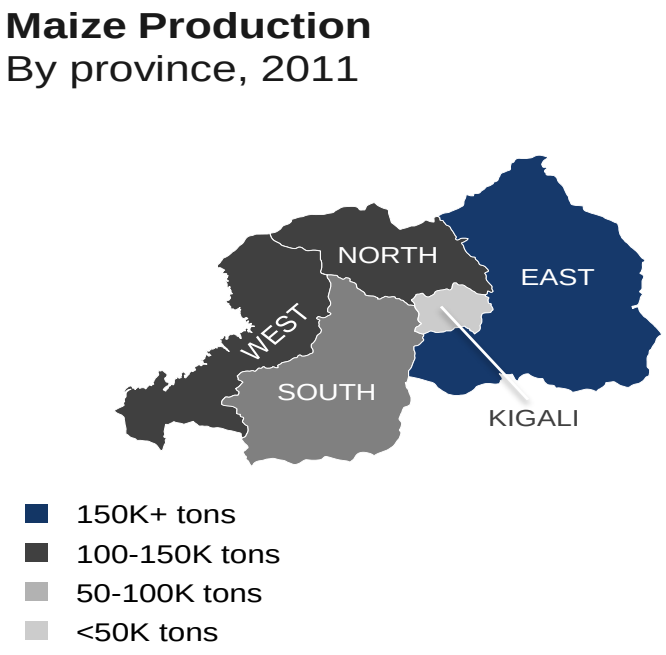
Figure 27: **Maize area, production, and yield.**



Source: Rwanda Country Stat (viewed in February 2016).

Despite the significant increase in maize production, Rwanda continues to be a net importer of maize. Maize yields reported in 2013 (as graphed in Figure 27) put the country in the middle of the region on an absolute basis. However, the relative yields compared to countries like Zambia and Uganda, where maize farming is well established, provide evidence that additional adoption of hybrids and continued emphasis on good farming practices could increase productivity and reduce the need to import maize.

Figure 28: **Maize production by province, 2011.**



Source: MINAGRI (2011) sourced from Japanese Ministry (2012).

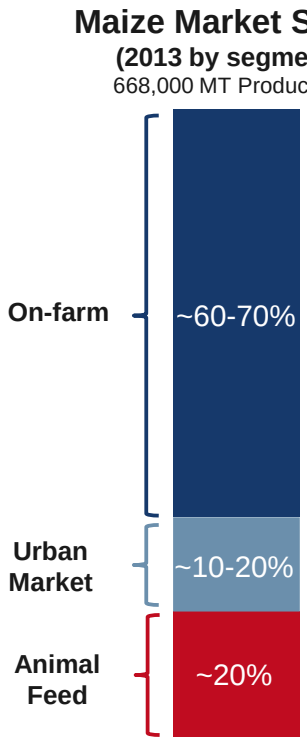
Maize is grown across all provinces in Rwanda with the largest production in the East, followed by the North and West, as illustrated in Figure 28.

DEMAND

As shown in Figure 29, the majority of maize is consumed on-farm as green maize or meal. Maize processors in Rwanda are typically small, operating hammer mills that produce lower value meal than roller mills. There is one large roller mill but data shown in Figure 30 (albeit limited) suggests mills are operating well under capacity due to supply constraints. Grading and quality segments are not common as they are in neighboring countries.

By moving maize production to hybrid and elevating on-farm production practices, there is an opportunity to develop a grain industry capable of supporting the growing demand for maize while reducing the current reliance on imported maize grain.

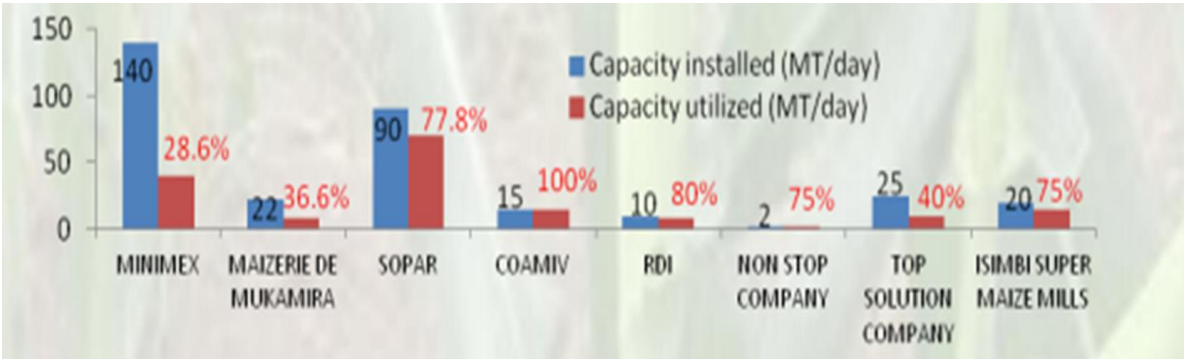
Figure 29: **Comparison of maize demand segments.**



	Segment Description	Segment Needs
On-farm consum.	• Mainly green maize eaten after harvest due to lack of drying and storage facilities • Seed ~2% of production	• Yield, no grading or quality segments defined
Urban Market	• Maize meal sold in urban markets • Network of cooperatives sell to traders who sell to small-scale hammer mills • Only one large commercial roller mill producing high-quality meal	• No grading or quality segments defined • Low-cost hammer mills in Rwanda do not produce high-quality meal grades No. 1 and No. 2 seen in Uganda and Tanzania with roller mills
Animal Feed	• Livestock feed a growing segment, driven by urbanization	• Yield

Source: Rwanda Country Stat (viewed in February 2016), USAID (2013), World Bank (2015), RDB (2013), expert analysis (2016).

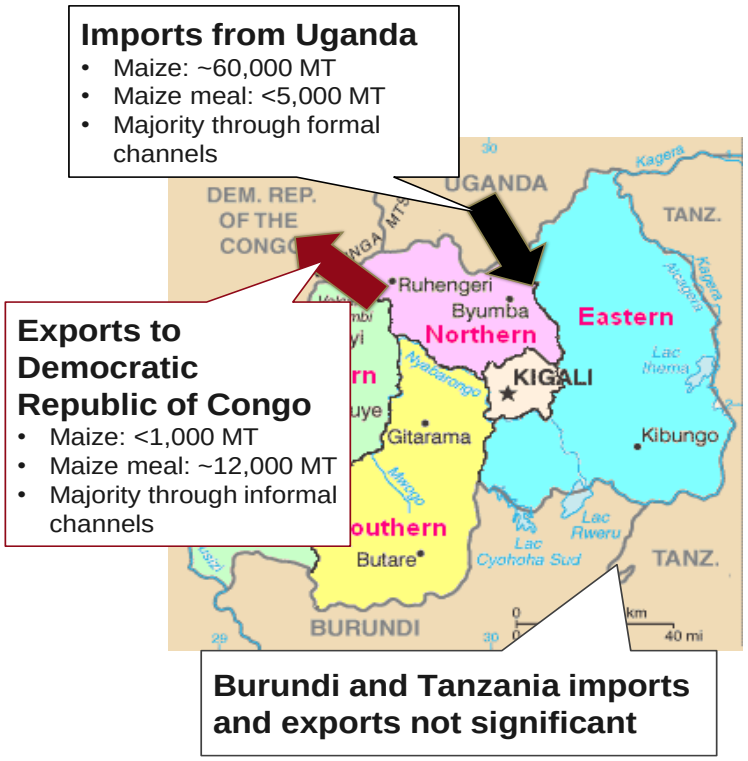
Figure 30: **Select maize meal processor capacity utilization (2013).**



Source: RDB (2013).

Rwanda is a significant importer of maize, as illustrated in Figure 31. Rwanda imported 60,000 MT of maize and 5,000 MT of maize meal from Uganda in 2013 through formal channels. During the same year, Rwanda exported an estimated 12,000 MT of maize meal to the DRC through informal channels. Maize production costs in Rwanda are considered competitive with regional partners but unlikely to be advantageous for export, as lower cost hammer mills do not produce the higher quality roller milled grain demanded in Uganda and Tanzania, thus limiting export opportunities. However, Rwanda's low-cost hammer mills make the country cost competitive to export milled maize to DRC (90% extraction with hammer mills versus 60-70% for roller mills). As such, there is significant opportunity to increase production for import competition and serve processors' demand.

Figure 31: Maize imports and exports.



Source: USAID (2013).

ADOPTON OF IMPROVED VARIETIES AND QUALITY SEED

Before hybrid maize was introduced, farmers grew OPVs of maize and intercropped with common bean, and was primarily consumed on-farm as fresh ("green") maize. The RAB cereals unit developed improved OPVs and the EGS system was identical to that of common bean, i.e., maize breeders were responsible for breeder and pre-basic seed and the seed production unit produced basic seed.

Like common bean, local OPVs of maize proliferated, and the use of certified seed was low. When the government decided to increase maize production, they did so by introducing hybrid maize which has a much higher yield potential than OPV maize. Although adoption of hybrid maize varies by region across Rwanda, approximately 70% of all maize grown is hybrid. RAB has stopped developing new OPVs and for the past two years has produced no basic OPV seed. It is the government's intent to convert maize to 100% hybrid, and without new genetics and no more EGS production, the OPV share will continue to decline.

Hybrids available to Rwandan farmers are developed and produced by regional seed companies including Kenya Seed, SeedCo., and Pannar, a subsidiary of DuPont Pioneer. All hybrid seed planted in Rwanda is imported. The North province has largely replaced OPVs with

hybrids due to the absence of OPVs well adapted to the region's production environment and the availability of hybrids which are well adapted to the region. There is significant opportunity to introduce hybrids best suited for the highest production province in the East, where farm sizes are largest and currently available hybrids are not as well adapted.

Although the use of OPVs is declining, there are still more than 800 maize varieties available in Rwanda, with the vast majority being local varieties. The move to hybrids is reducing the total number of varieties in production and will continue to do so. Table 13 presents a partial list of the hybrids available in Rwanda, as well as a few of the remaining improved OPVs.

Table 13: Key hybrids and OPVs.

Key maize varieties

	Variety Name	Developer	Country	Potential Yield Estimates MT/Ha
Hybrids	H628	Kenya Seed Company	Kenya	3-5 MT/Ha
	H629	Kenya Seed Company	Kenya	
	PANNAR 691	PANNAR	South Africa	
	SC 719	SEEDCO	Zambia	
	SC 637	SEEDCO	Zambia	
	DH 04	Kenya Seed Company	Kenya	
	PANNAR 4M21	PANNAR	South Africa	
	PANNAR 53	PANNAR	South Africa	
	PANNAR 67	PANNAR	South Africa	
	SC 513	SEEDCO	Zambia	
	SC 403	SEEDCO	Zambia	
OPV	ZM 607	RAB	Rwanda	1-3 MT/Ha
	M101	RAB	Rwanda	
	Pool 9A	RAB	Rwanda	
	M103	RAB	Rwanda	

Source: Expert analysis (2016).

RAB has replaced its OPV breeding program with a hybrid development program. This is not a line breeding program but a program to evaluate combinations of inbred lines obtained from CIMMYT or other sources. According to RAB, the first hybrids will begin to emerge from the program in 2019.

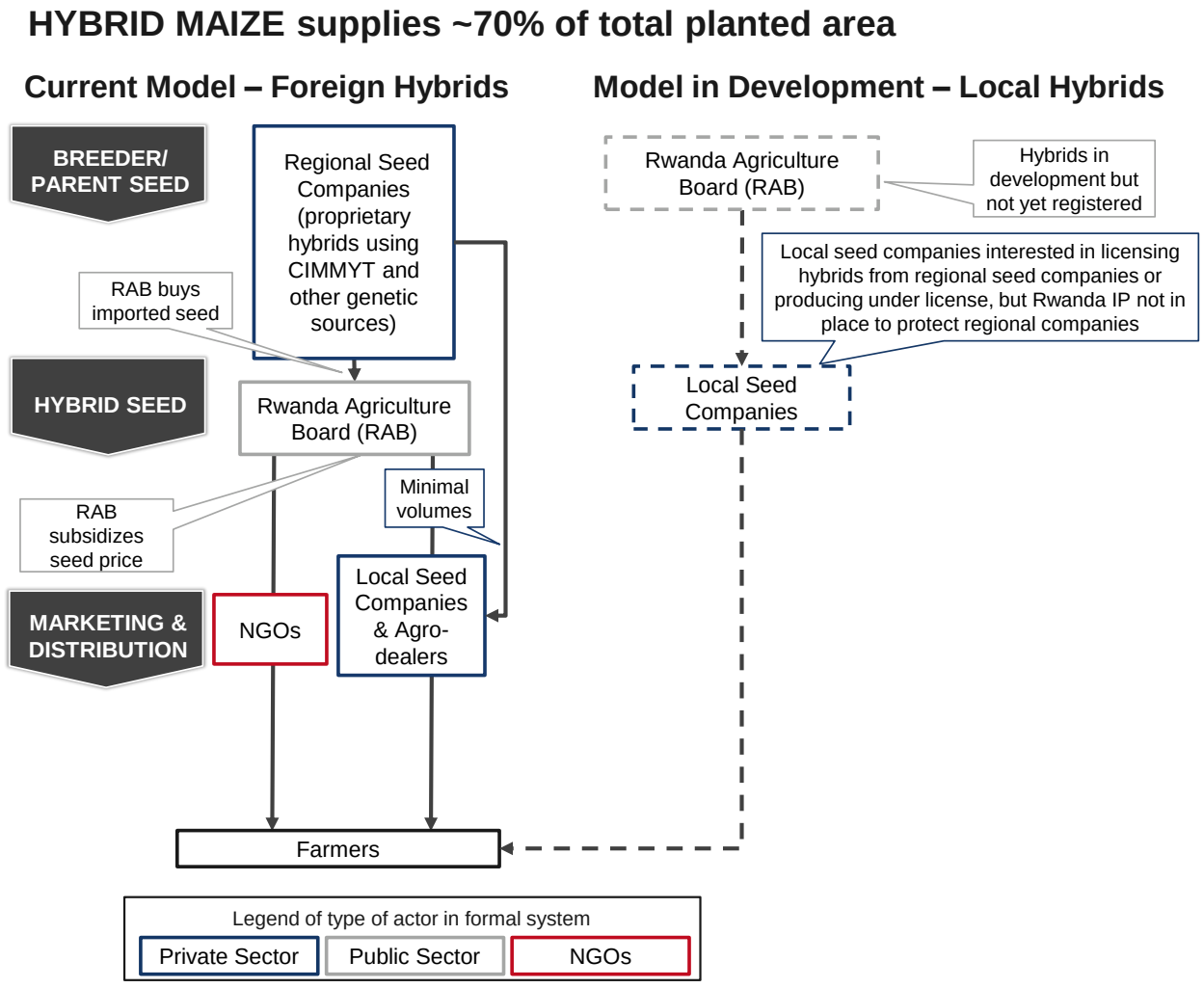
The hybrid combinations being evaluated by RAB are very similar if not identical to those already available through regional seed companies. It is highly unlikely that the resources RAB is using in its hybrid development program will result in hybrids that are especially well suited to Rwanda or are more competitive in farmer fields than those already available.

