KENYA EARLY GENERATION SEED STUDY

COUNTRY REPORT

June 2016

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CONTENTS

TABLES AND FIGURES

TABLES

FIGURES

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 Evans Sikinyi and James Karanja.

The team is grateful for the support of DAI including David Tardif-Douglin, Charles Johnson, Sonja Lichtenstein, and Dorcas Mwakoi as well as guidance from BFS Senior Food Policy Advisors, David Atwood and Mark Huisenga, and USAID Kenya's, Andrew Read and Samson Okumu.

The team would also like to thank all key stakeholders in Kenya 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 Kenya (GoK) 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 Kenyan government's continued efforts.

ACRONYMS

AATF	African Agricultural Technology Foundation
ADC	Agricultural Development Corporation
AGRA	Alliance for a Green Revolution in Africa
BFS	Bureau for Food Security (USAID)
BMGF	Bill and Melinda Gates Foundation
CAADP	Comprehensive African Agricultural Development Program
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
DAI	Development Alternatives, Inc.
EAC	East African Community
EGS	Early generation seed
EGS-PPP	Early generation seed public-private partnership
FAO	Food and Agriculture Organization of the United Nations
FTF	Feed the Future
GDP	Gross Domestic Product
GoK	Government of Kenya
KARI	Kenya Agricultural Research Institute
KALRO	Kenya Agricultural and Livestock Research Organization
KSC	Kenya Seed Company
KSU	KALRO Seed Unit
KEPHIS	Kenya Plant Health Inspectorate Service
MTP	Medium Term Plan
MoA	Ministry of Agriculture, Livestock, and Fisheries
NGO	Non-governmental organization
OPV	Open pollinated variety
QDS	Quality Declared seed
SACCO	Savings and credit cooperative society
USAID	United States Agency for International Development
WEMA	Water Efficient Maize for Africa

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 Kenya.

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.

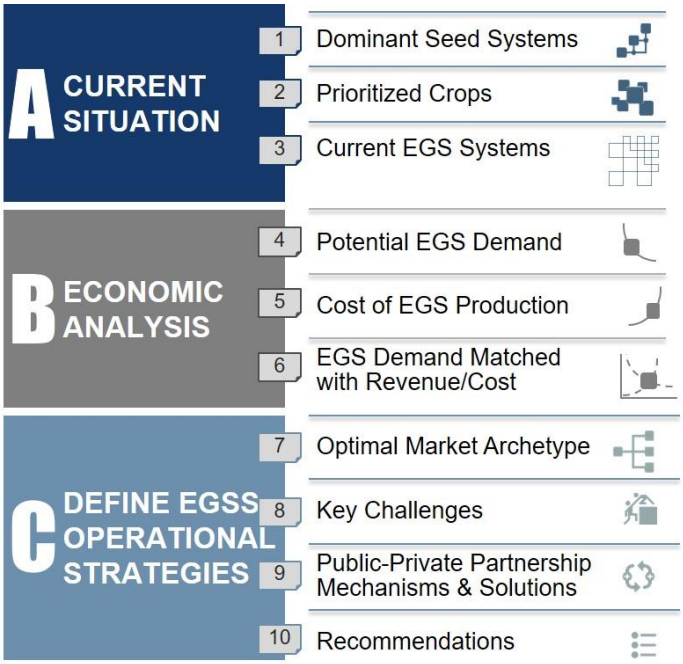
Formal seed system: The formal seed system is a deliberately constructed system that involves a chain of activities leading to genetically improved products: certified seed of verified varieties. The chain starts with plant breeding or a variety development program that includes a formal release and 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 Kenya 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.

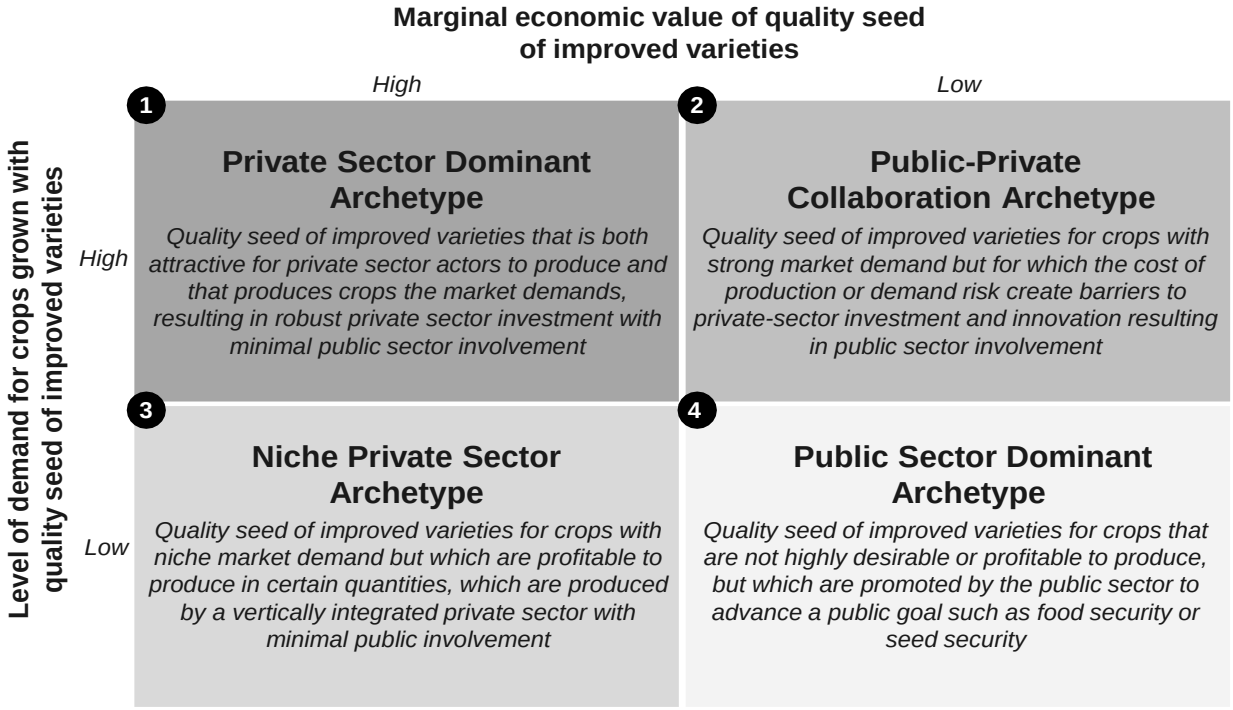
Figure 1: **EGS System ten-step process.**



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 key seed system and agricultural stakeholders from the public and private sectors during a roundtable meeting convened in Nairobi, Kenya on March 16, 2016. Attendees included representatives from USAID, Kenya Agricultural and Livestock Research Organization (KALRO), Kenya Plant Health Inspectorate Services (KEPHIS), the Seed Trade Association of Kenya, African Agricultural Technology Foundation (AATF), National Potato Council of Kenya, public universities, Consultative Group on International Agricultural Research (CGIAR), and private seed companies. Please refer to Annex C, the stakeholder list.

PRIORITY CROPS

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

EXECUTIVE SUMMARY

SEED SYSTEMS IN KENYA

There are five identified dominant seed systems in Kenya, which include farmer-saved, NGOs and cooperatives, parastatal, private international, and private local. The farmer-saved seed system accounts for the majority of seed volume, while the parastatal and private sector companies contribute the majority of EGS.

The dominant source of seed varies by crop, but crops tend to be aligned with one of three primary segments:

- Primarily formal (<35% informal): Wheat and maize are the primary focus of the formal seed sector, within which seed sales are dominated by the Kenya Seed Company (KSC), a parastatal entity.
- Primarily informal (35-95% informal): The majority of seeds sold in Kenya are through the informal channel, with important staple/food security crops forming a large percentage of this segment.
- Informal only (>95% informal): Cassava, soybean, and sweet potato seeds are sourced from the informal sector.

In the latest available figures, based on pre-2010 studies, the informal market is estimated to be responsible for approximately 75-80% of the total seed market in Kenya (Tegemeo, 2006). Interviews with key stakeholders indicate that the formal share has increased in recent years, particularly in maize, common bean, sorghum, and cowpea, due to additional seed companies entering the market, high disease pressure pushing farmers to buy certified seed, and new varieties being available in the market.

EARLY GENERATION SEED SYSTEMS BY CROP

The Kenyan EGS system involves many organizations across both the public and private sectors, with specific roles and responsibilities dependent upon the crop. KALRO is the primary research and breeding organization within the country, KEPHIS responsible for all inspection and certification across crops. Private sector participants are also involved in breeding and EGS seed production, providing their own genetics or additional production capacity depending on the crop.

Maize: The production and delivery of hybrid maize seed to farmers requires a formal seed system. As noted previously, approximately 80% of the Kenyan maize area is planted with improved, certified hybrid and OPV (Open Pollinated Varieties) seed and is therefore serviced through a formal seed system. Of this segment of the market, hybrids account for the vast majority, making up an estimated 75% of planted area overall. The formal OPV seed system has been in decline for several years, and is estimated to represent approximately 10% of total planted area. The remaining 20-30% is the informal OPV market. Although some private seed producers and local seed companies produce certified OPV maize, it is clear from interviews conducted for this study that this segment of the market has experienced a decrease in overall investment, research, and breeding efforts from private seed companies and public institutions and is expected to decline significantly over the next five years.

Potato: It is estimated that only 3-5% of the potato planted area is supported by the formal seed system, while more than 95% of potato area is planted with seed sourced by farmers through informal means. However, current EGS demand is estimated to be significantly greater than supply due to supply bottlenecks beginning at the plantlet level and extending through the system. The formal system is public sector driven, but there is growing private sector participation, specifically from international seed companies, NGOs, and private seed companies, such as Kisima.

Common bean: It is estimated that only 5-10% of the common bean seed originates in the formal seed system, with the balance of 90-95% of 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. Comparing the formal and informal markets, there is a large difference between the planting rates, with the formal planting rate estimated to be 25 kg/ha, with the informal rate estimated to be twice that rate at 50 kg/ha. Interviews indicate this variance is due to farmers compensating for lower quality of seed in the informal market and the resulting low germination rate.

EARLY GENERATION SEED SYSTEM CONSTRAINTS BY CROP

Maize: Maize seed supply bottlenecks stem mainly from the certification system as well as production issues, with several smaller demand constraints. These include:

Supply bottlenecks

- Lengthy certification process for breeder seed.
- Lengthy certification process for commercial seed.
- Absence of an adequate EGS demand forecasting system.
- Insufficient land for seed production.
- Limited irrigation for seed production.

Demand constraints

- Lack of yield benefits from hybrids in low-input (e.g. fertilizer and insect control) conditions.
- Lack of affordable credit options for smallholder farmers.
- Competition from counterfeit seed and lack of farmer trust in “improved” seed.
- Lack of supply of appropriate and improved varieties.
- Lack of farmer awareness in the advantages of improved varieties.

Potato: EGS potato seed demand is currently significantly greater than supply due to issues that include:

Supply bottlenecks

- Inadequate *in vitro* production capacity.
- High cost of production due to a high reliance upon power.
- Lengthy payback period discourages new market entrants.
- Lack of capacity and slow approval process in the certification system.