Given the budget and human resource constraints that all research programs confront, careful consideration should be given to the need for a RAB hybrid maize development program. The government has expressed a desire to see the private sector play the dominant role in hybrid maize. If it acts upon that interest and enables a competitive hybrid market to emerge, Rwandan farmers will be well served and have access to the best possible hybrids. In turn, RAB can redirect funds and human resources currently focused on developing maize hybrids toward other activities, i.e. potato and common bean.

STRUCTURE OF THE EGS VALUE CHAIN

The production and delivery of hybrid maize seed to farmers requires a formal seed system. As noted previously, 70% of the Rwanda maize area is planted with hybrid seed and therefore serviced through a formal seed system, as Figure 32 illustrates. The remaining 30% is the OPV market which is rapidly becoming an informal market. Although some private seed producers and local seed companies are attempting to produce certified OPV maize, it is clear from interviews conducted for this study that RAB's decision to stop production of early generation OPV seed is having a negative impact on the ability of the seed system to produce quality OPV maize seed.

Figure 32: **Structure of hybrid maize seed chain.**



Source: Expert analysis (2016).

HYBRID FORMAL SYSTEM

All hybrid seed is currently produced outside of Rwanda by regional seed companies. RAB is the primary buyer of hybrid maize and subsidizes 75% of the price farmers pay. Regional seed companies are not yet routinely selling directly to distributors or farmers. RAB has declared its intention to eventually eliminate seed subsidies but has not provided guidance to industry or

farmers on how and when the subsidy program will be withdrawn. The uncertainty is a constraint on seed companies that might otherwise be inclined to invest resources to establish a market presence in Rwanda.

The government is actively encouraging regional seed companies to develop hybrid production programs in Rwanda. While this strategy may be understandable, it could present negative outcomes. Production of hybrid maize in Rwanda faces numerous challenges, including small farms, absence of mechanization, no in-country experience or expertise in hybrid maize production, and inadequate seed processing facilities. The investment required to develop a minimally adequate production capability is high, and insisting that seed planted by Rwandan farmers is produced in Rwanda may discourage private seed companies from participating in the market at all. Even if the GoR persists and local producers acquiesce to the demand for locally grown seed, it is very likely they will choose which hybrids to sell based on production characteristics rather than agronomic value. As a result, Rwandan farmers will not have access to the most up-to-date and best performing hybrids, reducing the country's ability to meet its maize production needs.

Production of hybrid maize seed requires a high degree of expertise and specialized infrastructure for production and processing. The companies supplying seed to Rwanda can meet the needs of Rwandan farmers without undue difficulty as long as Rwandan policy and seed importation infrastructure enables them to work efficiently and profitably.

OPV FORMAL AND INFORMAL SYSTEMS

As described above the market share of OPVs is steadily declining, and the government aims to convert the market to 100% hybrid to meet Rwanda's growing demand for maize. As a result, the production of OPV seed is becoming more and more informal in the sense that it is harder and harder to produce certified OPV seed.

RAB's decision to stop production of basic OPV seed is forcing the market to use seed produced outside the EGS system in place of basic seed. An interview with a seed industry consultant provided a picture of the problem. A Rwanda seed company was attempting to produce certified OPV seed. After the crop emerged, the consultant was called to look at problems in the field, and he saw that the "basic" seed used by the company was in fact a population of maize and not basic seed of a known variety; therefore, the field would never qualify as certified. This type of situation will become more common as the formal system focuses ever more exclusively on hybrid maize. For these reasons, this study's analyses and recommendations focus on the hybrid seed system.

KEY HYBRID MAIZE SYSTEM BOTTLENECKS AND CONSTRAINTS

Hybrid maize issues are mainly driven by supply bottlenecks that stem mainly from policy issues that constrain private sector supply growth and success. These include:

Supply bottlenecks

- **Inadequate seed import process**: RALICS, the government agency responsible for issuing import permits, is understaffed, especially with respect to plant pathologists, and it does not fully accept the phytosanitary findings of countries from which maize seed is imported (primarily Zambia). As a result, the importing companies require additional time

and incur additional cost to get the same phytosanitary inspection from Rwanda that they have already obtained from inspectors in exporting countries.

- **Inadequate demand forecast system**: RAB determines which hybrids are to be made available in Rwanda and those decisions often come late and close to planting. The late decision on hybrids, coupled with the slow seed import process, make it difficult and in some cases impossible for seed to arrive in time for planting. As a result, farmers are forced to plant different maize varieties, often OPV maize from the informal system.
- **Inequitable private sector exposure to risk**: Although RAB is the official purchaser of hybrid seed, it does not pay the seller until after seed is delivered to farmers. It also requires evidence from the seed company that the seed was actually planted, which requires the seed company to rely on agro-dealers who deliver seed to the farmer to track seed use. As a result, the seed companies are financially exposed for an inordinate length of time and subject to payment withholding if documentation of planting is inadequate.
- **Unclear subsidy strategy**: There is no evidence of when the government plans to phase out subsidies which makes planning for seed companies very difficult and contributes to their unwillingness to invest in the market.
- **Inefficient and unclear registration process**: There is no formal system to get a variety into and out of registration. RAB breeders run variety registration trials, creating a potential conflict of interest with private variety developers. Additionally, the process is too long with four years of station and on-farm testing. The registration process is not aligned to the East African Community process which requires half the time to register a variety and imposes an unnecessary burden public and private variety developers.

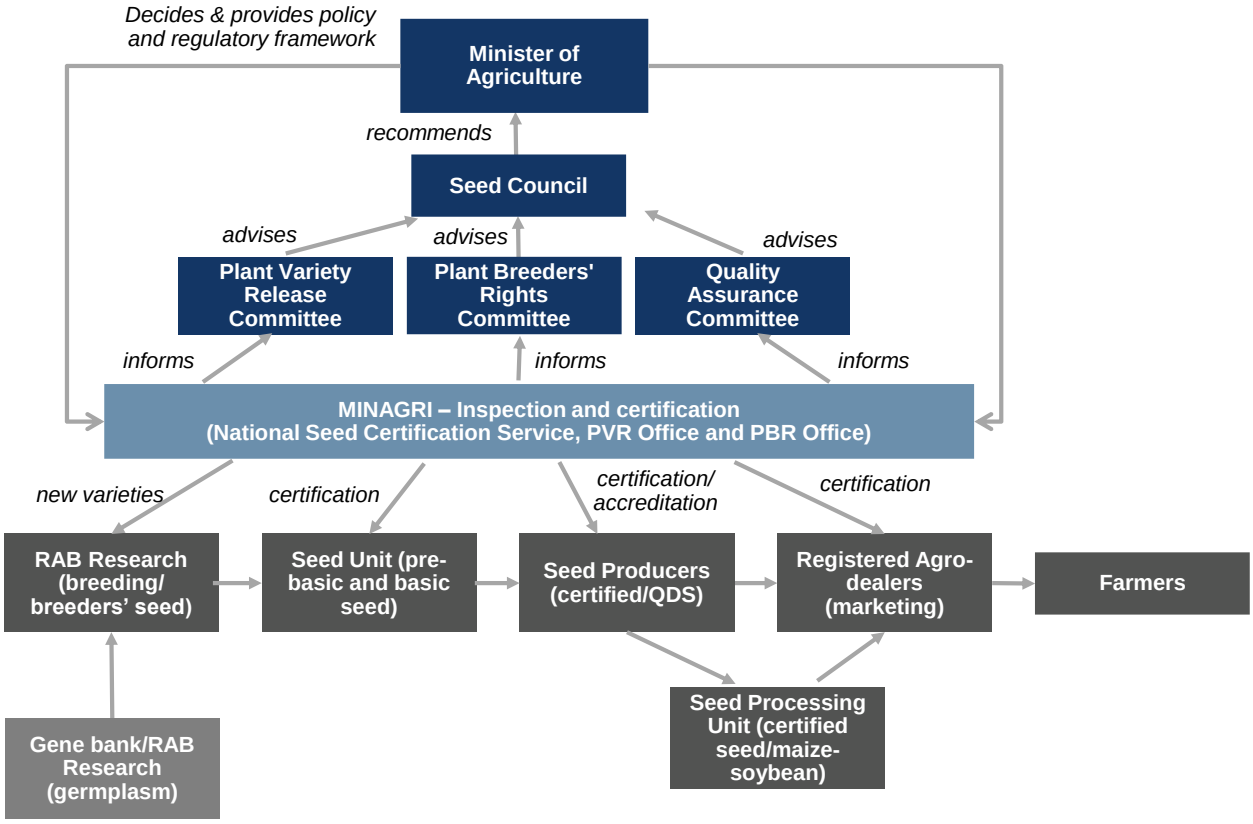
Demand constraints

- **Suitability of hybrids for specific growing conditions and areas:** The first hybrids to be introduced were not well adapted to some regions of the country, most notably the East province. This is changing as newer hybrids are evaluated and introduced.
- **Smallholder farmers lack access to credit from SACCOs:** Hybrid seed is much more expensive than non-hybrid seed, and many smallholder farmers lack access to agricultural lending institutions that would enable them to purchase seed and other inputs required to realize the full potential of hybrids. As the government has stated its intention to phase out subsidies, access to credit will become an even more important need for smallholder farmers to ensure they can continue to invest in hybrid maize seed.

3.5 RECENT DEVELOPMENTS

The recently passed National Legislative Framework for Seeds includes a completely new organizational design, as illustrated in Figure 33. However, it is not known when these critical policy reforms will be implemented. The final structure is currently being defined in the form of ministerial directives that transform the new law into policy, regulations and procedures. The National Legislative Framework for Seeds addresses many of the identified EGS constraints. However, the research teams' interviews suggest that there still is a preference within the government for seed to be produced in Rwanda, which could jeopardize EGS success, especially in potato and hybrid maize.

Figure 33: **New organizational design – a work in process.**



Source: Broek (2013), expert analysis (2016).

3.6 PROMISING MODELS

SEED PRODUCER TRAINING PROGRAM – BELGIUM TECHNOLOGY CORPORATION MODEL

Private seed producers in Rwanda are farmers without a deep understanding of the challenges of seed production. A common theme that emerged from our interviews is the need for more seed production expertise in the government and the private sector. Producing seed requires different management practices, access to resources, and facilities than those required for crop production. The lack of knowledge about seed production practices and inadequate infrastructure, e.g., for timely harvest, adequate drying and seed storage, makes it very hard to produce a high-quality seed crop for common bean, maize, and potato. The RAB seed production unit has insufficient resources for adequate seed production and is neither funded to, nor charged with responsibility for, training farmers to be seed producers. The RAB extension service does not appear to be meeting the needs of conventional farming and is unlikely to have seed production expertise even if it were adequately staffed. Consequently, the government, which is the central actor in the Rwandan seed sector, is poorly positioned to train private farmers in the science and art of seed production.

Although the government does not have the resources or expertise to build capacity in the Rwandan seed sector, it has recognized the need for improved seed production skills and knowledge and secured support from the BTC, a long-time donor and partner of the Rwandan government, to fund and operate a Seed Producer Training Program. This program used the methods, experiences, and outcomes achieved in the FFS, a RAB-operated program which provides training to farmers and which has operated for several years, as the basis for the FFS organization and operation.

The FFS provided farmers interested in seed production with training and mentoring in wheat, rice, common bean, soybean, potato, cassava, and OPV maize. The program introduced the concept of quality assurance through quality control plots where seed producers planted the seed they harvested, and which were then assessed for germination and uniformity. The FFS included four key components. First, program trainers identified and organized seed producers into producer groups. They then hosted regular seed producer meetings before, during, and after the season to share seed producer best practices, address issues seed producers were experiencing during the season, and develop tailored solutions to address these specific issues. Additional training sessions were conducted on seed producers' fields to ensure the hands-on training was practical and relevant. At harvest, the FFS facilitated distribution of seed produced by the producer groups with end users.

The program trained 653 private seed producer groups and was considered a successful, scalable program to train seed producers. Unfortunately, the government asked BTC to redirect its funding to the energy and health sectors, and the program ended in early 2016. Among the recommendations emerging from this study, a high priority should be given to renewing the program through outside providers with extensive knowledge and experience in seed production.

FARMER TRAINING PROGRAM - TUBURA ONE ACRE FUND

Tubura is successfully proving that smallholder farmers will buy nonsubsidized seed if they have access to demonstration trials, inputs, training, and credit. The One Acre Fund is an NGO that works directly with small farmers to help them improve financial returns generated in their farming operations, as outlined in Figure 34. The program was first launched in Kenya and began operations in Rwanda in 2008. The Rwandan branch of the One Acre Fund is known inside Rwanda as "Tubura," a Kinyarwanda word that roughly translates to "multiply" or "multiplying."

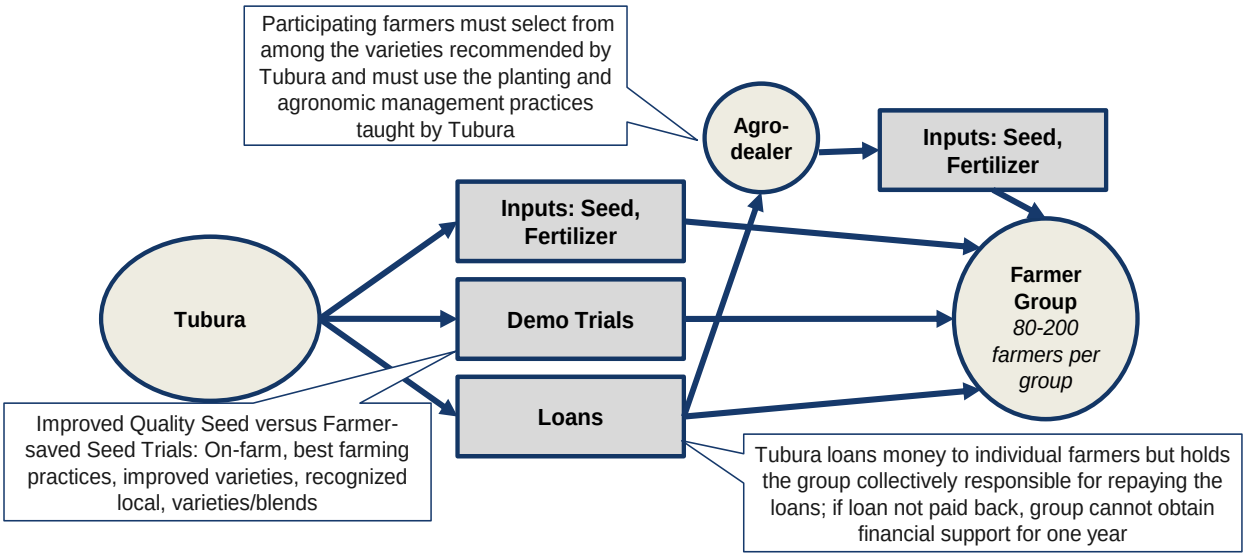
Tubura's core program, which is focused on helping individual farmers, includes variety evaluations for the crops it has targeted (currently hybrid maize, common bean, potato, and vegetables) to identify best varieties, training farmers in best farming practices, purchasing seed of the selected varieties, and providing credit to farmers to purchase seed and fertilizer. In 2016 Tubura will work with 150,000 farmers and expects to reach 300,000 farmers by 2020. Farmers in the program have increased their profits by an average of $135 after repaying loans.

Tubura operates a second program through which it finances inventory purchases by agro-dealers enabling them to stock seed and fertilizer for resale to farmers. That program now reaches approximately 25% of the agro-dealers in the North and West provinces where Tubura is currently active.

Through this combination of programs, Tubura has become the largest single private sector seed purchaser in Rwanda. It works with RAB and the private seed sector to encourage better seed policies and to support private sector development.

The Tubura program provides very clear evidence of the impact that occurs when farmers understand the value of improved crop varieties, employ good farming practices, and have access to finance.

Figure 34: **Tubura model.**



Source: Field research team interviews (2016).

Tubura does face challenges, many of which confirm the bottlenecks described in this study. These include:

- RALICS capacity is limited to facilitate requests for seed import, even small quantities for variety testing, which slows down the evaluation of new varieties.
- Obtaining needed quantities of quality commercial seed is difficult.
- An inefficient demand forecasting process makes obtaining the desired varieties very difficult and oftentimes, untimely.

CHAPTER 4: ECONOMIC ANALYSIS

4.1 POTENTIAL EARLY GENERATION SEED DEMAND

INTRODUCTION

The amount of EGS required for a given crop is a key variable in determining the optimal crop archetype. To aid in identifying these crop archetypes, the team developed an EGS demand model for the three crops included in this study.

As official early generation supply and demand figures were difficult to obtain, the team conducted interviews with key stakeholders to obtain information on current usage of EGS and to identify demand constraints. Because much of the data obtained in interviews was informal, (i.e. the reported usage and determinants of usage were based on the interviewee's experience and view of the system rather than formal records), the field researchers attempted to triangulate data through interviews with several individuals about a given crop and in links sectors of the value chain.

The information and data obtained during field interviews was used to formulate assumptions that informed models of the potential demand for EGS. Given the absence of formal data, the team modelled cases and sensitivities to estimate the magnitude of potential demand and the impact of the key variables within the model on demand. The three cases developed include:

- **Current EGS supply:** Current level of supply in market.
- **Potential EGS demand - base case:** All EGS specific recommendations are implemented, with other market impediments assumed to remain in place.
- **Potential EGS demand - best case:** All EGS specific recommendations are implemented, with other value chain and policy constraints addressed (e.g., downstream value chain improvements, non-EGS policy changes, agronomic best practices, packaging, credit).

The potential EGS demand cases are based on a five to seven-year timeline for implementation of the recommendations. It is critical to note that these models are not seed production plans or detailed bottom-up evaluations of demand, but rather a high-level analysis to inform the selection of crop archetypes.

POTATO

The current supply of early generation potato seed is limited by the capacity of the RAB potato tissue culture laboratory which produces *in vitro* plantlets and to start the EGS production chain. The capacity of the laboratory is 160,000 plantlets per year and cannot be increased without purchasing additional laboratory equipment.

The potato early generation demand model, based on planting rates and yield data obtained from RAB and private sector seed producers, projects an estimated supply of commercial seed at ~23,000 MT (Figure 35) when starting with 160,000 *in vitro* plantlets, the maximum number

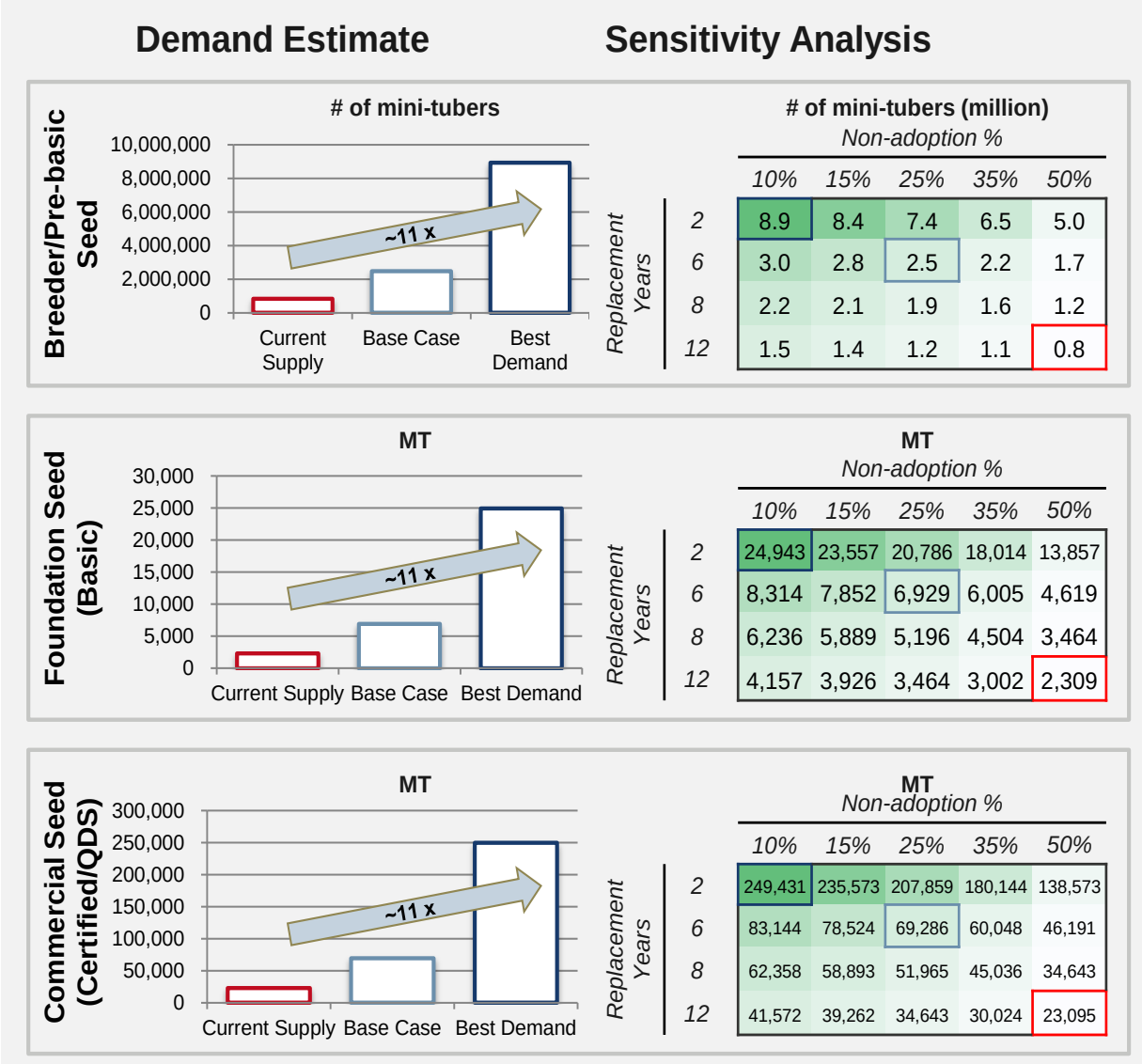
RAB can currently produce. 23,000 MT would plant approximately 3% of the potato area on an annual basis which matches the estimates provided by every interviewee in the potato sector for the impact of quality seed in Rwanda today. The correspondence between independent estimates of current seed availability and the model values provides some confidence in the model.

RAB personnel working in potato and seed production believe demand for potato EGS is at least three-fold greater than the current supply; and interviews with other potato stakeholders supported that view. This information was used to produce the base case model which would require approximately 2.5 million mini-tubers and 7,000 MT of basic seed to provide ~70,000 MT of commercial seed.

The impact of trebling seed availability would depend on whether the additional seed supplied more farmers with seed or enabled farmers to replace seed more often. The rate of non-adoption and rate of seed replacement can be adjusted to provide alternative scenarios that could be used to inform investment and policy decisions.

Field interviews suggest a further potential demand upside in a best case scenario in which 90% of growers adopt, buying new seed every two years. In this scenario improved varieties are introduced, agronomic best practices are applied related to disease management, credit is easily accessible to smallholder farmers, and demonstration trials are successfully executed across Rwanda.. This would lead to a potential demand of ~8.9 million mini-tubers, ~25,000 MT of basic seed and ~250,000 of commercial seed and would require significant enhancements to the early generation system to fulfil.

Figure 35: **Potato - potential early generation seed demand.**



Source: Field research team interviews (2016).

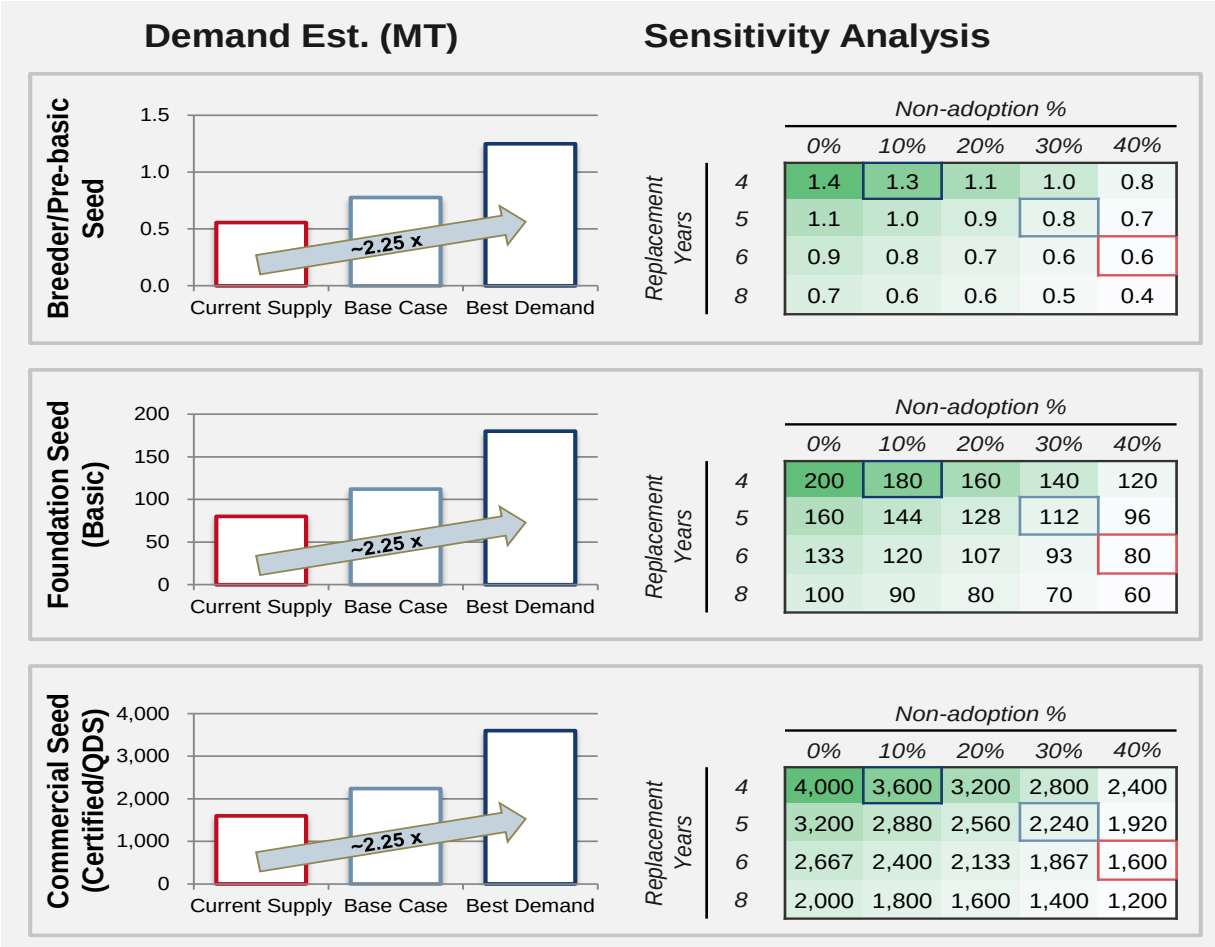
BUSH BEAN

Bush-type beans are planted on approximately two thirds of the total common bean crop area in Rwanda. Official figures on current EGS supply and use are not readily available and officials have limited data on supply and demand of EGS. Model assumptions are based on estimates provided by RAB personnel and interviews with other stakeholders including HarvestPlus.