- Lack of adequate supply information in the market increases farmer confusion and limits their ability to find the right variety at the right time.
- Lack of an adequate distribution system increased the difficulty in accessing seed.
- Lack of storage for EGS and commercial seed.

Demand constraints

- Fluctuating prices for ware (non-seed) potatoes increases profit uncertainty for farmers.
- Limited farmer knowledge of agronomic best practices.

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

Supply bottlenecks

- Lack of production of breeder and basic seed.
- Inadequate supply of breeder seed from public sector breeders precludes private sector involvement in EGS production and limits EGS production overall.
- Lack of GoK investment in non-maize crops.
- Lack of involvement and support from developing institutions for private sector companies through commercialization of new varieties.

Demand constraints

- Prior demand generation activities were not matched with supply, leading to farmers being skeptical of seed availability.
- Limited awareness among smallholder famers of the business case to invest in improved seed.
- Limited availability of and access to credit for smallholder farmers.

PUBLIC-PRIVATE PARTNERSHIPS

There are different challenges and opportunities identified in hybrid maize, potato, and common bean, but all three crops would benefit from having their own public-private partnership (PPP) aimed at improving the current EGS systems. For each crop, an effective EGS-PPP would significantly reduce or even eliminate government responsibility for production of EGS at various stages and would further align the public and private sector interests within a crucial sector for Kenya's economy. Following the successful creation and implementation of an EGS-PPP for each crop, the government would be able to redirect resources away from EGS production to further develop the national research program and reinstate national level extension services. These two programs would help to ensure a sustainable supply of improved varieties for Kenyan farmers in the future.

An EGS-PPP would have four 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 improved varieties and quality seed at the farm level.
- Facilitate receipt of licensing revenue to foster sustainable public sector breeding efforts.

The EGS-PPP concept would provide value for hybrid maize, potato, and common bean, but important differences between these three crops suggest that each should have an individual

structure and goal. KALRO and KEPHIS would be the public partners in all three, but the nature of the crops and market opportunities for each requires additional public and private partners specific to the goals and needs of the crop.

A critical success factor in each PPP, and a significant change from prior PPPs in Kenya, would be the alignment of interests and sharing of information across a diverse set of organizations. To further this goal, one of the high level recommendations is that each PPP form within their structures Deployment and Communication working groups that focus on key problems and develop solutions. These working groups would function as internal, cross-functional groups with representation from stakeholders already present in the PPP, and disseminate information to other stakeholders within and outside of the PPP. In order to ensure participation, PPP members would be expected to provide representation to these working groups as a part of their commitment to the PPP. This model has been successfully utilized in other organizations, such as Water Efficient Maize for Africa (WEMA), which is itself a PPP.

For each PPP, the Deployment working groups would be focused on how varieties are moved from development to commercialization. This would involve demand estimation/forecasting, provision of demonstration seed, and ensuring varieties continue to be supported as needed in order to ensure successful commercialization. The Communication working groups would be focused internally to ensure that important lessons learned and feedback are being shared throughout the seed system, fostering an environment where information is transferred from actors interacting with farmers to actors responsible for variety development. The Communication working group would be charged with ensuring confidentiality when appropriate, particularly when multiple private sector partners are involved with gathering market intelligence and potential concerns about competitive dynamics arise. Taken together, these groups would be charged with working across the seed system production chain to help communicate farmer needs to breeders in the form of demand forecasting and ensure that private sector actors charged with variety commercialization have the support they need from breeders and the PPP to be successful.

RECOMMENDATIONS

Detailed recommendations for each crop can be found in section 5.4. The field research team recommends that there be a public-private partnership established for each crop 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.

HYBRID MAIZE

The priority objectives for hybrid maize are to increase private sector access to public sector varieties and to support the development of a sustainable supply of high quality EGS to support market demand for hybrid seed. The combination of these objectives is intended to create additional choices for farmers and broaden the potential royalty base for the public sector. In order to accomplish these objectives, the field research recommends a public-private collaboration be established at the basic seed stage across KALRO, private seed companies, and public universities.

Hybrid maize is a sector in which private seed companies are already active and engaged, with a long history of hybrid adoption within Kenya. Removing any current barriers to the success of

these private companies will be crucial for the success of the PPP, with specific areas of improvement coming from inspection and certification and reducing the overall cost of production.

Specific recommendations are as follows:

- Ensure broad private sector representation within the PPP.
- Revise current inspection and certification system.
- Allocate required resources to national extension service.

POTATO

The priority objective for potato is to expand and enhance EGS production to meet current and future demand through public-private collaboration.

Kenya has strong demand for potato and the supply of EGS currently falls well short of what is needed to serve current market demand. The primary need is a fully capable and scalable EGS system for potato. The overarching recommendation is to do so through a PPP anchored at the mini-tuber (breeder seed) production level between KALRO and private seed companies.

Specific recommendations are as follows:

- Involve international companies in the creation and operations of the PPP.
- Align EGS production locations with demand centers.
- Realize the potential marginal economic value of potato.

COMMON BEAN

The priority objectives for common bean are to increase the supply of improved seed to meet current market demand, build on-farm demand for improved varieties and quality seed, and create a sustainable demand by increasing the marginal economic value of common bean. To meet these objectives, there is a need for a robust and capable EGS system built as a PPP. The following are specific recommendations:

- Facilitate the direct engagement with farmers through on-farm trials to stimulate adoption of improved varieties and quality seed.
- Enhance the marginal value of common bean for farmers.

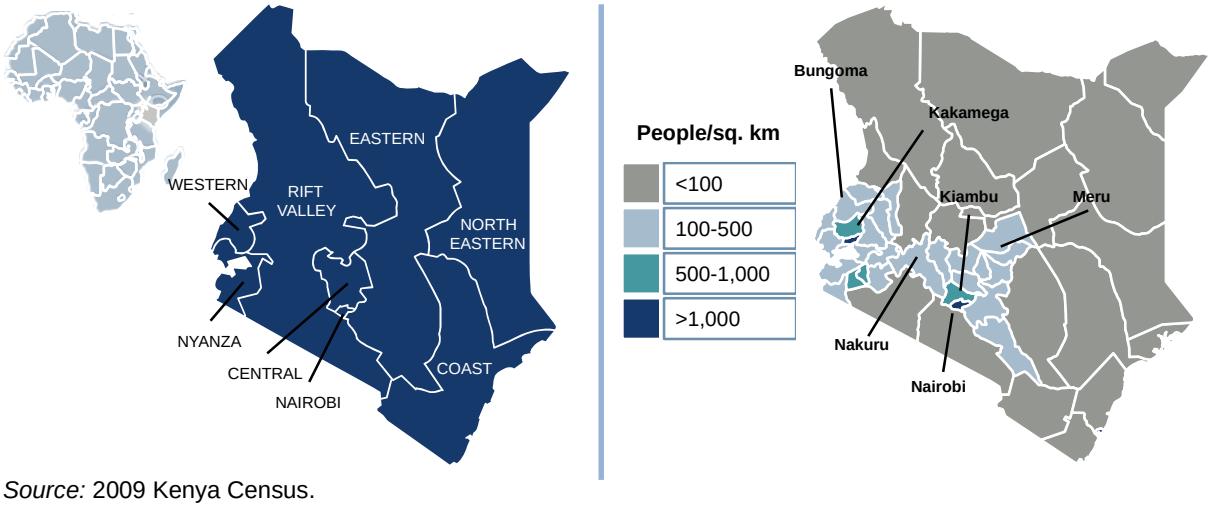
CHAPTER 1: CURRENT SITUATION – DOMINANT SEED SYSTEMS

1.1 COUNTRY OVERVIEW

Kenya is a regional hub in Eastern Africa with a highlands region that comprises one of the most successful agricultural production regions in Africa. The country shares boundaries with Somalia, Ethiopia, and South Sudan to the north, Uganda to the west, and Tanzania to the south. Forty-five million inhabitants live in an area of 580,000 square kilometers, creating a denser population than many other East African countries. In its 2010 constitution, Kenya altered its administrative divisions, decentralizing authority from seven provinces and the Nairobi administrative area to 47 underlying counties; however, much of the country's historical and trend data is still reported based on the original provinces.

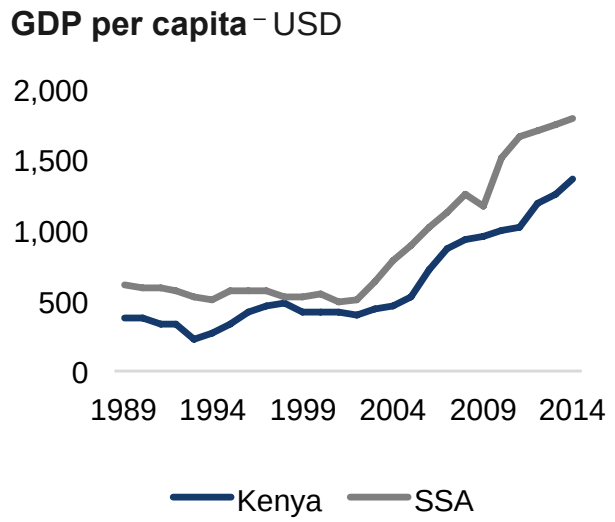
According to 2009 census data, the largest share of population by county can be found in Nairobi (8%), followed by Kakamega and Bungoma from the Western province, Kiambu (Central), Nakuru (Rift Valley), and Meru (Eastern) with 4% each, illustrated in Figure 3. Kenya is also home to 42 ethnic communities, with the two largest accounting for more than one-third of the population (Kikuyu 22% and Luhya 14%).

Figure 3: **Map of Kenya pre-2010 Constitution provinces and population density by county.**



Source: 2009 Kenya Census.

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



Source: World Bank (2016).

In 2014, real per capita gross domestic product (GDP) was $1,358, significantly below the Sub-Saharan average of $1,776 (World Bank, 2016), as shown in Figure 4. GoK's national long-term development policy (Vision 2030) is aimed at transforming Kenya into a newly industrializing, middle-income country. The plan aims to achieve annual GDP growth of 10% by 2017, with that growth rate continuing through at least 2030. Vision 2030 relies upon three primary pillars of development (economic, social, and political), with eight key underlying sectors and reforms implemented as a series of five-year Medium-Term Plans (MTPs), each having a series of interim development goals (currently in MTP II).

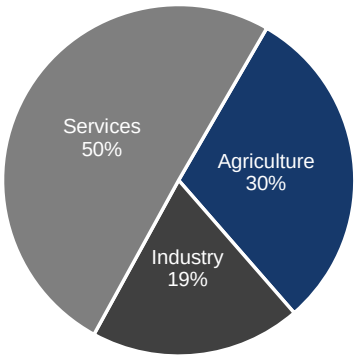
GDP has consistently grown since the 1990s, averaging 5% annually since 2006, with this growth primarily driven by the services sector, which accounted for 72% of the increase between 2006 and 2013 (World Bank, 2016). Nonetheless, despite consistent GDP growth rates, poverty remains high, ranking 145 of 188 in the Human Development Index (United Nations, 2015).