Estimates of replacement rates and non-adopter rates varied considerably and given that low demand for certified seed is the primary constraint on EGS production, the assumptions used to build the base case and best case potential demand estimates were conservative (Figure 36). As such, current breeder seed supply estimated at 0.6 MT would imply basic seed supply of 80 MT and commercial seed supply of 1,600 MT. This amount could supply roughly 60% of farmers assuming they purchase seed from the formal system every six years.

As mentioned previously, farmers tend to buy seed for a small fraction of their area and use the resulting crop both as a test of the variety and as a source of additional seed for subsequent planting. Assuming more adopters and decreasing replacement rates from six years to five in the base case and four years in the best case would require about 50% more EGS production in the base case and roughly twice as much in the best case.

Figure 36: **Bush bean - potential early generation seed demand.**

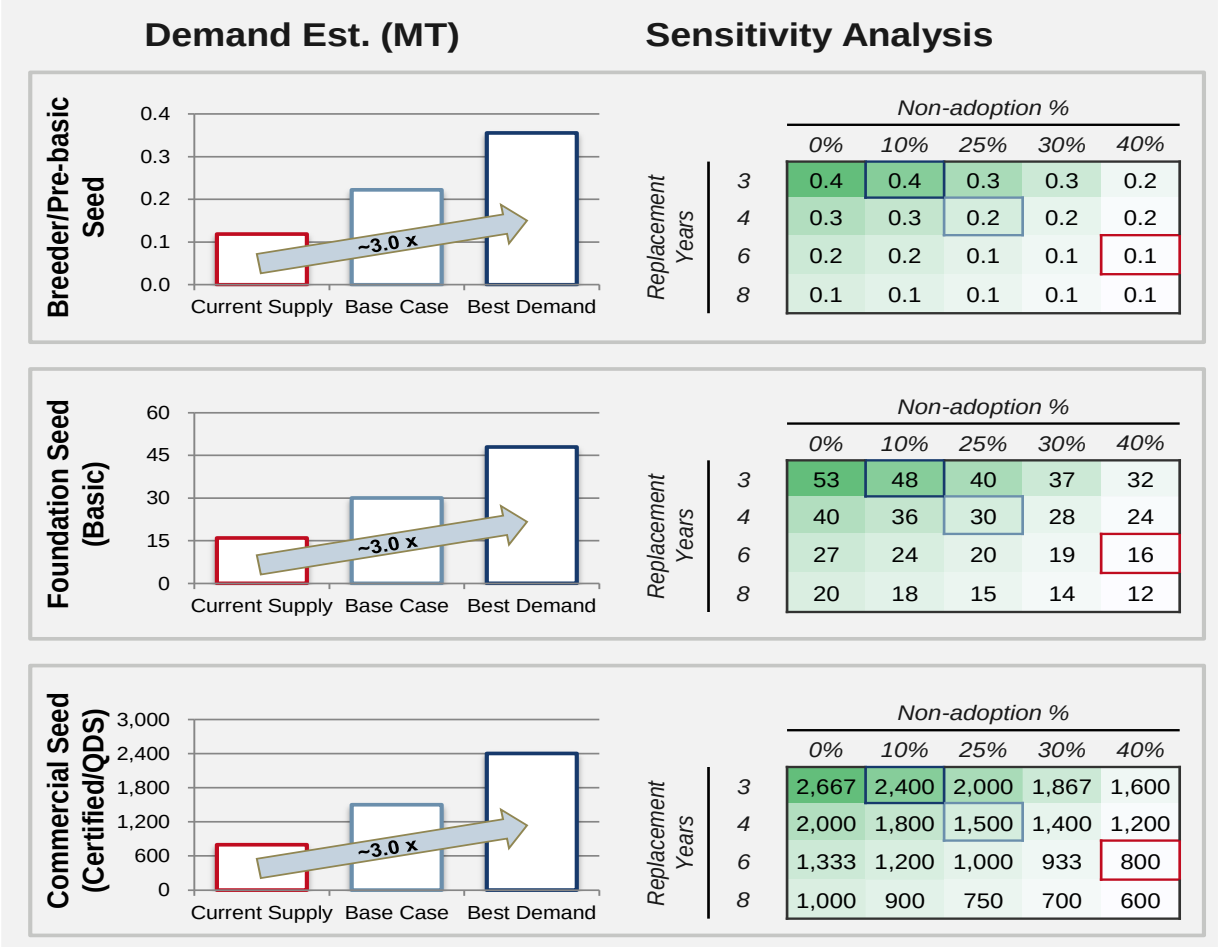


Source: Field research team interviews (2016).

CLIMBING BEAN

Climbing bean is a very similar story to bush bean in terms of lack of official data availability and the assumptions for calculating demand. The only key difference with climbing bean is that the yields of improved varieties are higher and therefore the value to the grower considered more compelling than in bush bean. Adoption rates and replacement years are estimated to be slightly higher (Figure 37). As such, the best case potential of demand is estimated to be three times that of supply versus two times for bush bean.

***Figure 37*: Climbing bean - potential early generation seed demand.**

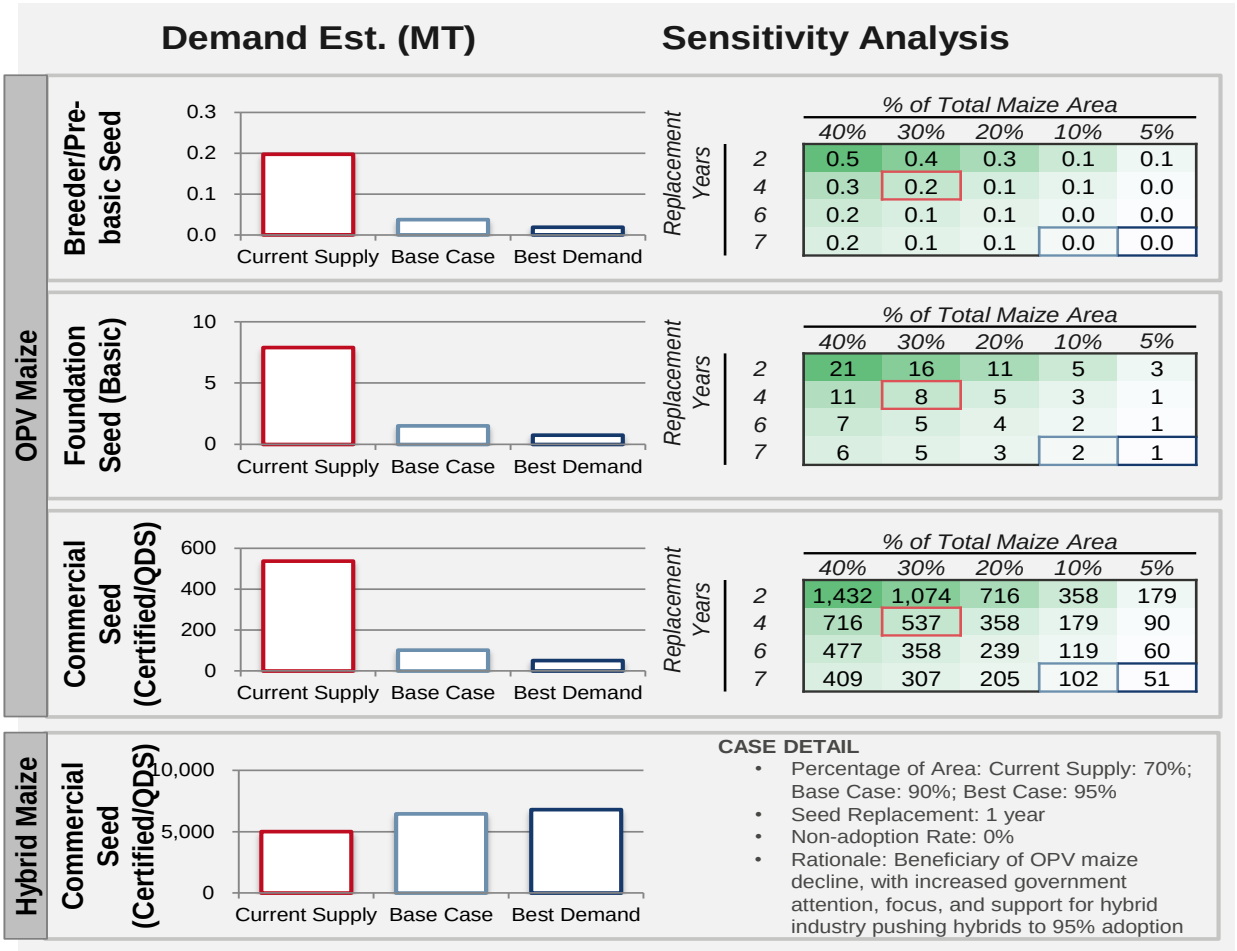


Source: Field research team interviews (2016).

MAIZE

As previously mentioned, there are two key sub segments of maize, OPV and hybrids. OPV continues to decrease from its current estimated 30% penetration and as such demand for EGS is projected to continue to decline, reaching less than 10% of total area planted (Figure 38). Conversely, hybrid maize seed demand is estimated to continue to increase reaching 90-95% adoption. As no hybrids are currently produced in Rwanda (nor does this report recommend they should be), demand of hybrid maize parental seed was not calculated.

Figure 38: **Maize - potential early generation seed demand.**



Source: Field research team interviews (2016).

4.2 PRODUCTION COST OF EARLY GENERATION SEED

INTRODUCTION

The cost of EGS production will have a major impact on the optimal archetype for each crop, on the ability to scale up EGS, and on the sustainability of the system. Understanding the cost is critical to developing a realistic and achievable plan for increasing the supply of EGS. For this study cost models were built using very limited data available from official sources and obtaining best estimates of the cost of production through interviews with seed producers, farmers and RAB personnel engaged in seed production.

Due to the lack of official cost information and the diversity of actors in the Rwandan seed sector, the cost models developed for this study primarily focus on the variable costs of production. It is critical to note that this analysis is not a full costing of production costs, as factors such as start-up costs, infrastructure, depreciation of fixed assets, cost of unapproved varieties, testing, and other early-stage investments were not included.

It should be further noted that hybrid maize costs were not assessed due to the fact that all production currently takes place outside of Rwanda, and we recommend the continuation of this part of the supply chain.

The tables below provide high level estimates of the cost of production for each crop assessed. It should go without saying that breeder seed is not a profit center and the actual cost of producing breeder seed is trivial compared to the cost of the R&D activities that led to the variety being produced in the first instance. If there is a need or interest in making the research and variety development programs whose end product is breeder seed financially self-sustainable, that would be an entirely different question and would have to be addressed separately.

The cost of multiplying breeder seed through pre-basic and basic seed production is a discrete cost that can be estimated and accounted for in the prices paid by seed producers for pre-basic and basic seed. In Rwanda the cost of EGS production significantly exceeds the prices charged by RAB. RAB also influences seed prices charged by the private sector both directly through setting the price that can be charged for seed and in some cases indirectly through unofficial subsidies (i.e. not cost accounting for all activities within their seed production unit).

POTATO

The cost of EGS production for potato is, comparatively speaking, lower than in the other crops assessed in this study mainly because of the higher seed yields (Table 14). Despite these lower relative costs there is further room for improvement with the adoption of technologies such as aeroponics.

***Table 14*: Potato - early generation seed cost of production.**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT	231		2,310		23,095	
Variable Cost $ per Ha	$13,616	*Herbicides and pesticides are ~50% of variable costs; seed costs are ~42% of total*	$5,869	*Herbicides and pesticides are ~50% of variable costs; seed costs are ~32% of total*	$3,276	*Inputs represent ~70% of total variable costs*
Fixed Cost $ per Ha	$3,771	***Breeder salaries $450***	$1,337	***Breeder salaries $750***	$504	***No breeder salary allocation; labor in variable costs***
Total Costs	$17,387		$7,206		$3,780	
Margin	*$1,739*	*10% base assumption*	*$721*	*10% base assumption*	*$378*	*10% base assumption*
Cost + Margin $ per Ha	$19,126		$7,926		$4,158	
Cost + Margin $ per Kg	$1.59	***12,000 Kg/Ha yield***	$0.40	***20,000 Kg/Ha yield***	$0.21	***20,000 Kg/Ha yield***

Source: Field research team interviews (2016).

COMMON BEAN

Common bean EGS production costs are relatively high versus potato due to the low yields in seed production (Tables 15 and 16). Costs are higher in climbing bean than bush bean due to the higher production costs as climbing bean requires more in-field management. It's counter intuitive that basic seed production costs are higher than breeder seed production. This is mainly due to how RAB allocates its breeder seed costs.

***Table 15*: Bush bean - early generation seed cost of production.**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT	6.7	*3 cycles required (breeder/pre-basic)*	80	*1 cycle required*	1,600	*1 cycle required*
Variable Cost $ per Ha	$4,162	*Herbicides and pesticides are ~25% of variable costs; plowing and harvesting are both ~16% of total*	$1,396	*Herbicides and pesticides are ~27% of variable costs; plowing and harvesting are both ~16% of total*	$1,029	*Labor is ~40% and fertilizer is ~30% of total variable costs*
Fixed Cost $ per Ha	$1,556	***Breeder salaries $810***	$4,913	***Breeder salaries $2,957***	$1,792	***No breeder salary allocation; labor in variable costs***
Total Costs	$5,718		$6,309		$2,821	
Margin	*$572*	*10% base assumption*	*$631*	*10% base assumption*	*$282*	*10% base assumption*
Cost + Margin $ per Ha	$6,290		$6,940		$3,103	
Cost + Margin $ per Kg	$3.49	***1,200 Kg/Ha yield (600 Kg/Ha per cycle)***	$6.94	***1,000 Kg/Ha yield***	$3.10	***1,000 Kg/Ha yield***

Source: Field research team interviews (2016).

***Table 16*: Climbing bean - early generation seed cost of production.**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT	.356	*3 cycles required (breeder/pre-basic)*	16	*1 cycle required*	800	*1 cycle required*
Variable Cost $ per Ha	$5,523	*Herbicides and pesticides are ~37% of variable costs; plowing and harvesting are both ~12% of total*	$1,865	*Herbicides and pesticides are ~37% of variable costs; plowing and harvesting are both ~12% of total*	$1,394	*Labor is ~50% and fertilizer is ~25% of total variable costs*
Fixed Cost $ per Ha	$3,986	***Breeder salaries $3,420***	$13,785	***Breeder salaries $11,829***	$1,798	***No breeder salary allocation; labor in variable costs***
Total Costs	$9,509		$15,649		$3,192	
Margin	*$951*	*10% base assumption*	*$1,565*	*10% base assumption*	*$319*	*10% base assumption*
Cost + Margin $ per Ha	$10,460		$17,214		$3,511	
Cost + Margin $ per Kg	$4.10	***2,550 Kg/Ha yield (150 Kg/Ha per breeding cycle, 2.5 MT/Ha per basic cycle)***	$6.89	***2,500 Kg/Ha yield***	$1.40	***2,500 Kg/Ha yield***

Source: Field research team interviews (2016).

OPV MAIZE

OPV EGS production costs are lower than common bean but higher than potato. As RAB is discontinuing production, resources used for producing OPV seed could be reallocated to other crops for which RAB is still responsible.

***Table 17*: OPV maize - early generation seed cost of production.**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT	0.2		7.9		537	
Variable Cost $ per Ha	$1,577	*Herbicides and pesticides are ~25% of variable costs; plowing and harvesting are both ~15% of total*	$1,599	*Herbicides and pesticides are ~25% of variable costs; plowing and harvesting are both ~15% of total*	$3,337	*Casual labor represents the bulk of the total variable costs (~85%)*
Fixed Cost $ per Ha	$1,485	***Breeder salaries $762***	$323	***Breeder salaries $40***	$381	***No breeder salary allocation; labor in variable costs***
Total Costs	$3,062		$1,922		$3,719	
Margin	*$306*	*10% base assumption*	*$192*	*10% base assumption*	*$372*	*10% base assumption*
Cost + Margin $ per Ha	$3,368		$2,115		$4,090	
Cost + Margin $ per Kg	$3.37	***1,000 Kg/Ha yield***	$1.24	***1,700 Kg/Ha yield***	$1.49	***2,750 Kg/Ha yield***

Source: Field research team interviews (2016).

4.3 EARLY GENERATION SEED MATCHED WITH REVENUE/COST

When matching revenues and costs of the selected crops in this study, the key takeaway is that potato is a much more commercially attractive crop than common bean or OPV maize (Table 18). While it is expected that breeder seed in all crops is not profitable, only potato appears to be profitable at the basic and commercial seed levels. Profitability levels are quite low across crops and this is likely due to the fact that retail prices do not fully reflect the value created by the improved varieties. The table also reveals an opportunity for more private sector involvement in potato seed systems while common bean likely requires a greater level of public sector support. Tables 19, 20, and 21 provide summaries of the three key crops in terms of marginal economic value of improved varieties versus demand of improved varieties which informs their optimal market archetype classification in the next chapter.

Table 18: **Early generation seed matched with revenue/cost.**

Crop	BREEDER/PRE-BASIC SEED						
	Price/Kg	Cost + Margin/Kg	Seed Rate (Kg/Ha)	Demand (MT)	Total Revenue (Ha)	Total Cost (Ha)	Contribution (Ha)
Bush Bean	$0.00	$3.49	50	6.7	$0	$175	($175)
Common Bean	$0.00	$4.10	50	0.4	$0	$205	($205)
OPV Maize	$0.00	$3.37	25	0.2	$0	$84	($84)
Potato	$0.93	$1.59	2,000	231	$1,867	$3,188	($1,321)
Crop	**BASIC SEED**						
	Price/Kg	Cost + Margin/Kg	Seed Rate (Kg/Ha)	Demand (MT)	Total Revenue (Ha)	Total Cost (Ha)	Contribution (Ha)
Bush Bean	$0.86	$6.94	50	80	$43	$347	($304)
Common Bean	$0.86	$6.89	50	16	$43	$344	($301)
OPV Maize	$0.60	$1.24	25	7.9	$15	$31	($16)
Potato	$0.60	$0.40	2,000	2,310	$1,200	$793	$407
Crop	**COMMERCIAL SEED**						
	Price/Kg	Cost + Margin/Kg	Seed Rate (Kg/Ha)	Demand (MT)	Total Revenue (Ha)	Total Cost (Ha)	Contribution (Ha)
Bush Bean	$0.70	$3.10	60	1,600	$42	$186	($144)
Common Bean	$0.73	$1.40	60	800	$44	$84	($40)
OPV Maize	$0.93	$1.49	25	537.0	$23	$37	($14)
Potato	$0.33	$0.21	2,000	23,095	$667	$416	$251

Source: Field research team interviews (2016).

Table 19: **Summary of potato assessment.**

Potato	Assess-ment	Comments
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES		
Differential performance of improved varieties	**Med.**	While improved varieties widely adopted, there haven't been any new releases in two decades, growers demanding yield, quality, and disease resistance.
Frequency of seed replacement	**Med.**	High disease pressure drives growers to buy seed more frequently than common bean but not annually as potato not hybridized.
Differentiating characteristics	**Med.**	Consumer markets have clear preferences and price of potato seed reflects market price for potato; nascent processing industry needs processing varieties that are not available at this time; Rwanda could become a regional supplier of market potatoes which could drive demand for varieties meeting specific market needs.
Fragility of seed	**High**	Serious lack of good storage facilities coupled with high disease incidence makes seed quality difficult to maintain; as a result, most seed is planted in the growing season following harvest.
Cost of quality seed production	**Med./High**	Low multiplication rates and high volumes require multiple cycles of seed increase, and disease pressure requires high use of fungicides.
Overall Value of Improved Varieties	**Med.**	**Currently marginal value of improved varieties is limited by lack of technology adoption to lower costs and absence of a formal market that supports premium pricing.**
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES		
Total demand for seed	**Med.**	Fifth-largest area in Rwanda and third-largest producer in Africa.
Requirement for quality assurance	**High**	Quality assurance critical to ensure seed is pure and disease free and could potentially be a requirement for varieties with processing characteristics.
Farmer demand for specific varieties	**High**	Growers growing ~10 key varieties with one variety (Kigali) the market leader; farmers generally have a strong understanding of strengths and weaknesses of varieties.
Market demand for specific varieties	**Med./High**	While rural and urban markets have clear preferences, larger opportunity exists if industrial processing and export markets develop.
Overall Demand for Quality Seed	**Med./High**	**Current high demand has potential to further grow with introduction of new varieties that meet farmer, market, and export needs; opportunity for processing varieties to drive emerging sector.**

Source: Research team analysis (2016).

Table 20: **Summary of common bean assessment.**

Common Bean	Asses-ment	Comments
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES		
Differential performance of improved varieties	**Low/Med.**	Potential yield benefits 2-3x for improved varieties, greater than national averages, but on-farm results have yet to demonstrate potential in a compelling way.
Frequency of seed replacement	**Low**	Farmers plant saved seed for 5+ years to reduce cost of production.
Differentiating characteristics	**Low**	While characteristics in color, taste, and cooking quality exist, opportunity to capture value via price premiums is nonexistent in current market environment.
Fragility of seed	**Low**	Seed durability a nonissue as seed is not stored for a significant time and seed is used locally.
Cost of quality seed production	**High**	Production costs high due to low multiplication rates and low yields; climbing bean highly labor intensive .
Overall Value of Improved Varieties	**Low/ Med.**	**Marginal economic value of improved varieties low to medium as cost of production high and pricing opportunities minimal.**
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES		
Total demand for seed	**High**	Real demand for seed is high as most widely grown crop in Rwanda but value of improved variety yields needs to be validated and demonstrated.
Requirement for quality assurance	**Low/Med.**	Attributes relatively easy to maintain (low genetic drift and hardy seed), therefore certified seed does not provide the same value in common beans as in other crops.
Farmer demand for specific varieties	**Low**	Farmers plant variety mixes rather than specific varieties. The value of any single variety is difficult for a farmer to see in this situation and makes widespread adoption of any one variety a challenge.
Market demand for specific varieties	**Low**	No existing downstream demand from large-scale industrial processors and no variety-specific export demand to stimulate adoption of specific varieties. The ongoing attempt to introduce bio-fortified varieties might stimulate demand for specific varieties.
Overall Demand for Quality Seed	**Low/ Med.**	**While largest crop in acreage terms in Rwanda, until value of improved varieties is demonstrated and/or cash markets are created, demand will be below potential.**

Source: Research team analysis (2016).

Table 21: **Summary of hybrid maize assessment.**

Hybrid Maize	Assess-ment	Comments
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES		
Differential performance of improved varieties	**High**	Hybrids clearly outperform OPVs, especially in the North.
Frequency of seed replacement	**High**	Growers purchase hybrid seed every year due to high yield degeneration.
Differentiating characteristics	**High**	High yield of hybrids compared to OPVs would support premium pricing.
Fragility of seed	**N/A**	Must purchase hybrid seed every year due to high yield degeneration.
Cost of quality seed production	**Med./High**	Intensive management requirements, a high level of expertise required to minimize risk and maximize production.
Overall Value of Hybrid Maize	**High**	**Marginal economic value of hybrids highest of all crops in Rwanda.**
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES		
Total demand for seed	**High**	Maize represents third-largest area in Rwanda and fastest growing; hybrid maize adoption has reached 70% in <10 years and expected to continue as Rwanda has a maize production deficit.
Requirement for quality assurance	**High**	Hybrid performance can suffer significantly if seed purity and quality are low; a robust certification process is needed to ensure seed is high quality.
Farmer demand for specific varieties	**High**	Driven by need for adaptation to specific growing conditions.
Market demand for specific varieties	**Low**	Limited industrial processing opportunity as Rwanda processors are mostly lower-value hammer mills; export opportunity minimal as currently importing 60K MT from Uganda.
Overall Demand for Hybrid Maize	**High**	**Demand for hybrids will continue to grow due to clear economic benefits of hybrids versus OPVs and country level production deficit.**

Source: Research team analysis (2016).

CHAPTER 5: EARLY GENERATION SEED OPERATIONAL STRATEGIES

5.1 OPTIMAL MARKET ARCHETYPE

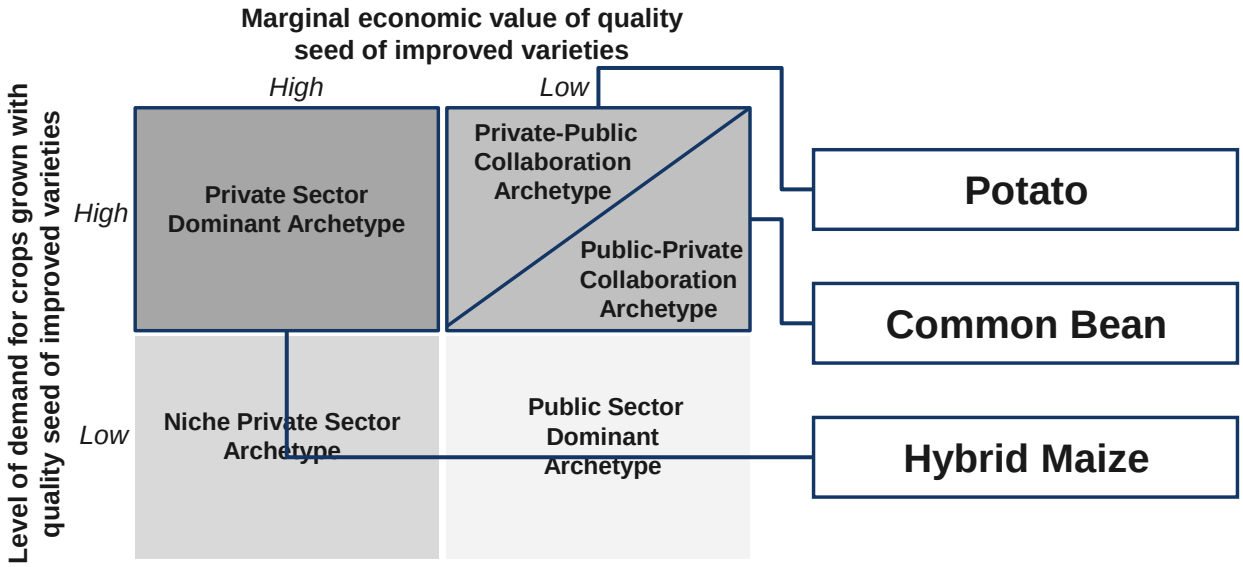
Potato, common bean, and hybrid maize have been classified into specific market archetypes based on their respective marginal economic value of quality of improved varieties and the level of demand for crops grown with quality seed of improved varieties.