1.2 AGRICULTURE SECTOR

OVERVIEW

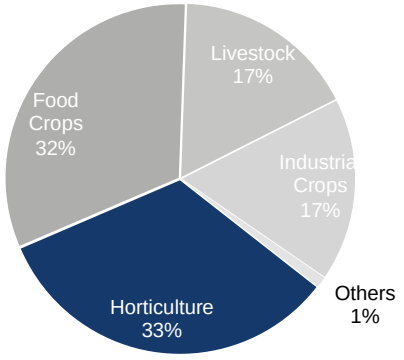
Agriculture contributes 30% to Kenya's GDP, as shown in Figure 5, which is comparable to Rwanda (33%) but more than Nigeria (20%). The other two sectors contributing to the national GDP are services with 50% and industry with 19%.

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



Source: World Bank (2016).

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



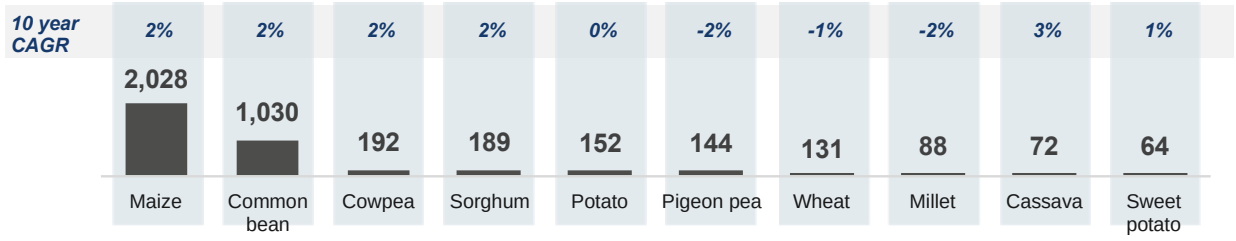
Source: World Bank (2015).

Additionally, agriculture is the most significant sector for employment in Kenya, with approximately 75% of the workforce engaged in an agriculture-related field (World Bank, 2016). Within the agriculture sector, 32% of GDP comes from the production of food crops (Figure 6), with horticulture crops representing the largest share at 33%. Industrial crops such as tea, coffee, and sugarcane account for only 17% of agriculture GDP but make up 55% of agricultural exports. Additionally, Kenya is a regional leader in the dairy industry, featuring the largest dairy herd in Eastern Africa.

KEY CROPS

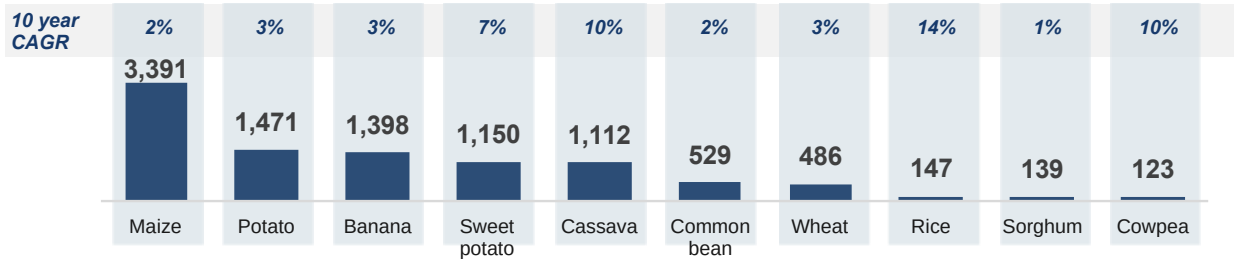
The top ten food crops in Kenya, based on area harvested and production, are presented in Figures 7 and 8. Maize is the largest crop based on area harvested and production volume and is grown by 95% of rural households. It is the most significant food crop, accounting for upwards of 30% of daily caloric intake for the average Kenyan. There has been slight but consistent production growth in several of the top food crops, with cassava, rice, and cowpea growing fastest, while maize and common bean production have increased only slightly.

***Figure 7*: Top 10 food crops by area harvested (2013, '000 Ha).**



Source: Kenya Country Stat (viewed in March 2016).

***Figure 8:* Top ten food crops by production (2013, '000 MT).**



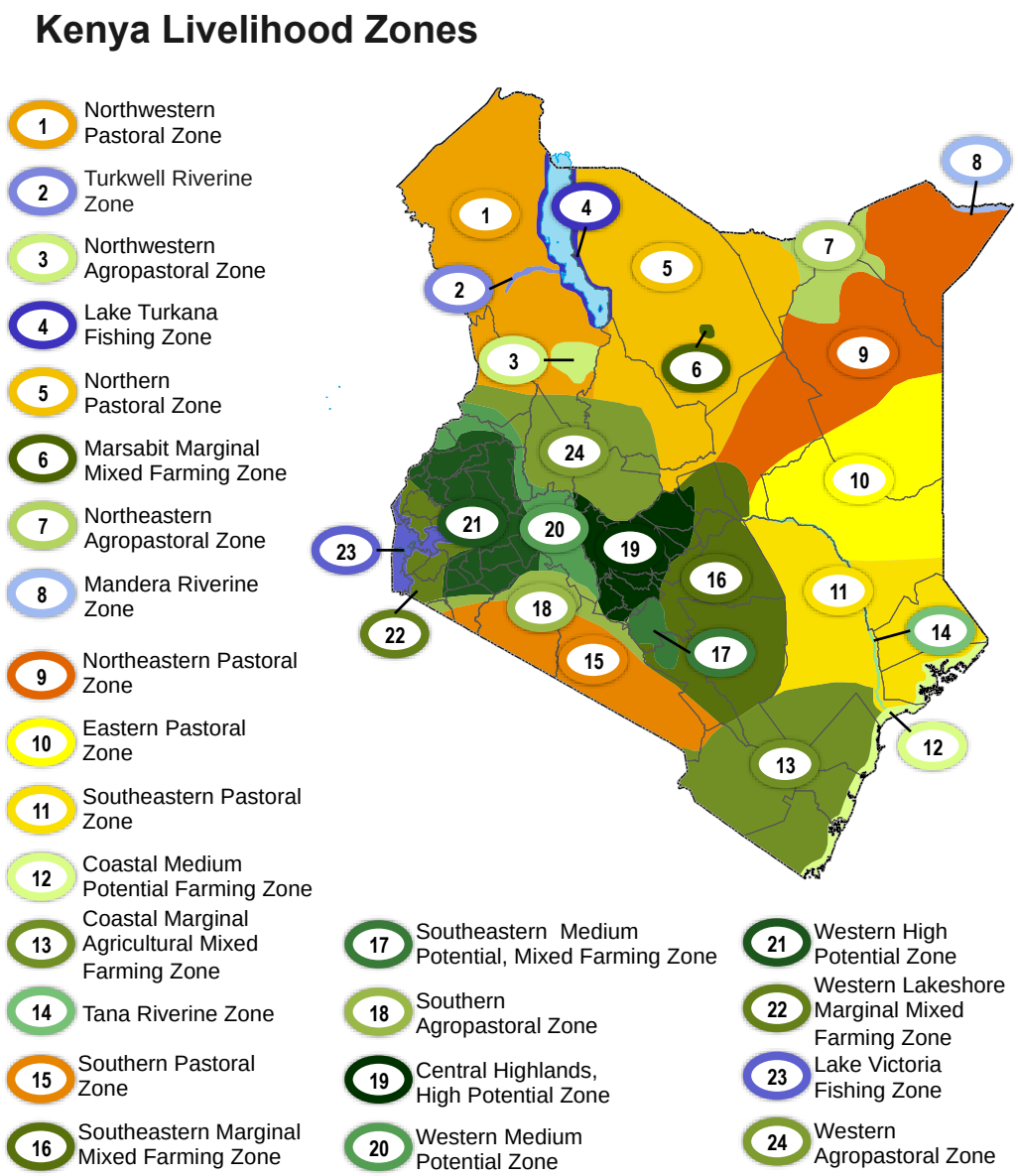
Source: Kenya Country Stat (viewed in March 2016).

GROWING CONDITIONS

Kenya has a number of diverse climatic zones, driven by significant differences in elevation and rainfall across the country. Figure 9 shows that USAID's Famine Early Warning System has identified 24 distinct livelihood zones, only five of which are rated as medium or high potential (Figure 10). The balance of the country is a mix of lower potential zone types including agropastoral, pastoral, fishing, mixed farming, and riverine. These zones correspond with the primary agroclimatic zones the FAO recognizes in Kenya, which can be grouped into two primary archetypes:

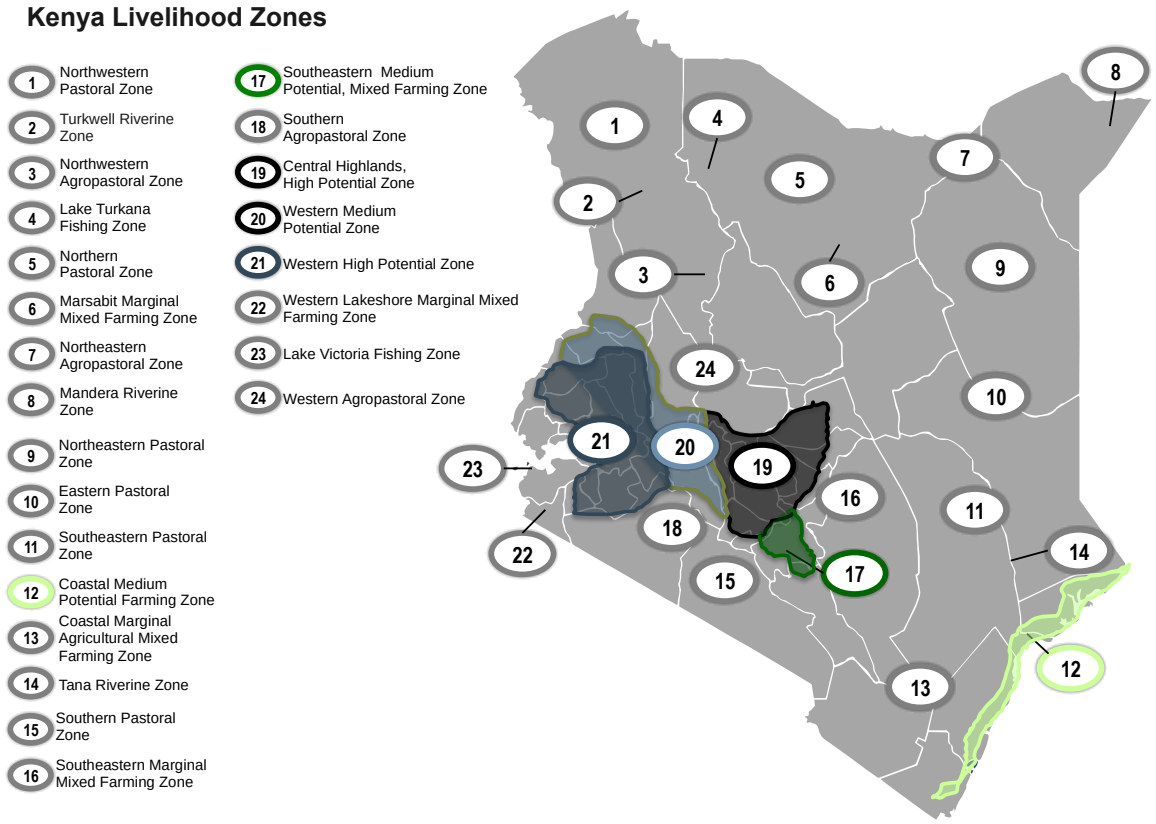
- Arid and semi-arid: Approximately 80% of Kenya is represented by semi-arid to very-arid zones unsuitable for rain-fed cultivation due to limitations related to climate and poor overall vegetation. These land zones are predominately pastoral and agropastoral, supporting more than 50% of the country's livestock population and more than seven million residents.
- Medium- and high-potential: Zones II, III, and IV in Figure 11 represent the medium- and high-potential zones around Mt. Kenya and the coast where annual rainfall is greater than 500 mm of moisture. These areas account for approximately 20% of total landmass in the country.