Table 22: **Summary of crop assessments.**

	Common Bean	Potato	Hybrid Maize
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES			
Differential performance of improved varieties	**Low/Med.**	**Med.**	**High**
Frequency of seed replacement	**Low**	**Med.**	**High**
Differentiating characteristics	**Low**	**Med.**	**High**
Fragility of seed	**Low**	**High**	**N/A**
Cost of quality seed production	**High**	**Med./High**	**Med./High**
Overall Value of Improved Varieties	**Low/Med.**	**Med.**	**High**
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES			
Total demand for seed	**High**	**Med.**	**High**
Requirement for quality assurance	**Low/Med.**	**High**	**High**
Farmer demand for specific varieties	**Low**	**High**	**High**
Market demand for specific varieties	**Low**	**Med./High**	**Low**
Overall Demand for Quality Seed	**Low/Med.**	**Med./High**	**High**

Source: Research team analysis (2016).

Figure 39: **Optimal archetype classification.**



Source: Research team analysis (2016).

Potato: Public-private collaboration archetype

- *Economic value*: Currently, marginal value of improved varieties is limited by the lack of adoption of advanced propagation technologies (which has kept technology costs high) and the absence of a formal market to support premium pricing.
- *Demand*: Current high demand has the potential to further grow with the introduction of new varieties that meet farmer, market, and export needs, with an opportunity for processing varieties to drive an emerging sector.

Common bean: Public-private collaboration archetype

- *Economic value*: Marginal economic value of improved varieties is low to medium as cost of production is high and pricing opportunities minimal.
- *Demand*: While largest Rwandan crop in acreage terms, demand will be below potential until value of improved varieties is demonstrated and/or cash markets are created.

Hybrid maize: Private sector dominant archetype

- *Economic value*: Marginal economic value of hybrids highest of all crops in Rwanda, but intensive management requirements and a high level of expertise are required to minimize risk and maximize production.
- *Demand*: Demand for hybrids will continue to grow due to clear the economic benefits of hybrids versus OPVs and country-level production deficit.

5.2 KEY CHALLENGES

In order to reach the identified optimal market archetypes for each respective crop, there are both crop specific and cross crop challenges to overcome, which are outlined in Table 23.

Table 23: **Summary of key challenges**

	Ideal State	Current State			
	Key Factors	**Obstacles to Overcome**	**Common Bean**	**Potato**	**Hybrid Maize**
Policy	Harmonize Rwanda seed policies with COMESA and EAC	Current policy that all seed planted must be grown in Rwanda			✓
	Efficient and liberalized import policy	Inadequate staffing and training in risk assessment/management		✓	✓
	Adequate farm size for seed production	Farm sizes small and lack of isolation areas for seed producers		✓	
Regulation & Quality Assurance	Efficient and fair registration process	Not functioning, conflict of interest, not aligned with COMESA	✓	✓	✓
	Documented quality standards	Growers lack access to quality standards which are rarely communicated and enforced	✓	✓	✓
	Functioning Quality Declared system	Quality Declared system not operational	✓	✓	
Technical & Mgmt. Capabilities	Properly trained and staffed personnel for quality testing labs and field inspection	Inadequate qualified lab personnel; lack of skilled personnel for field inspection and sampling	✓	✓	✓
	Properly trained and staffed extension system	Understaffed and limited ability to support seed producers	✓	✓	✓
	Seed producers with business and technical skills	Seed producers lack training and ongoing support	✓	✓	
Demand Creation & Market Linkages	Improved varieties meeting grower needs	Bush bean breeding not meeting farmer needs; potato program not actively developing varieties	✓	✓	
	Robust demonstration trial platform driving grower adoption	Demonstration trials constrained by seed availability, trained personnel, and number of plots	✓	✓	
	Best in class agronomic practices	Limited access to fertilizer, lack of agronomic best practices	✓	✓	✓
	Demand generation targeted to smallholder famers	Tailored small pack sizes, robust marketing communications (i.e. radio	✓	✓	
	Clear visibility of demand	No market demand system in place for EGS producers to forecast demand accurately	✓	✓	
Incentives & Access to Capital	Clear subsidy strategy to ensure sustainable improved seed adoption	Strategy to eliminate hybrid maize subsidy unclear to industry			✓
	Capital to support grower investment	Poor access to loans and nascent agricultural lending sector	✓	✓	✓
	Government financing for private seed companies	No financing exists for capital-intensive seed production costs		✓	✓

Source: Research team analysis (2016).

5.3 PUBLIC-PRIVATE PARTNERSHIP MECHANISMS AND SOLUTIONS

DEFINITION AND BACKGROUND

A PPP is commonly defined as a government service or private business venture that is funded and operated through a partnership between the public sector or government entity and one or more private sector companies. Accordingly, the public sector or government actor may provide support in a number of ways, including through fiscal policy or the contribution of infrastructure or expert capabilities. Typically, a PPP involves the transference of risk from the public sector to the private sector, with the balance of risk often determined by the allocation of potential value in the partnership. Within the PPP, private sector actors should not be viewed as comparable to a contractor or vendor, but instead as equal partners with the public sector, aligned at every stage of the PPP.

PPPs have increased in prevalence in recent decades, especially in the developing world. This has corresponded with the increase of private sector resources dedicated to developing countries. The Congressional Research Service notes that government development assistance agencies such as USAID and the State Department are working with private sector entities in unprecedented ways to determine when and if such partnerships can lead to improved development results. As explained in the Obama Administration's 2010 Quadrennial Diplomacy and Development Review, "private sector partners can add value to our missions through their resources, their capacity to establish presence in places we cannot, through the technologies, networks, and contacts they can tap, and through their specialized expertise or knowledge." Modern PPPs, characterized by joint planning, joint contributions, and shared risk, are viewed by many development experts as an opportunity to leverage resources, mobilize industry expertise and networks, and bring fresh ideas to development projects. Partnering with the private sector is also widely believed to increase the likelihood that programs will continue after government aid has ended. From the private sector perspective, partnering with a government agency can bring development expertise and resources, access to government officials, credibility, and scale.

Several benefits and disadvantages exist for PPPs (IISD, 2011):

Potential Benefits

- Increased efficiency, expertise, and innovation from the private sector contribute to better infrastructure and greater cost and time savings.
- Project risks are distributed between public and private sectors according to the party best equipped to deal with it.
- Access to private sector financing allows increased investment.
- PPPs provide the private sector with access to reduced risk, secure, long-term investment opportunities that are underwritten by government contracts.

Potential Disadvantages

- A PPP may prove to be more expensive in the long-term than standard procurement, due mainly to the higher costs of private sector borrowing when compared to government rates.

- Accountability and transparency issues are distorted under PPP models of financing and agreements; as private sector funding components fail to appear on the public spending records. Similarly, evaluation is made more difficult as private sector data on profits, costs, or lessons learned can be considered issues of commercial confidentiality and less easily accessible.
- The inclusion of exclusivity agreements within PPP contracts can have the effect of awarding monopoly markets to private partners.
- It is necessary for both the public and private sectors to possess PPP-specific capacity for an agreement to be signed and administered successfully, which takes both time and experience.

Many organizations have found successful ways to implement PPPs within a variety of industries. An example from the Congressional Research Service of the Malawi Dairy Association Development Alliance is below:

Objective: Build the capacity of small dairy farmers, local milk processing plants, and farmer-owned milk bulking programs in order to improve production and profitability.

Mechanisms and Solutions: Partners collaborated on improving the entire dairy value chain, including loan programs that allow farmers to purchase new heifers, improved feed and cattle health, loan guarantee programs for local milk processing facilities, and improved milk bulking practices. The alliance provides rural dairy farmers, feed producers, and small and medium-size dairy processing facilities with the resources and tools required for a successful local dairy industry.

Table 24: **Partners, contributions, and motivations for Malawi dairy PPP.**

Partner	Contribution	Motivation
Land O'Lakes	Technical expertise, significant experience in Malawi, introduction of new cattle breeds	National visibility, social responsibility
Local milk producers/dairies	Investments in new practices and technology, capital for farmer loan programs	Higher, more predictable income
General Mills	Financing	National visibility, social responsibility
Monsanto	Soybean seeds and technical assistance. The mature beans are used for cattle feed	National visibility, social responsibility
USAID	Technical advice, financing, partner and alliance coordination	Economic growth
Government of Malawi	Extension agents that worked in the value chain, assistance with animal importation, assistance with processing paperwork quickly	Economic growth

Source: Congressional Research Service (2013).

RATIONALE

The most significant challenges confronting EGS systems in Rwanda are the cost of current systems and the growing unwillingness of major donors to fund EGS systems in Africa. The structural and demand issues identified in this study that impact quantity, quality, and use of early generation and certified seed can be addressed and resolved, but only if adequate financial and human resources are brought into play.

It would be a daunting task for the government of Rwanda to undertake all of the changes necessary to build a fully capable and effective EGS system, even in the absence of funding constraints. In the absence of donor funding for EGS systems, the government should be willing to consider alternatives that will incentivize private sector participation and reduce the need for government support of the seed sector.

Although the challenges and opportunities identified in common bean and potato are not identical, in both cases a public-private partnership could be established as the foundation for building high-performance EGS systems. The differences in the two crops warrant slightly different approaches, but before addressing differences, it is instructive to consider the concept of a public-private partnership and how it would address EGS needs.

The early generation seed-PPP (EGS-PPP) would be responsible for the production of basic seed. The breeding organization would continue to have responsibility for breeder seed production, which for common bean would include pre-basic seed. In the case of potato, the EGS-PPP may be involved in pre-basic production at some level. Certified or QDS would be produced in the private sector.

Although the EGS-PPP would not have responsibility for the production of breeder seed, there would need to be a close working relationship with the breeders. The breeder is the ultimate authority on the phenotype of the varieties in production and would play a critical role in ensuring basic seed meets the variety specifications. When questions arise in basic production fields, the breeder must be available to walk fields with the EGS-PPP personnel and identify key quality issues such as “off types.”

An important difference between the current system of certified seed production and the approach taken with an EGS-PPP is that basic seed would only be sold to qualified seed producers who have demonstrated expertise and capabilities in producing quality seed of a defined standard. The EGS-PPP would work with private growers (farmers, cooperatives, and local seed companies) to certify their standing as Quality Seed Producers.

An effective EGS-PPP would significantly reduce or even eliminate government responsibility for production of EGS for certain crops and stimulate the development of a robust private seed sector. This would allow the government to redirect resources away from EGS production and provide additional support for research and extension activities to ensure a steady supply of improved varieties and enable farmers to realize more of the potential inherent in improved varieties.

MECHANISMS AND SOLUTIONS

An EGS-PPP would have three primary objectives:

- Produce enough EGS to meet current and future demand.
- Produce seed at the lowest possible cost while continuing to meet quality standards
- Stimulate demand for quality seed at the farm level

Quantity of seed: To achieve a system capable of meeting current and future needs the EGS-PPP would have an in-house production program, based at RAB facilities, and would engage farmers, cooperatives, and local seed companies as contract producers of EGS to add capacity to the system. Using RAB stations to produce basic seed will allow the EGS-PPP to focus on adding people and equipment for the program rather than using its financial resources to acquire or rent land. Using RAB stations would provide a diversity of locations for basic seed production.

In order to provide flexibility and expansion capabilities to the production of basic seed the EGS-PPP would utilize the FFS framework established by the BTC to build and train networks of basic seed producers.

An added benefit of this approach is the carryover into the production of certified seed and QDS. Because the EGS-PPP would only sell basic seed to qualified growers, growers who become part of the EGS production system would automatically qualify as certified seed and QDS producers, thus providing a second opportunity to leverage their expertise and resources and generate additional income.

Cost and quality: The EGS-PPP would strive to increase efficiency and productivity of basic seed production to meet the low-cost objective. This would include using seed production resources already in place, i.e., RAB facilities for an EGS system. The strengths of the system include availability of land, expertise in seed production, a national seed laboratory, and a seed certification program with trained field inspectors.

RAB assets should be leveraged by the EGS-PPP to avoid duplicating facilities and resources. The EGS-PPP would conduct its in-house production activities on RAB stations and provide additional equipment to existing RAB seed processing facilities and to the RAB seed laboratory. During peak seasons, private seed company partners would work alongside RAB personnel to ensure standard operating procedures (developed and documented by the EGS-PPP) are followed and to provide additional labor, ensuring timely completion of seed processing and testing.

RAB would benefit from the EGS-PPP by having access to more equipment, standard operating procedures that could be adjusted to work in other crops, and personnel with first-hand experience in a quality seed production system.

Stimulate Demand for Quality Seed: The EGS-PPP can play an important role in stimulating demand for quality seed by working with RAB extension, relevant CGIAR organizations, and NGOs to conduct on-station and on-farm trials using best agronomic practices and quality seed in comparison with farmer-saved seed. A key reason to focus on EGS systems is the knowledge that quality seed provides inherent benefits compared to farmer-saved or other informal seed sources. Although this principle is generally recognized, there is no data to confirm or refute the hypothesis in Rwanda. The EGS-PPP can play a central role in generating data showing the value of quality seed.

Demand for quality seed also depends on farmers' understanding the value of improved varieties. The EGS-PPP can help demonstrate the value of improved varieties through variety demonstration trials conducted in conjunction with the same partners mentioned in the preceding paragraph.

The EGS-PPP would also have a stimulating effect on demand for quality seed by building farmer trust in the quality seed system. In Rwanda today, farmers cannot count on quality seed being available, or if it is available, it may not be the variety in demand. The EGS-PPP would play a central role in the Rwandan seed system, and its focus on delivering both quality and quantity will impact on the commercial seed system as well. By having the right varieties in the right quantities at the right time, farmers would come to trust the system and be more willing to invest in high quality seed of improved varieties.

OPERATING PRINCIPLES

The EGS-PPP for basic seed should be established under a legal structure that allows it to generate and retain operating profits. The only way to ensure the EGS-PPP can meet its goals in the long term is to enable it to charge market rates for seed and use retained profits for continuing improvements to operations.

The RAB breeding programs would receive royalties on sales of EGS and potentially on the sales of certified or quality declared seed of varieties originating in their program. The basic concepts of the royalty program could be built into the formation documents, leaving specific royalty rates and terms determined on a case-by-case basis.

Private sector partners would expect to benefit financially from the operations of the EGS-PPP. This could come in the form of royalties on sales of proprietary varieties (a distinct possibility in potato) or expanded market presence for crop protection partners or a growing and assured supply of raw product for processing partners.

The EGS-PPP should develop, or tap into, an effective system to forecast product demand. A major limitation of the current system is the absence of real-time information on the specific varieties and quantities needed to meet market demands. The EGS-PPP will be well placed to collect and utilize demand information.

Identifying and securing the right private sector partners is the crucial requirement for success. The Rwandan private seed sector is not sufficiently established to be a key private partner and therefore the government should look outside Rwanda for partners with expertise and interest in seed and seed-related products. This will be a difficult task and it may require securing several private sector partners. Thus the government would need to be flexible and creative in its search and in the terms it is willing to accept.

PUBLIC-PRIVATE PARTNERSHIPS IN COMMON BEAN AND POTATO EARLY GENERATION SEED

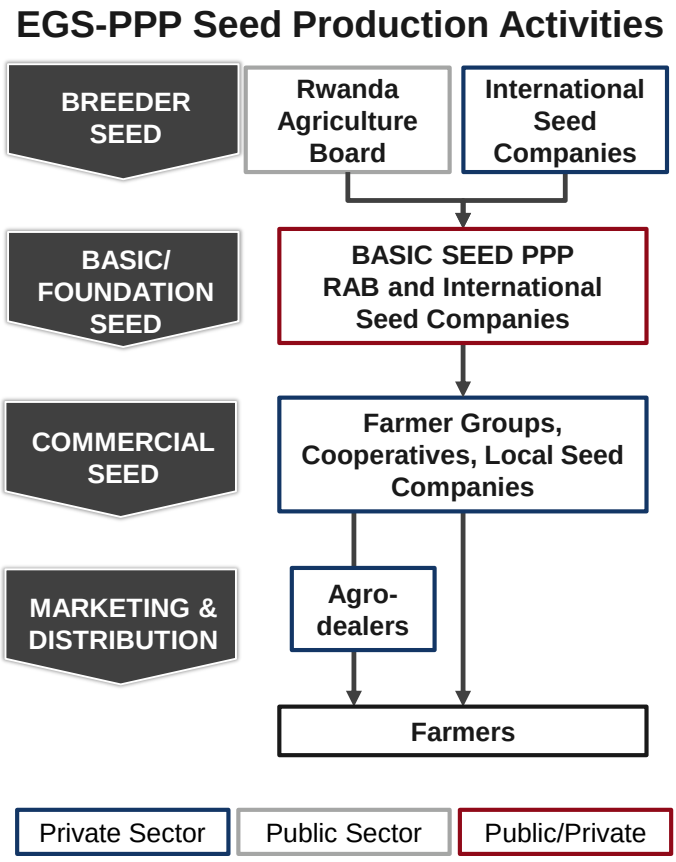
The EGS-PPP concept has merit for common bean and potato, but important differences between the two crops suggest that two such partnerships may be needed. RAB would be the public partner in both, but the nature of the crops and market opportunities for each may dictate different private partners.

A key to achieving success in both PPPs is finding a way to build synergies without necessarily creating formal linkages. However, if RAB is able to build synergies by (for example) co-location of field staff, open exchange of information and best practices, etc., it could create an appealing opportunity for both partnerships.

POTATO

Potato has greater potential to become economically interesting to the private sector than does common bean, and this difference will be key for attracting private partners. Figure 40 below outlines the EGS production steps in a potential EGS-PPP. The basic seed production level would be the focal point of the EGS-PPP and include RAB, international and local private seed companies. Because of the greater market opportunity in potato, the EGS-PPP should include a broader set of private stakeholders across the potato value chain, including processors, banks, MFIs, SACCOs, farmer groups, cooperatives, and agro-dealers as well as NGOs with critical experience in project coordination and implementation. Table 25 below highlights a not exhaustive list of potential stakeholders including their contributions and motivations.

Figure 40: **Potato EGS-PPP Seed Production Activities.**



Source: Research team analysis (2016).

Table 25: **Potato EGS-PPP Potential Stakeholder List.**

	Actors	Contribution	Motivation
Public	MINAGRI	Administrative facilitation and expedition, financial support, concept validation	Economic growth
	RAB	Improved varieties, land for seed production, *in vitro* lab, extension services, quality assurance services	Freed up resources, demand forecasting, increased revenue
	RALICS	Phytosanitary inspection services	Social responsibility
	RDB	Facilitation of private sector investment	Drive economic development
Private	International Seed Companies	Improved varieties and traits, seed production and business operations expertise, technology integration know-how, best-in-class agronomy, training, demand pull strategies such as demonstration plots	Access to Rwanda seed market and existing seed distribution networks, support for import seed
	Local Seed Companies, Farmer Groups, Coops, Agro-Dealers	Land and personnel for seed multiplication, mini-tuber production infrastructure, seed distribution networks	Business and technical training, access to improved varieties, increased revenue
	Agro-processors	Market information for processed products, consistent demand for higher priced products, export market linkages	Access to consistent supply and quality potatoes for processing
	Banks, MFIs, and SACCOs	Credit for agribusiness investment and working capital, short term credit for smallholder farmer input purchases	Economic growth
NGOs	Tubura, CIP, AFR	Implementation expertise, partner and alliance coordination, technical advice	Program benefits aligned with NGO objectives

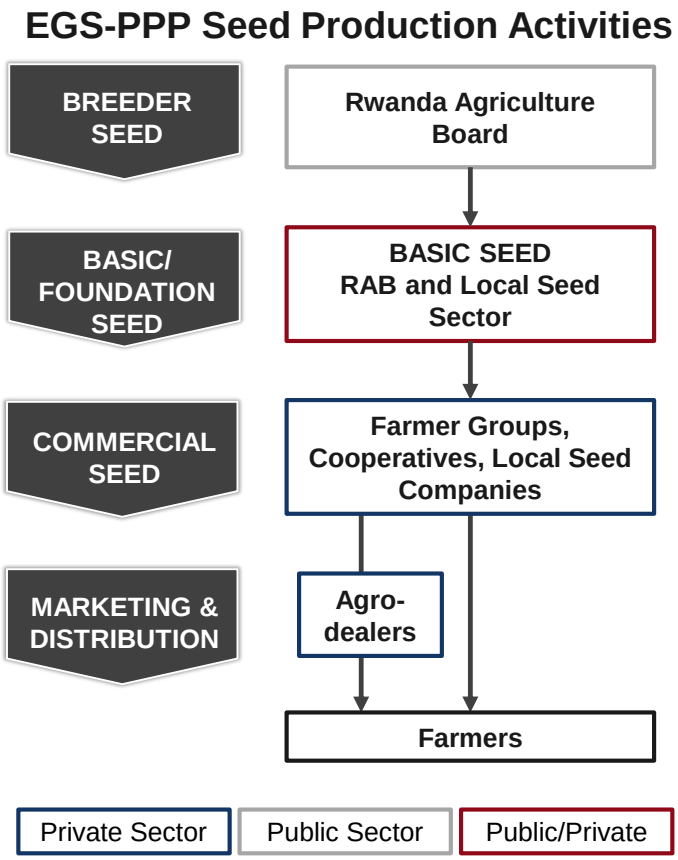
Source: Research team analysis (2016).

COMMON BEAN

The economics of common bean and common bean seed are inherently less attractive than in potato and will make it difficult to attract seed or other industry partners to participate in the common bean PPP. Attracting significant levels of private support for the common bean PPP could be enhanced by incorporating other crops that have production and processing requirements similar to common bean, such as soybean and wheat. Increasing the number of crops included in the PPP will create an economy of scale that enhances the attraction for private partners. At minimum, the common bean PPP should be seen as an opportunity to leverage the enhanced EGS resources created through the potato EGS-PPP and for building the Rwandan seed sector, while meeting the needs of Rwanda and Rwandan farmers in common bean.

Since RAB would be the public partner in both the bean and potato PPP, the enhanced seed production infrastructure arising from the potato PPP can be used for the common bean PPP as well. The BTC Seed School approach can cover two crops almost as easily as one crop, and if RAB is able to reduce its resources invested in maize as the private sector becomes more active in maize, it could redirect resources into bean PPPs. Figure 41 below highlights the specific seed production activities within the common bean EGS-PPP and table 26 outlines a non-exhaustive list of potential stakeholders in the EGS-PPP including their potential contributions and motivations.

Figure 41: **Common Bean EGS-PPP Seed Production Activities.**



Source: Research team analysis (2016).

Table 26: **Common Bean EGS-PPP Potential Stakeholder List.**

	Actors	Contribution	Motivation
Public	MINAGRI	Administrative facilitation and expedition, financial support, concept validation	Economic growth
	RAB	Improved varieties, land for seed production, extension services, quality assurance services	Freed up resources, demand forecasting, increased revenue
	RDB	Facilitation of private sector investment	Drive economic development
Private	Local Seed Companies, Farmer Groups, Coops, Agro-Dealers	Land and personnel for seed multiplication, seed distribution networks	Business and technical training, access to improved varieties, increased revenue
	Agro-processors	Market information for processed products, consistent demand for higher priced products, export market linkages	Access to consistent supply and quality beans for canning
	SACCOs	Short term credit for smallholder farmer input purchases	Economic growth
NGOs	Tubura, HarvestPlus, CIAT, AFR	Implementation expertise, partner and alliance coordination, technical advice	Program benefits aligned with NGO objectives

Source: Research team analysis (2016).

ESTABLISHING POTATO AND COMMON BEAN EGS-PPPS

In order to establish successful EGS-PPPs, it would be critical to develop a structured approach that manages the complexity associated with partnering with a broad set of stakeholders. The Urban Land Institute outlined ten principles that can and should guide the development of a successful PPP which have been tailored to the proposed potato and common bean EGS-PPPs (Urban Land Institute, 2005). These principles will have different action items depending upon the crops, but can provide a framework for the public and private sector actors involved in the PPP.

1. **Prepare properly for a PPP**: MINAGRI, RAB, the RBD, and NGOs such as Tubura and AFR, CGIARs such as CIP and HarvestPlus representing CIAT, private sector seed companies (local and regional), agro-dealers, farmer group and cooperative representatives, and key agro-processors will need to convene multiple meetings and interactions to jointly assess priorities and capabilities, determine potential roadblocks (legislative, resource based, etc.), develop timelines and expectations, establish feasibility, get to know the other partners, and establish the right team.
2. **Create a Shared Vision**: Within each PPP, the joint team established will need to then cast a wide net giving all stakeholders and potential partners an opportunity to provide input on the vision, determine the best ways to sustain the vision through a detailed implementation strategy, potential partners, and a time frame for achieving the vision.

3. **Understand Your Partners and Key Actors:** MINAGRI, RAB, and the RDB should validate the project's purpose, while the private sector will provide technical know-how and funding. The EGS-PPP concept will provide value for potato and common bean, but important differences between these crops suggest that each should have an individual structure and vision. RAB and the RDB would be the public partners in both EGS-PPPs, but the nature of the crops and market opportunities for each requires additional public and private partners specific to the vision, goals and needs of the crop.
4. **Be Clear on the Risks and Rewards for All Parties**: Each party identified and included in earlier principles will need to be fully involved so as to have the full understanding of the risks and rewards for their portion of involvement, whether they are public sector or private sector actors.
5. **Establish a Clear and Rational Decision-Making Process**: For each EGS-PPP, the partners will need to create a road map, define roles and responsibilities, and create appropriate checks and balances to ensure actions are taken in a timely manner and every actor is accountable to the other partners.
6. **Make Sure All Parties Do Their Homework**: Prior to entering into any partnership agreements, ensure that all actors have completed their due diligence to their own level of satisfaction, ensure that information is shared openly and freely, adopt scenario planning, and pursue creative public/private financing plans.
7. **Secure Consistent and Coordinated Leadership**: Focus on qualities such as integrity, vulnerability, discernment, and awareness of the human spirit, courage, compassionate sense of humor, intellectual energy and curiosity.
8. **Communicate Early and Often**: Prioritize both internal and external communication with internal communication ensuring roles and responsibilities are clear and complexity managed and external communication ensuring the PPP is transparent to all stakeholders. This type of communication will be a critical success factor with the purpose of aligning interests and consistent information sharing across a diverse set of organizations.
9. **Negotiate a Fair Deal Structure**: General principles to reach a fair deal should include a detailed division of responsibilities among the stakeholders, outcomes, and objective performance measures. Each stakeholder should perform its own due diligence before committing to the EGS-PPP charter and plans.
10. **Build Trust as a Core Value**: Building trust from the beginning of the EGS-PPP that endures throughout the course of the partnership should be a priority for all stakeholders. As noted by the Urban Land Institute, "to endure, partnerships require a foundation of trust in each partner's commitment to the project and its objectives" (Urban Land Institute, 2005).

5.4 RECOMMENDATIONS

POTATO AND COMMON BEAN

Establish a public-private partnership for potato and common bean

Both PPPs will require engagement with a broad set of private and public sector actors which span the potato and common bean value chains and include local and international private actors. The leadership of MINAGRI, RAB, and the RDB will be essential in positioning the PPPs as a strategic priority and ensuring administrative hurdles are quickly and efficiently overcome.