Figure 9: **Kenya livelihood zones.**



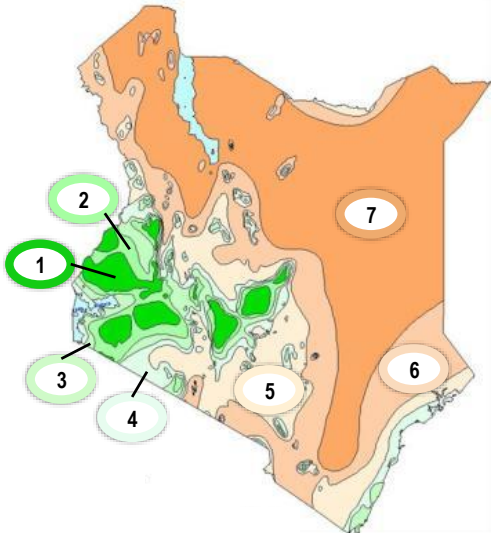
Source: Famine Early Warning Systems Network. (2011).

Figure 10: **High and medium potential livelihood zones.**



Source: Famine Early Warning Systems Network. (2011).

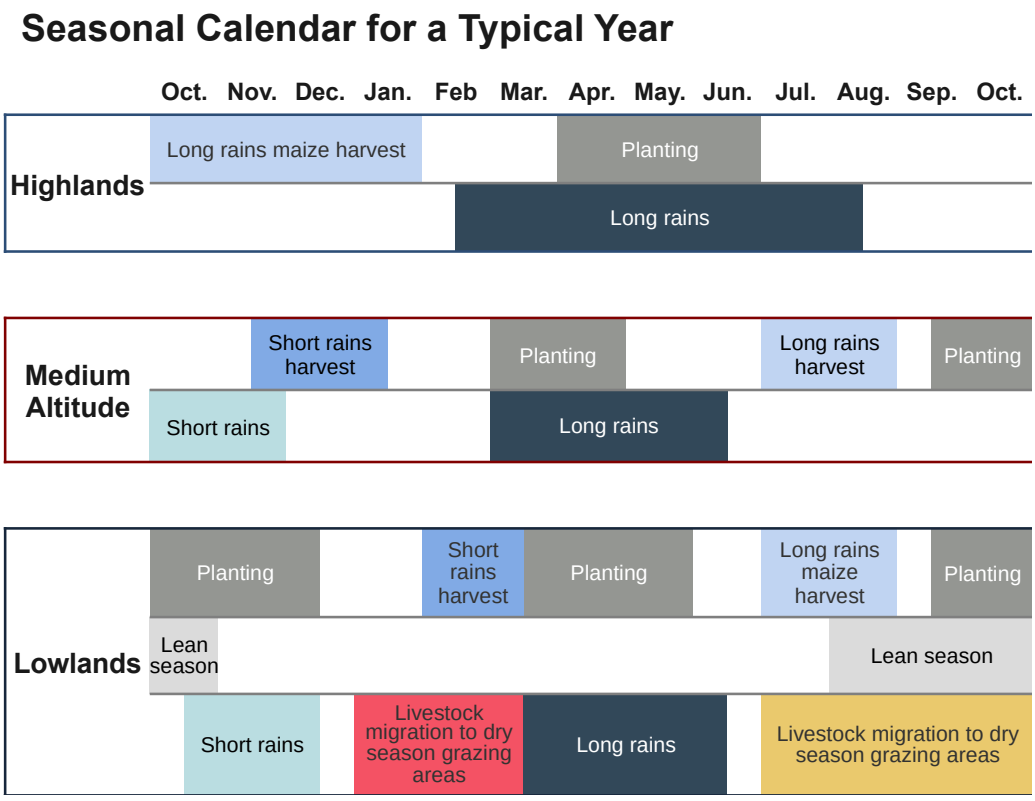
Figure 11: **Agroclimatic zones.**



Source: FAO

Multiple seasons exist in the majority of the country, featuring both long rains and short rains. The long rains season tends to have planting in March-June for harvests occurring mainly in September-November. The short rains season, which is the main season for a large portion of the country, including Machakos, Kitui, and Makweni counties, features planting in September through November with harvest occurring in February through April. All of these dates are dependent upon the actual timing of rainfall that can vary across the different regions of the country. Often times, seed harvested during one season is sold for planting in the next, which can create bottlenecks in the certification process and create supply shortages if the certification process cannot keep up with demand. With shifting weather patterns, the timing of seasons and the predictability of rainfall have become more variable over the past several years, increasing the perceived risk in the system.

Figure 12: **Typical year cropping season calendar.**



Source: Famine Early Warning Systems Network (2011), field research team interviews (2016).

PROVINCIAL CROP PRODUCTION

Most of the staple crops are produced throughout Kenya, but yields vary by location because of agroclimatic conditions. Central and Nairobi provinces contribute very little to maize and common bean production volume, but Central province represents approximately 25% of total potato production. Additionally, Central and Nairobi provinces represent a significant end market for production of many crops. Maize production is concentrated in Rift Valley and Western provinces, while common bean is grown throughout the country. Average farm size in Kenya ranges from 0.5-2.0 Ha, with differences by region and crop, depending on industrialization, the profit potential, and agro-climatic conditions. Additional detail on crop production by region can

be found in Chapter 3. The division of labor in Kenyan agriculture varies by task and by crop. Women are more active in the production of food security crops such as common bean, banana, potato, and cassava, as illustrated in Table 2.

Table 2: **Gender roles in crop production.**

Top crops	Seed selection	Land preparation	Planting	Weeding/ In-season tasks	Harvesting	Post-harvest processing	Marketing	Regional differences
Maize								Northern Rift Valley features large-scale/ mechanized farms (men)
Common bean								Rift Valley has market-focus, expected to be more male dominant
Banana								Commercial growing near Mt. Kenya has a higher degree of male domination
Cassava								Men have larger role where commercialized; primarily home consumption
Potato								Commercial growing with larger roles for men in Central and Mt. Kenya
Wheat								Production is primarily large-scale/mechanized, most roles handled by men
Tea								Both small- and large-scale operations lead to a more balanced average

Source: Context expert analysis, Katungi (2010).

Most of women's production is consumed on-farm with small amounts sold locally. Women generally receive lower prices for their products than men and are underrepresented in agribusiness. In general men are more involved in the production of cash crops such as maize, wheat, and tea. They are more open to taking risks in order to optimize payout potential.

While research suggests crop-specific distinctions in gender roles (World Bank 2015), 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 off-farm jobs, responsibilities are highly dependent on the dynamics of specific households.

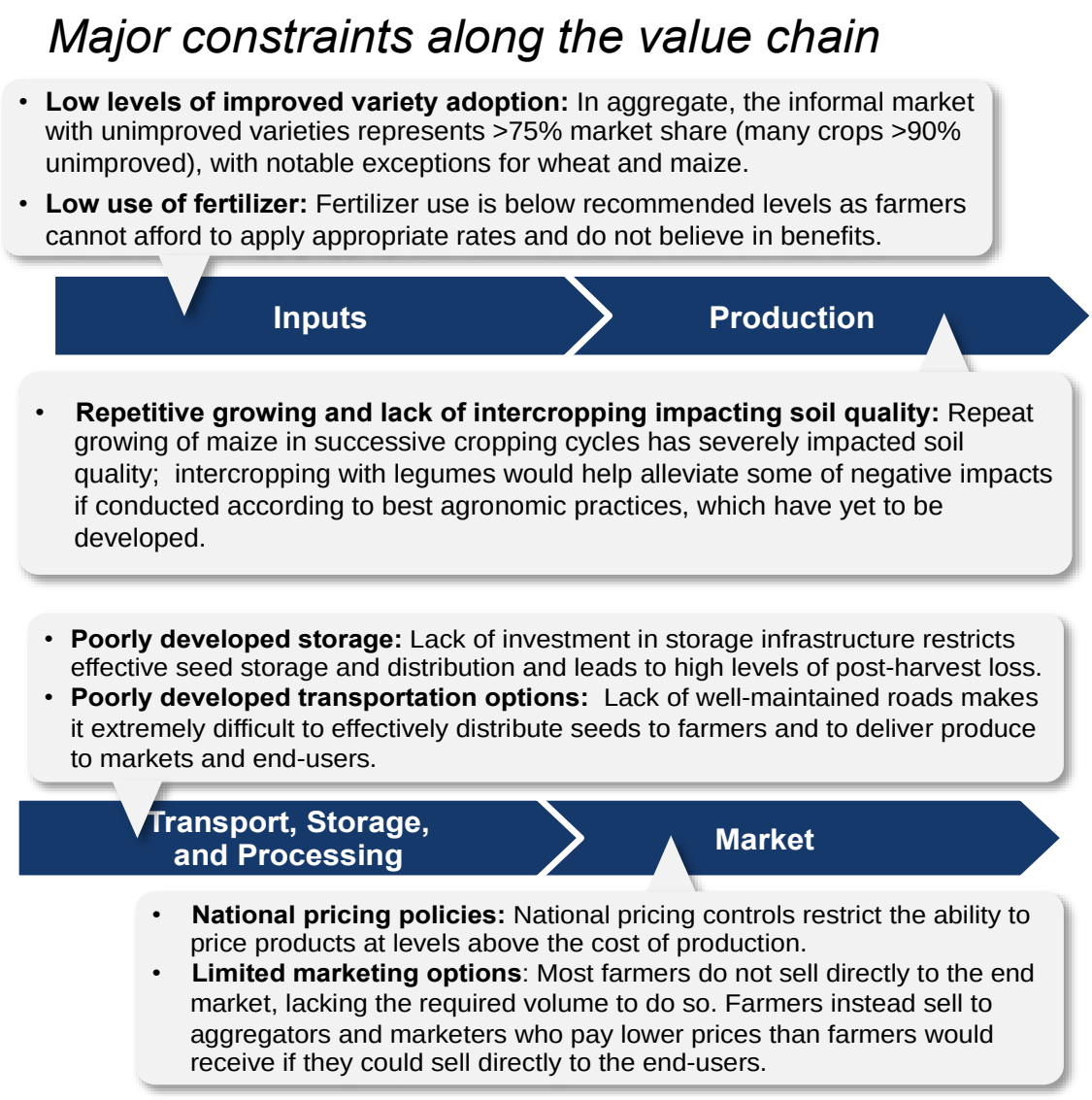
Many crops see significant differences in gender roles by size and scale of farm, with the general observation being that women have a greater role in small-scale farming operations, while men play a larger role in commercial or large-scale farming and agribusiness operations that are market facing.