Private seed companies, including international actors specific to the potato PPP will be important partners that need to be empowered to ensure best practices are shared. While the processing industry is in its early stages, processors will play a critical role driving the economic value of potato seed production and could also play a role in the development of a common bean canning industry. Additionally, farmer groups, cooperatives, agro-dealers, banks, MFIs, and SACCOs are key stakeholders in the PPP that should play significant roles in the formation and design of the PPP to ensure long term economic sustainability.

This diverse set of stakeholders should be convened to develop a consensus on structure, final PPP participants, and roles. This initial group of stakeholders should include the widest range of possible actors to make sure all opinions are included in the initial formation documents. This group should be refined to create an industry task force with the responsibility of creating a draft PPP proposal, including the draft operational plan, analysis and proposal for suitable legal and operating structures, and a timeline for establishing and operationalizing the PPP. Donors such as USAID and BTC can play important roles in supporting infrastructure needs of the PPP and scaling up of training programs such as the FFS and the One Acre Fund's farmer training school.

POTATO

The priority for potato is to expand and enhance EGS production capabilities to meet current and future demand. Rwanda has a robust domestic market for potato and is well positioned to become a regional supplier of potato. Demand for EGS of potato already exceeds supply by at least threefold. The primary need in early generation potato seed is a fully capable and scalable EGS system. The overarching recommendation is to do so through a PPP as described in the previous section. In addition to building a scalable and efficient early generation potato seed system, steps should be taken to increase the availability of new, improved potato varieties and to further enhance the economic value of potato.

Here following are specific recommendations:

Increase availability of improved varieties

In order to increase the availability of improved varieties, there are several policy changes that are recommended. Rwanda's variety registration process should be harmonized with EAC and COMESA procedures to cut the current process from four years to two years. Furthermore, the proposal in the recently passed National Legislative Framework for Seed to move variety registration out of RAB and into an independent bodied should be implemented. Additionally, seed import policies and procedures should be reformed and harmonized to reduce time and regulatory delays that negatively impact seed importation. Plant variety protection policies that have been embodied in the new seed law should be quickly operationalized to encourage proprietary seed developers to enter Rwanda with improved genetics.

It is also recommended that the RAB potato research unit focus its efforts on variety evaluation and release by moving all seed production activities, including *in vitro* plantlet production, out of RAB and into the potato EGS-PPP. RAB hasn't released an improved potato variety since the 1990s and therefore it is important for RAB to refocus its efforts on variety evaluation and release rather than seed production, which the private sector is better positioned to lead in the EGS-PPP.

Finally, it is recommended that investments are made in increasing storage capacity for seed which will allow seed producers the opportunity to store inventory from successful harvests and increase sales flexibility.

Realize the potential marginal economic value of potato

The potato industry needs to continue to work towards realizing the potential marginal economic value of potato. This can be accomplished through a variety of interrelated efforts led by the PPP covering both increasing the volume of production and decreasing costs through the utilization of macro-propagation technologies.

By introducing new, high yielding varieties, smallholder farmers will be able to increase production and generate additional profit from the land they currently allocate to potato. Matched with this increased yield will be the need to expand storage capacity to enable smallholder farmers and traders the flexibility to store potato and to sell excess production (not required to generate operating cash) at the most ideal times, as dictated by market pricing, rather than selling any and all production immediately after harvest. The processing industry should also be engaged to determine which varieties are in demand and create an action plan for processors to source these varieties from farmers.

COMMON BEAN

The priorities for common bean are to build on-farm demand for improved varieties and quality seed and increase the marginal economic value of common bean. As these two objectives are realized, there will be a need for a robust and capable EGS system built as a PPP. In order to make this PPP attractive to the private sector, the government should consider including soybean and wheat with common bean.

Here following are specific recommendations:

Stimulate farmer adoption of improved varieties and quality seed of common bean

To increase farmer demand for high quality improved seed it is recommended that the PPP design and execute on-farm trials to compare the performance of farmer-saved seed and quality seed. Successful execution of these trials will require sufficient numbers of plots, seed, and staff to reach smallholder farmers. This will allow for direct engagement with the farmers and also help to prove out the value proposition of the seed being sold by the PPP. Additionally, RAB extension service programs should be expanded to provide training and ongoing support in not only the use of best agronomic practices, but also in calculating the costs and benefits of investment in inputs. Once the investment case for investing in improve varieties is demonstrated and understood by farmers, the GoR through AFR should work with SACCOs with the aim of establishing purpose-built agricultural lending products to smallholder farmers. As a longer term recommendation, RAB should intensify its efforts in its bush bean breeding program, emphasizing yield and disease resistance, in order to keep pace with the number of releases in the climbing bean program.

Enhance the marginal value of common bean

There is an opportunity to reposition common bean as a higher value crop in Rwanda. As a production hub in East Africa, there is significant opportunity to increase exports through

increased production. It is recommended that the RDB through the common bean PPP prioritize common bean as a key opportunity for smallholder farmers. Additionally, it is recommended that the HarvestPlus within the PPP promote the value of biofortified beans to farmers and consumers to build demand for improved varieties.

In order to enhance the marginal value of common bean, increasing yield and decreasing costs should be prioritized. As a part of the common bean PPP, there will need to be promotion of the value of improved varieties and efforts made to educate farmers on higher yields and associated higher incomes through field trials and demonstrations. These two priorities will help to increase demand, but also will communicate and demonstrate the agronomic best practices that can result in higher yields for farmers. Supporting these efforts to increase yields will be cost reduction efforts within the seed system, where the PPP will encourage public and private sector actors to increase the scale of their operations and focus on cost reduction efforts in order to bring down overall costs within the common bean seed system. The PPP itself would be a prime example of the benefits of scale and it should strive to provide high quality commercial seed at the lowest possible cost to farmers so as to support the adoption and demand stimulation efforts noted above.

HYBRID MAIZE

The priority objective for hybrid maize it to stimulate sustainable private sector growth by removing barriers to participation, which will allow the public sector to exit the market.

The government of Rwanda has stimulated significant growth of maize production through its support and focus on replacing OPV maize with high-performance maize hybrids. The current program, including ongoing seed price subsidies, encourages farmers to adopt hybrid maize and use good agronomic practices. The Tubura experience has proven that smallholder farmers clearly benefit from using hybrids and that the lack of agricultural credit is the key bottleneck limiting further adoption. Maintaining an OPV EGS system props up an inferior product and is detrimental to smallholder farmer's interests.

Maize is clearly a private sector crop. Across the globe, maize hybrids are developed and supplied to farmers through private sector activities motivated by profit. In Rwanda, the private sector is the exclusive source of maize hybrids and maize seeds. Rwanda has no established hybrid maize development or seed production programs. If the government would fully enable the maize private sector by removing all policy and regulatory barriers and allowing market forces to dictate which hybrids are sold and at what prices, Rwandan farmers would be well served, Rwanda's food and economic security needs would be well served, and the government can redirect resources into support for other crops.

Here following are specific recommendations:

MINAGRI should work in close collaboration with local seed companies to develop and communicate a strategy to eliminate maize subsidies. This will remove market distortions, enabling private seed companies the opportunity to develop long term seed production plans. Additionally, it is recommended that MINARGI allow private maize seed companies to make seed production decisions, including what to produce and where to produce it, without government approval. In the absence of subsidies, it will be critical that MFIs and SACCOs

develop purpose-built agricultural lending products tailored for smallholder farmers to ensure that they continue to adopt hybrid maize seed.

Policy changes recommended for potato also are necessary for hybrid maize. Rwanda's variety registration process should be harmonized with EAC and COMESA procedures to cut the current process from four years to two years. The proposal in the recently passed National Legislative Framework for Seed to move variety registration out of RAB and into an independent bodied should be implemented. Additionally, seed import policies and procedures should be reformed and harmonized to reduce time and regulatory delays that negatively impact seed importation. Plant variety protection policies that have been embodied in the new seed law should be quickly operationalized to encourage proprietary seed developers to enter Rwanda with improved genetics. It is also recommended that RAB focus its hybrid maize program on conducting trials to provide farmers with unbiased data to support hybrid purchase decisions rather than hybrid seed development and production.

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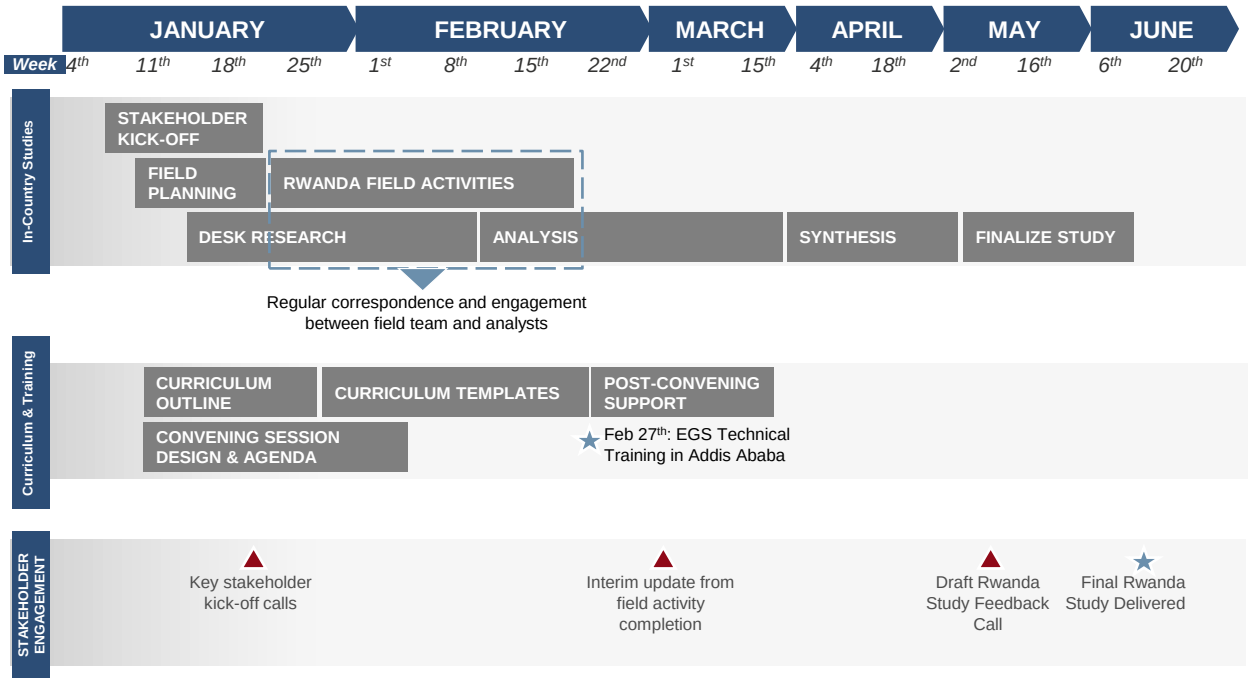
ANNEX A: PROJECT TIMELINE



ANNEX B: FIELD RESEARCH TEAM

Rwanda Field Research Team	Rwanda Stakeholders	Project Management Team
Mark Walton (Lead) **Evans Sikinyi** (CCN) **Clement Urinzwenimana** (CCN)	**Malick Haidara, Patrice Hakizimana** (USAID Rwanda) Rwanda Agriculture Board, Ministry of Agriculture, selected seed companies, NGOs active in seed supply, and value chain actors such as processors, farmers, farmer groups, and traders	**Africa Lead/DAI**: David Tardif-Douglin, Chuck Johnson **USAID**: David Atwood, Mark Huisenga **Context**: Mark Nelson, Rob Lowenthal, Seth Taylor, and Dan Creagh

ANNEX C: STAKEHOLDER INTERVIEW LIST

Interview	Role
Ministry	MINAGRI Agricultural Development, Director General
Ministry	RALICS Phytosanitary Control, Director General
Public – National Research Institute	RAB, Head of Maize Breeding
Public – National Research Institute	RAB, Head of Common Bean Breeding
Public – National Research Institute	RAB, Head of Potato Breeding
Public – Quality Assurance	RAB Seed Inspection and Lab Services, Director
Public – Seed Producer	RAB Seed Production Unit, Director
Private – Seed Producer	Maize, Potato, Climbing Bean, North province
Private – Seed Producer	Maize, Bush Bean, East province
Private – Seed Producer	Maize, Bush Bean, South province
Private – Seed Producer	Potato, North province
Private – Seed Company	SEEDCO, Country Representative
Private – Seed Company	Kenya Seed Company, Country Representative
Private – Seed Company	Win-Win, Country Representative
Private - Processor	Potato Processor Representative
Farmer Group/Cooperative	Farmer Representative, North province
Farmer Group/Cooperative	Farmer Representative, North province
Farmer Group/Cooperative	Farmer Representative, North province
Farmer Group/Cooperative	Farmer Representative, North province
Farmer Group/Cooperative	Farmer Representative, North province
Farmer Group/Cooperative	Farmer Representative, North province
Farmer Group/Cooperative	Farmer Representative, East province
Farmer Group/Cooperative	Farmer Representative, East province
Farmer Group/Cooperative	Farmer Representative, East province
Farmer Group/Cooperative	Farmer Representative, East province
Farmer Group/Cooperative	Farmer Representative, East province
Farmer Group/Cooperative	Farmer Representative, East province
NGO	Tubura One Acre Fund, Head of Partnerships
NGO	Tubura One Acre Fund, Program Associate
NGO	AGRA, Independent Consultant (working with local seed producers)
CGIAR	HarvestPlus (CIAT), Rwanda Country Manager
CGIAR	CIP, Rwanda Country Manager
Donor	Belgium Technology Corporation, Seed Producer School Lead
Donor	USAID Rwanda Mission, Agriculture Specialist
Donor	Netherlands Embassy in Kigali, Agricultural Counselor