Marketing of crops generally falls more to men than to women, especially in cash crops such as maize, wheat, and tea. This finding stays relatively consistent when looking at marketing of crops in formal cross-border trade, with men taking a leading role in the majority of crops and situations. Informal cross-border trade has a different dynamic, featuring heavier involvement from women.

AGRICULTURE AND ENABLING ENVIRONMENT CONSTRAINTS

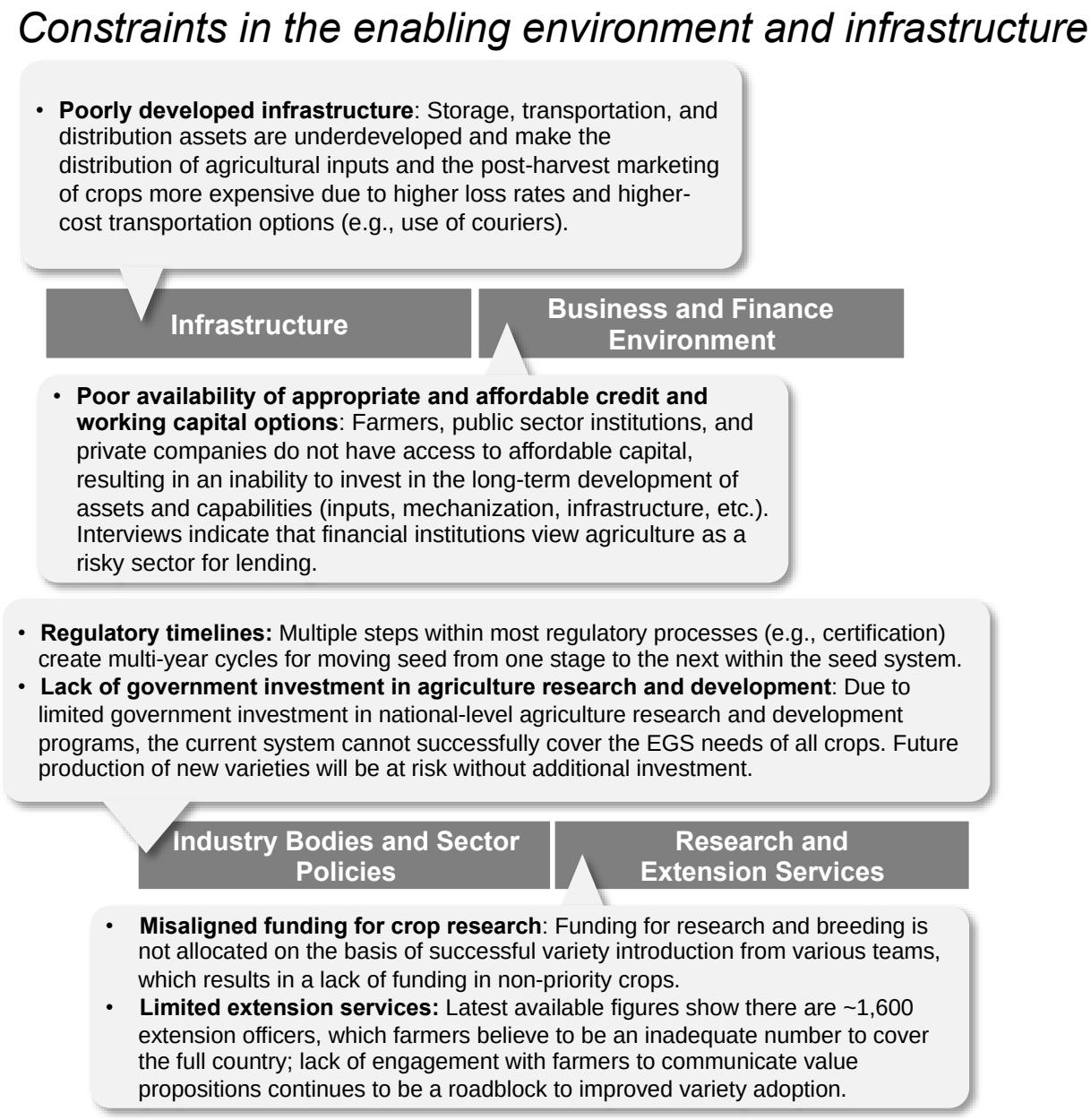
While this study focuses primarily on constraints related to seed systems, it's critical to review a more comprehensive set of constraints across multiple crop value chains to better inform the seed situation. Figures 13 and 14 provide a high-level but not exhaustive list of key constraints across the most agricultural value chains and enabling environment in Kenya. Critical value chain constraints include low levels of adoption of improved varieties, small farm sizes which limit the benefits of scale (0.5-2.0 Ha per household on average nationally), a lack of proper on-farm storage facilities which lead to highs levels of post-harvest loss, and lengthy regulatory and certification procedures which make it more difficult to commercialize new varieties.

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



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

Figure 14: **Major enabling environment constraints.**



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

As of June 2016, the Central Bank of Kenya lists 54 commercial banks and mortgage finance institutions and 12 microfinance banks as regulated entities. Additionally, according to the Oxford Business Group, as of June 2015 there were over 4,000 savings and credit cooperative societies (SACCOs), of which 180 were deposit-taking SACCOs licensed by the SACCO Societies Regulatory Authority. Central Bank statistics indicate that total lending to the agriculture sector was approximately KSh.75 billion as of December 2014, or approximately 4% of total outstanding credit in the economy.

While Kenya's financial sector is one of the more robust in the region, interviews and published reports indicate that access to credit and working capital remain significant issues for smallholder farmers, and agribusiness entities in general. Field interviews indicate that the options that are available to farmers, particularly microfinancing options, fall far short of effective demand and that agriculture in general is viewed as a risky sector for investment from these institutions.

Latest available data indicates that agricultural lending remains a small portion of the overall market for microfinance institutions, representing approximately 8.5% of gross loan portfolio across the 34 responding institutions in a 2014 study from the Association of Microfinance Institutions in Kenya. When this list is narrowed to institutions exclusively focused on microfinance (excluding commercial banks), this percentage increased to approximately 11.4% of the gross loan portfolio, or approximately KSh. 4.5 billion. Comparing this to agriculture as a percentage of GDP shows a smaller proportion of credit availability as compared to economic output (11% vs. 30% of GDP), which underscores the issue raised in interviews indicating a lack of credit availability.

NATIONAL AGRICULTURAL STRATEGY

Kenya signed the Africa Union's Comprehensive Africa Agriculture Development Program (CAADP) agreement in 2010. The main goal of CAADP is to help African countries 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 (government, private sector and donor) in the agricultural sector in the countries with signed compacts.

Recent laws, plans, and regulations have shaped the agricultural sector in Kenya. In 2008, Kenya spelled out a new long-term development strategy known as Vision 2030. The goal for Vision 2030 is to create a newly industrialized, middle-income country providing a high quality of life to all its citizens in a clean and secure environment. Vision 2030 is divided into incremental five-year Medium-Term Plans based on the following three pillars:

- The economic pillar aims to improve the prosperity of all Kenyans through a broad-based economic development program to achieve an average GDP growth rate of 10% per annum beginning in 2012.
- The social pillar aims to build a just and cohesive society with social equity in a clean and secure environment, making special provisions for Kenyans with various disabilities and previously marginalized communities.
- The political pillar aims to realize a democratic political system founded on issue-based politics that respects the rule of law and protects the rights and freedoms of every individual in Kenyan society.

Kenya is currently in the second Medium-Term Plan (MTP II), which covers 2013-2017. Within MTP II, the economic pillar consists of five priority sectors: agriculture, livestock, and fisheries; trade; manufacturing; business process outsourcing/IT-enabled services; and oil and other minerals. The top priority under agriculture, livestock, and fisheries is to increase acreage under irrigation in order to lessen the reliance upon rain-fed agriculture. Other priorities include the

mechanization of agricultural production, reestablishing cooperatives and farmer unions, and increasing subsidies related to farm inputs in order to increase productivity.

In support of these priorities, there are several specific agricultural programs and projects. These include:

- Implementation of the consolidated agricultural reform legislation.
- Fertilizer cost-reduction initiative.
- Establishment of five livestock disease-free zones.
- Expansion of irrigation coverage.
- Fisheries development and management.

Other interventions include improving delivery of extension services, strengthening producer institutions, intensification and expansion of irrigation, seed improvements, livestock development, and fisheries development.

There have been a series of legislative and regulatory changes following the launch of Vision 2030, including the development and approval of a new constitution, which took effect in 2010. Included were provisions for a progressive series of rights, including the right to gainful and dignified employment. Additionally, regulations related to land reform and the devolution of power to local authorities were implemented in order to provide customized local solutions and programs. Also under the new constitution, the Agriculture, Fisheries and Food Authority Act, the Crops Act, and the Kenya Agriculture and Livestock Act consolidated outdated laws and regulations to promote agriculture and to strengthen agricultural research.

Agricultural extension services were included as a part of the devolution of authority to counties, with the goal of aligning local needs with local resources. However, this has proven to be a roadblock for the development and commercialization of new varieties, as there are not enough national resources dedicated to this process under the new structure. Many interviews with key stakeholders indicated this was a crucial problem in Kenya and would likely need to be revisited in order to provide the requisite extension support.

1.3 DOMINANT SEED SYSTEMS IN KENYA

SEED SYSTEMS OVERVIEW

There are five identified dominant seed systems in Kenya (Figure 15), which include farmer-saved, NGOs and cooperatives, parastatal, private International, and private local. The farmer-saved seed system accounts for the majority of seed volume in aggregate, but there are specific exceptions to this such as maize, which is sourced primarily from the formal channels (parastatal and private companies).

Figure 15: **Dominant seed systems in Kenya.**

	Farmer-Saved *Traditional, for food and subsistence crops (informal)*	**NGO / Cooperatives** *Varieties and basic seed from public research; development and community based targeting food security (intermediary)*	**Parastatal** *Varieties and basic seed from public research; structured quality seed production and marketing (formal)*	**Private International Companies** *Own varieties and basic seed; structured quality seed production and marketing (formal)*	**Private Local Companies** *Own or license varieties and basic seed; structured quality seed production and marketing (formal)*
Type of crops	Local food and cash crops	Food crops	Major food and cash crops	Primarily maize	Food and cash crops
Crops	Banana Common bean Cassava Cowpea Groundnut Maize Millet Pigeon pea Rice Sorghum Soybean Sweet Potato	Common bean Groundnut Pigeon pea Maize	Banana Cowpea Maize Rice	Maize	Common bean Groundnut Maize Pigeon pea Sorghum
Types of Varieties	Local varieties	Improved, open pollinated varieties (OPV)	Improved maize varieties (Hybrid and OPV)	Improved varieties (Hybrids for maize)	Improved varieties
Quality Assurance System	Positively selected	Certified and positively selected	Certified	Certified	Certified
Seed Distribution	Farmer-saved, exchange, barter, and local markets	Local markets, distribution through government, some distribution through agro-dealers	Distribution through government and agro-dealers	Distribution through agro-dealers	Distribution through agro-dealers
Market Share	**75-80%**		**20-25%**		

Source: Field research team interviews (2016).

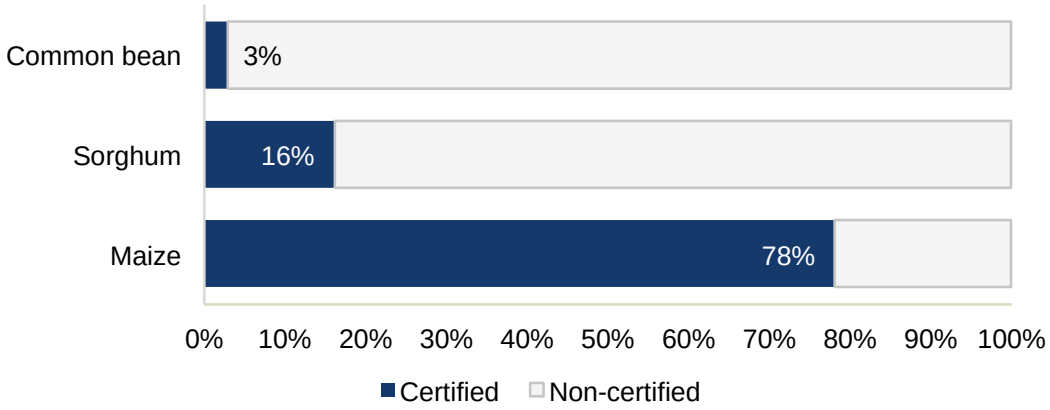
As discussed above, the dominant source of seed varies by crop, but crops tend to be aligned with one of three primary segments:

- Primarily formal (<35% informal): Wheat and maize are the primary focus of the formal seed sector, within which seed sales are dominated by the Kenya Seed Company, a parastatal company.
- Primarily informal (35-95% informal): The majority of seeds sold in Kenya are through the informal channel, with important staple/food security crops forming a large percentage of this segment.

- Informal only (>95% informal): Cassava, soybean, and sweet potato seeds are sourced from the informal sector >95% of the time.

Overall, the informal market is estimated to be responsible for approximately 75-80% of total seed transaction, sales and barter, in Kenya. Estimates of market share for certified seed by crop support these findings on informal vs. formal market share (Figure 16).

Figure 16: **Percentage of land planted with certified seed (2013).**

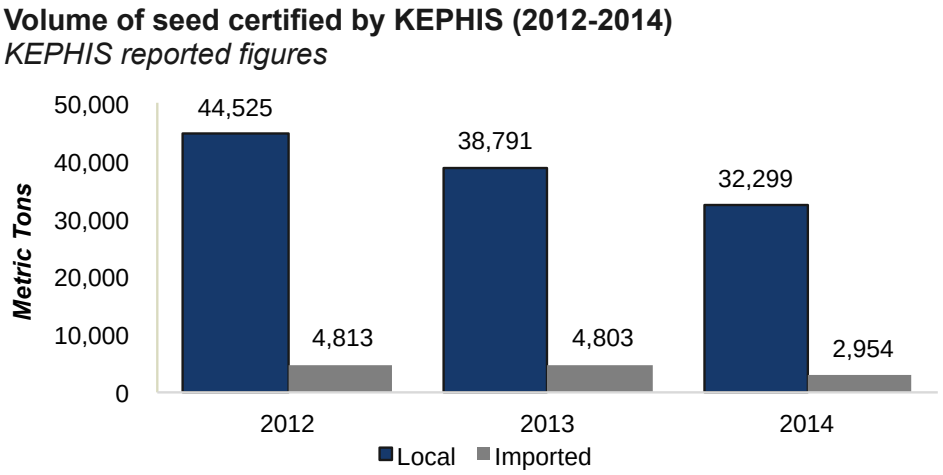


Source: Kariuki (2015).

Maize is the most significant market for improved varieties, with more than one-half (258 of 482 in 2013) of registered improved varieties in Kenya being maize. The only other crops with a significant number of improved varieties are common bean, wheat, sweet potato, and sorghum.

Certification is primarily concentrated in maize as well, with maize accounting for 80-90% of annual certification at KEPHIS. However, the overall volume of certified seed declined approximately 30% between 2012 and 2014, as shown in Figure 17, with maize certification declining by approximately 25% during that time period. Based on field interviews, this decline in maize certification is primarily due to disease pressure that has rendered some seed production land unusable, resulting in decreased maize seed production overall.

Figure 17: **Volume of certified seed.**



Source: KEPHIS (2015).

1.4 KEY ACTORS IN THE SEED SYSTEM

PUBLIC SECTOR OVERVIEW

Ministry of Agriculture, Livestock, and Fisheries

The Ministry's fundamental goal and purpose is conserving, protecting, and managing agricultural livestock, and fisheries resources for socio-economic development. It aims to improve the living standards of people by ensuring the maintenance of agricultural livestock and fisheries resources. The Ministry was created in 2013 by merging three ministries: agriculture, livestock development and marketing, and fisheries. The new Ministry has the vision of a secure and wealthy nation anchored by an innovative, commercially oriented, and competitive agricultural sector. The Ministry's mandate includes formulation, implementation, and monitoring of agricultural legislation, regulations, and policies; supporting agricultural research and promoting technology delivery; facilitating and representing agricultural state corporations in the government; development, implementation, and co-ordination of programs in the agricultural sector; regulating and quality control of inputs, produce, and products from the agricultural sector; management and control of pests; and collecting, maintaining, and managing information on the agricultural sector.

KALRO

In implementing MTP II, the GoK reformed the National Agricultural Research Systems through creation of the KALRO. Its formation was aimed at restructuring agricultural and livestock research into a dynamic, innovative, responsive, and well-coordinated system driven by a common vision and goal. KALRO is a corporate body created under the Kenya Agricultural and Livestock Research Act of 2013 to establish a suitable legal and institutional framework for coordination of agricultural research in Kenya with the following goals:

- Promote, streamline, coordinate and regulate research in crops, livestock, genetic resources, and biotechnology in Kenya.

- Expedite equitable access to research information, resources and technology and promote the application of research findings and technology in the field of agriculture.

The KALRO Seed Unit (KSU) is also an important actor in the seed production industry, having been created with the dual goals of producing EGS for public sector varieties and meeting farmer demand for high quality seeds and planting materials of vegetatively propagated and open pollinated selected horticultural and grain legumes crops. Interviews indicate that the goal of producing EGS for public sector varieties has not been fully met. Instead, KSU has dedicated more resources to meeting farmer demand for crops that fall outside of the private sector focus, such as OPVs and pulses.

KEPHIS

KEPHIS' goals are quite broad and diverse. KEPHIS is responsible for coordination of all matters relating to crop pests and disease control, administration of plant breeders' rights in Kenya, and liaison with the International Union for the Protection of New Varieties of Plants. In support of this, KEPHIS is tasked with inspection, testing, certification, quarantine control, variety testing, grading, and inspection of plants and produce at all border points, development and implementation of standards (locally and imported seeds), and approving importation and exportation licenses for plants and seeds. KEPHIS is also responsible for the implementation of national policy on the introduction and use of genetically modified plant species, insects, and microorganisms in Kenya, an area that is expected to continue to grow over the next several years.

PROGRAMS AND NGOS

Alliance for a Green Revolution in Africa (AGRA)

AGRA works across 18 countries focused on distinct problems related to seed production, soil health, and agriculture markets. AGRA has worked with partners in the public and private sector, and the alliance has reached out to 17 million family farmers and thousands of local African-owned agriculture businesses.

In Kenya specifically, from 2007 to 2015, AGRA made 86 grants totaling approximately $43 million covering research capacity building; research and development; input production and distribution; awareness creation on agriculture transformation; adoption of improved inputs; and production, postharvest handling, and marketing of produce. AGRA has worked directly with over 5,000 agro-dealers to provide training, and with multiple seed companies to provide financial and technical support, creating linkages with breeders, and in licensing varieties from KALRO. The goal of these efforts is to help agro-dealers and seed companies become better organized enterprises and to increase responsiveness to smallholder farmer demands.

CGIAR

CGIAR is a global research partnership for a food-secure future. CGIAR is the only worldwide partnership addressing agricultural research for development, whose work contributes to the global effort to tackle poverty, hunger and major nutrition imbalances, and environmental degradation. Research is carried out by the 15 centers, members of the CGIAR consortium, in close collaboration with hundreds of partners, including national and regional research

institutes, civil society organizations, academia, development organizations and the private sector.

The key CGIAR centers active in Kenya include the International Potato Center (CIP), which is actively engaged in both Irish potato and sweet potato; the International Maize and Wheat Improvement Center (CIMMYT), which is actively engaged in maize; and the International Center for Tropical Agriculture (CIAT) which is actively involved in common bean.

One Acre Fund

One Acre Fund is a nonprofit 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. In addition to Kenya and Rwanda, the organization works with farmers in Burundi and Tanzania. The organization is headquartered in Bungoma County in western Kenya, near the Ugandan border.

Using a market-based approach, One Acre Fund facilitates activities and transactions at various links of agricultural value chains, 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 more than 135,000 Kenyan farmers who have increased their annual incomes by an average of $211.

PRIVATE SECTOR OVERVIEW

Private seed companies

The private sector consists of international and regional seed companies mainly focused on hybrid maize and local seed companies focused on a variety of crops, including hybrid maize. Table 3 highlights a select group of private seed companies active in Kenya, their estimated share in the formal seed market, their reasons or motivation for participation in the market, and key crops in their product portfolio. More than 110 seed companies are registered with KEPHIS, with a majority focused on vegetable seed trading or the importation of seed for their own use (e.g., large commercial farmers).

Kenya Seed Company (KSC), a parastatal company owned jointly by public and private shareholders (52% public, 48% private), holds a substantial portion of overall market share. Initially, KSC was formed to multiply and market varieties developed by the public research system under the Ministry of Agriculture. Interviews indicate that this has stunted growth in the private sector, specifically in maize where KSC historically had sole access to the output of the KALRO breeding programs. KSC also has significant advantages compared to other private seed companies in terms of production assets and capabilities, including a substantial amount of company owned land, wet cob drying capacity (competitors have to field dry maize seed), modern storage facilities, processing and packaging capacity, and has recently instituted a proprietary breeding program.

KSC’s dominance has lessened in recent years following the liberalization of the seed industry. This policy change resulted in public varieties being available more broadly to private sector actors, and not exclusively to KSC. However, the significant asset advantage referenced above still allows KSC to dominate the vast majority of the formal sector market share.

Table 3: **List of select private seed companies.**

Company	Country of Origin	Formal Seed Market Share	Motivation	Key Crops
Kenya Seed Company	Kenya	~70-80%	Parastatal company, significant market share, long history as government-owned industry leader	• Maize (primarily hybrid), common bean, cowpea, sorghum, rice
PANNAR	South Africa	~5-10%	Long history as provider of hybrid maize seed across Africa, expansion into other crops	• Hybrid maize, sunflower, soybean, sorghum, wheat
SEEDCO Kenya	Zimbabwe	~5-10%	Significant presence in major maize markets across Southern Africa	• Hybrid maize, vegetables, soybean, sorghum
Monsanto	U.S.	~3-5%	Strong fit between agroclimatic needs and Monsanto's portfolio of hybrid maize	• Hybrid maize
Pioneer	U.S.	~3-5%	Strong fit between agroclimatic needs and Pioneer's portfolio of hybrid maize	• Hybrid maize
East African Seed	Kenya	~1-3%	40+ year history in Kenya of working with KALRO to develop hybrid maize varieties	• Hybrid maize, common bean, sorghum, cowpea, vegetables
Western Seed	Kenya	~1-3%	Only private company in East Africa with an end-to-end maize research, breeding, and distribution program	• Hybrid maize, common bean, sunflower

Source: Context expert analysis, company websites.

Many private seed companies, including KSC, PANNAR, and SEEDCO utilize their land and facilities in Kenya for the production of certified seed that is exported to surrounding countries, including Rwanda, Tanzania, Uganda, and South Sudan. Typical crops include maize, wheat, sunflower, soybean, and a variety of vegetables. Private companies utilize this arrangement due to the lack of commercial seed production resources and facilities in those countries. Interviews indicate that in some instances, seed is imported from Zambia and then re-exported to Rwanda. Expectations are that this practice may increase with harmonization of seed regulations across the region.

Cooperatives, farmer groups, and contract growers

According to the GoK, there are approximately 5,900 cooperatives in agriculture, with more than four million total members. These cooperatives can play a variety of key roles throughout the agricultural value chain, including input procurement, production, processing, packaging, and marketing. The importance of cooperatives varies by crop, with high involvement and importance in the coffee and tea markets, and lower involvement and importance in the maize and common bean markets. Cooperatives are registered entities and tend to be more structured and professionalized than farmer groups.

Farmer groups are assembled primarily to facilitate the sharing of knowledge, marketing of crops, and self-financing. These groups are generally viewed as less structured entities than are cooperatives. Farmer groups have a more difficult time finding affordable credit than cooperatives and often rely upon the savings of members to fund themselves.

Contract seed growers are important actors in the seed system. These growers are contracted to produce seed by KALRO, universities, and private seed companies, although the hiring entity (e.g. KALRO) maintains ownership of the seed throughout the process.

Agro-dealers

Cultivating New Frontiers in Agriculture, an international non-profit development organization, estimates that there are over 10,000 agro-dealers active in Kenya delivering seed, fertilizer and other agricultural products to farmers. Agro-dealers are a vital link in the seed supply chain providing farmers with access to the required seed and seed companies with the conduit for reaching farmers. Seed companies nominate local agro-dealers for registration with local agricultural boards, which verifies credentials and refers them to KEPHIS, which then provides the initial certification and ongoing oversight.

With many agro-dealers operating at the village level, they are the only local contact point for farmers and because of this, agro-dealers tend to carry an assortment of agricultural inputs, with seed representing a significant portion of their overall sales. This diversification is required due to the nature of the seed sales cycle, with only certain windows in the calendar being relevant for seed sales.

Many agro-dealers lack access to affordable credit, resulting in the need for seed companies to provide product to them on credit. Banks have historically viewed agriculture as a risky sector for lending, which has led to higher rates than most agro-dealers can afford to pay. This view has been changing recently, with more lenders entering the market targeting agriculture and the riskiness of agriculture being lowered by new insurance products in some instances (e.g. adverse weather).

While it is the seed company's responsibility to ensure quality seed is reaching the farmers, the agro-dealer plays a crucial role in providing feedback on demand and farmer preferences. Additionally, the agro-dealer is inspected by KEPHIS to ensure they are providing quality seed and not selling any seed with incorrect packaging, bad germination, or other substandard qualities.

CHAPTER 2: CURRENT SITUATION – PRIORITY CROPS FOR EGS STUDY

2.1 FRAMEWORK FOR SELECTING CROPS FOR STUDY

The crops selected for in-depth EGS system analysis were identified during a consultative process with key seed system and agricultural stakeholders from the public and private sectors during a roundtable meeting convened in Nairobi, Kenya on March 16, 2016. Attendees included representatives from USAID, KALRO, KEPHIS, the Seed Trade Association of Kenya, African Agricultural Technology Foundation (AATF), National Potato Council of Kenya, public universities, CGIAR, and private seed companies.

There were subsequent meetings held with public sector stakeholders on April 29, 2016 and with public and private sector stakeholders on May 5, 2016 to share and corroborate preliminary findings. Feedback from these meetings has been incorporated into this report.

As Table 4 depicts, a matrix of key indicators crossed with ratings definitions was used as the basis for discussions.

Table 4: **Crop selection framework.**

	RATING DEFINITIONS				
KEY INDICATORS	●	◕	◑	◔	○
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, etc. largest crop area
PRODUCTION	Largest production volume	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	>10% 10-year CAGR	5-10% 10-year CAGR	3-5% 10-year CAGR	0-3% 10-year CAGR	<0% 10-year CAGR
FOOD SECURITY FOCUS	Primarily consumed on farm AND is dietary staple		Primarily consumed on farm OR is dietary staple		Primarily a cash crop or exported
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
IMPORTANCE TO SMALLHOLDER FARMERS	High importance to smallholder farmers		Medium importance to smallholder farmers		Low importance to smallholder farmers

CAGR = Compound Annual Growth Rate

Low ○ ◔ ◑ ◕ ● High

Source: Research team analysis (2016).

2.2 SELECTED CROPS

As a result of this process (details of which are highlighted in Table 5), three crops were selected for the analysis: maize, potato, and common bean. Below is a summary of the key reasons why each crop was selected for this EGS study.

Maize

- **Import competition:** As a net importer of maize, Kenya cannot currently serve its growing demand for maize through local production without an increase in productivity. Continued adoption of the appropriate varieties of higher yielding hybrid maize is a critical piece of increasing maize yields of smallholder farmers.
- **Nutritional and economic importance to smallholder farmers:** Maize represents ~30% of the daily caloric intake for the average Kenyan, and is even more important in the daily lives of many smallholder farmers as the primary source of food and income.

Potato

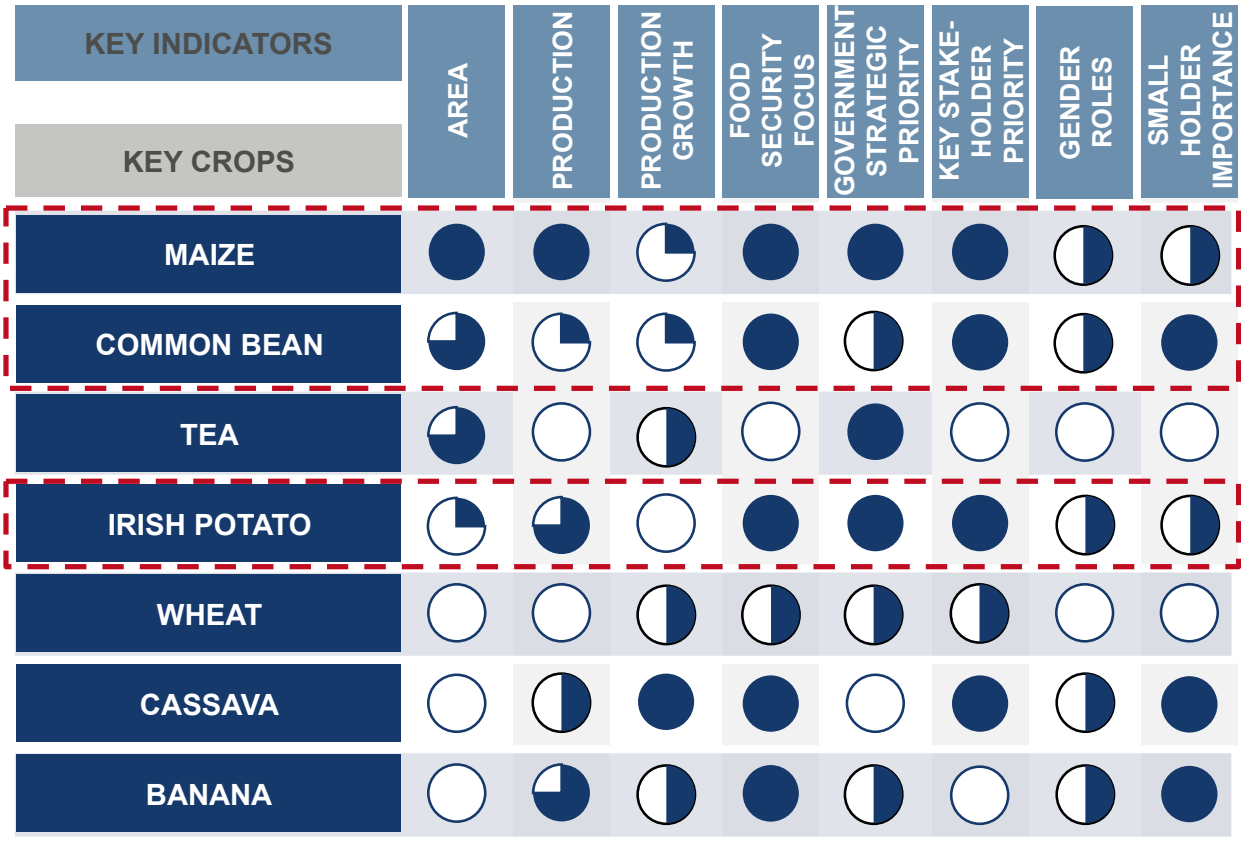
- **Unmet EGS demand**: There is a significant unmet demand for EGS in potato for two key reasons. First, high levels of disease pressure force farmers to access clean seed regularly to ensure their fields do not become infected with disease. Second, there is a significant gap between yield potential and average yields, with low-quality seed playing a large role in this shortfall. Farmers are looking for high-yielding, improved varieties to optimize their yield potential.
- **Processor demand**: Processors in Kenya routinely have to import potato to meet their demand and have recently been trying to contract with certain large-scale farmers to produce specific varieties to meet their needs. If farmers can align with processors on which varieties to grow, there is strong demand for their produce.

Common bean

- **Unmet EGS demand:** Currently, there is not enough EGS production to meet market demand for improved seed, with farmers seeking out all available seed in the marketplace on an annual basis. This lack of quality seed negatively impacts yields for farmers and keeps Kenya's average yield significantly below comparable countries.
- **Opportunity for increasing smallholder farmer economic security**: Increased productivity driven by improved varieties would allow smallholder farmers to allocate less land to grow the same amount of common bean, thus freeing up land to grow higher value crops that can in turn boost their economic security.

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

***Table 5*: Priority crop selection results in Kenya.**



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

CHAPTER 3: CURRENT SITUATION – EGS SYSTEMS

3.1 EARLY GENERATION SEED SYSTEMS

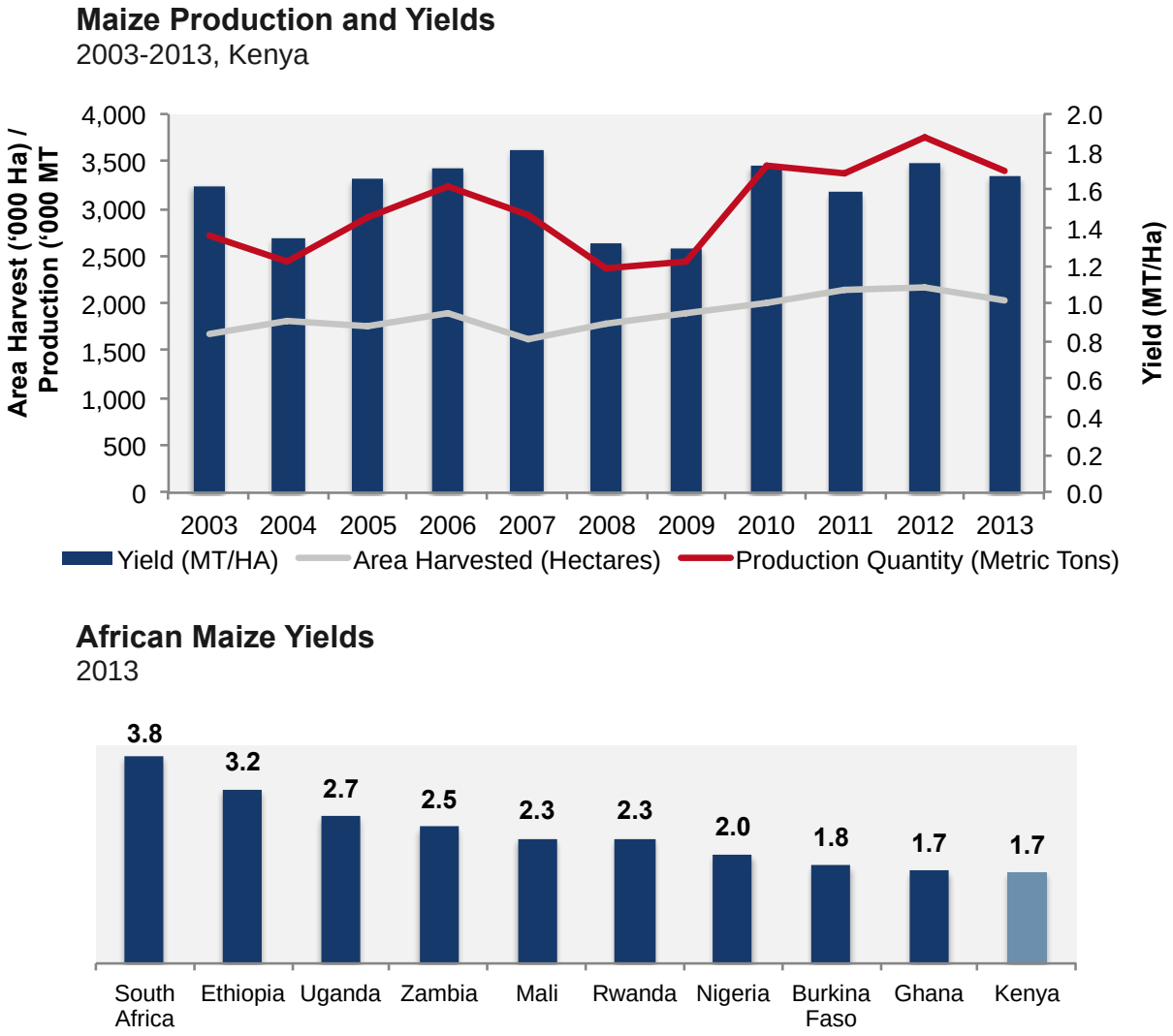
The Kenyan EGS system involves many organizations across the public and private sectors, with specific roles and responsibilities dependent upon the crop. KALRO is the primary research and breeding organization within the country, with KEPHIS responsible for all inspection and certification across all crops. Private sector participants are also involved in breeding and EGS production, providing their own genetics or additional production capacity depending on the crop.

3.2 MAIZE

SUPPLY

Maize (*Zea mays*) represents the largest crop area in Kenya, with total production fluctuating over the past ten years based on annual yields, as Figure 18 presents. Maize is an important staple crop in Kenya, accounting for approximately 30% of daily caloric intake for the average Kenyan. More than 95% of rural households in Kenya grow maize, with smallholder farmers responsible for approximately 75% of production.

Figure 18: **Maize area, production, and yield.**

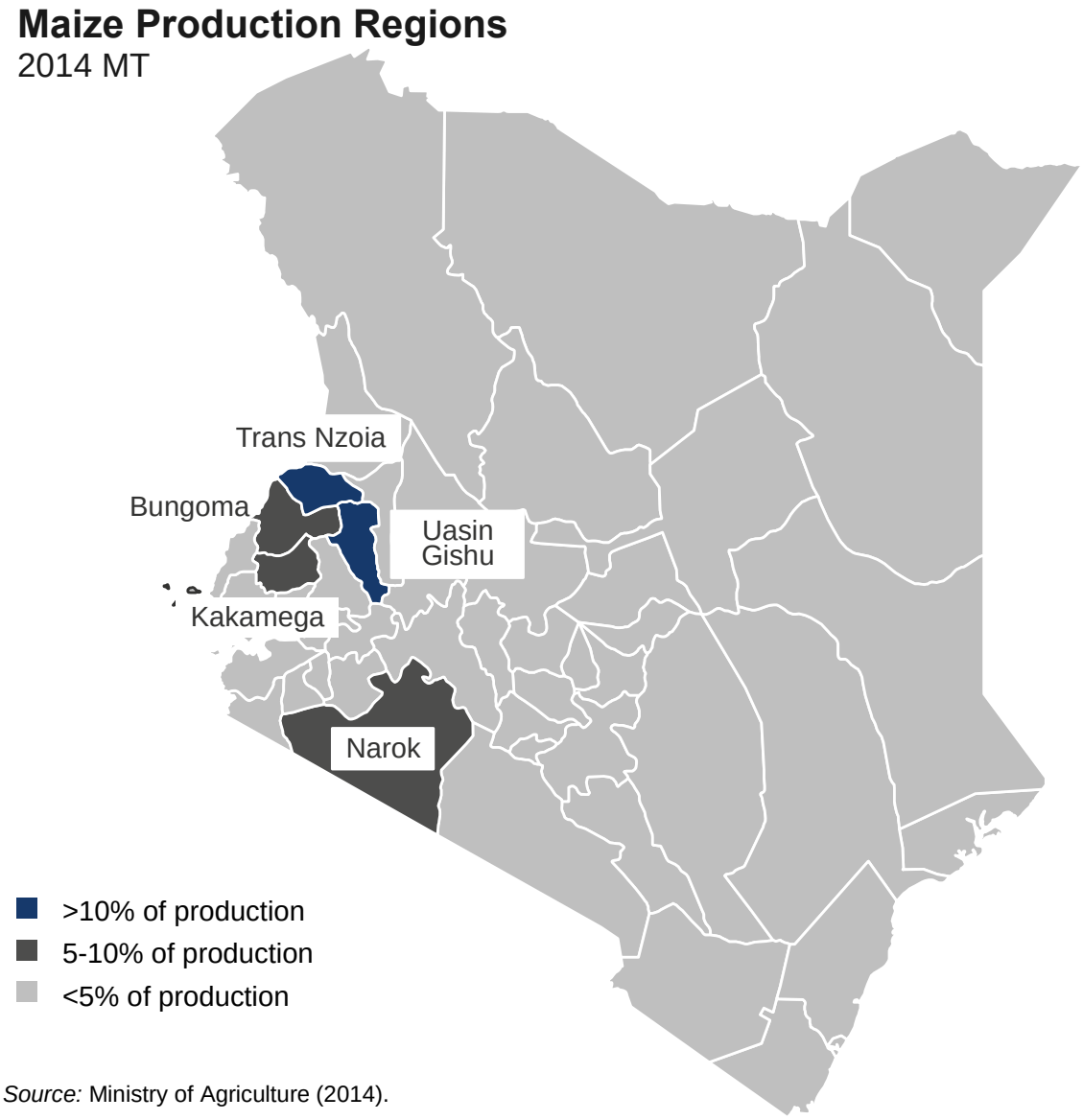


Source: Kenya Country Stat (viewed in March 2016).

Maize yields in Kenya are lower than comparable African countries and vary greatly across the country's regions, with the primary limiting factors being a lack of quality seed and low levels of fertilizer use (FAO, 2011). These low yields, combined with high demand for maize, have created a supply-demand gap that is filled with imports from neighboring countries, such as Tanzania, Uganda, and Zambia (US Foreign Agriculture Service, 2013).

Maize is grown across all provinces in Kenya, but approximately 45% of total production comes from five counties in the western area of the country (Rift Valley/Western provinces overall account for approximately 70% of total production). Production by county is shown in Figure 19.

Figure 19: **Maize production by county, 2014.**

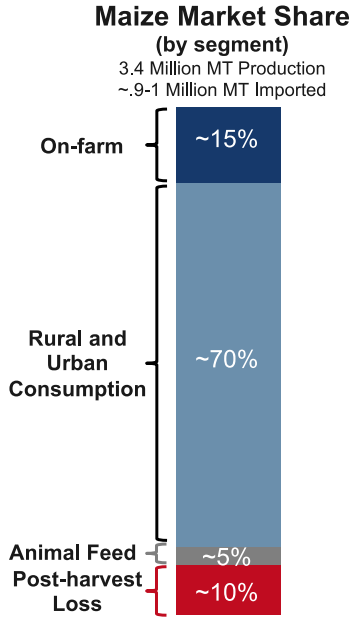


Source: Ministry of Agriculture (2014).

DEMAND

As shown in Figure 20, the majority of maize is consumed on-farm as green maize or meal, depending on the timing of harvest. Maize processors in Kenya are typically small, operating hammer mills that produce lower value meal than roller mills, with these smaller mills accounting for approximately 60% of total processing. A grading system within East Africa (EAS2:2005) has been implemented in Kenya (KS-EAS2:2005) but only applies to formal marketing channels.

Figure 20: **Comparison of maize demand segments.**

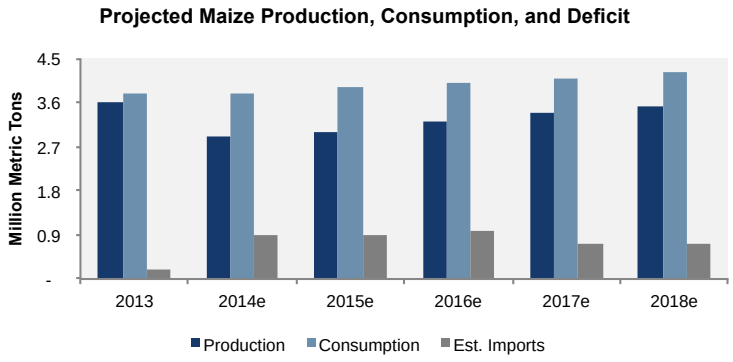


	Segment Description	Segment Needs
On-farm Consumption	• Household consumption of maize, primarily in the form of green maize (roasted and/or mixed with beans) or as maize meal after drying and harvesting • Seed ~1% of production	• Yield priority
Rural and Urban Consumption	• Combination of small- and large-scale farmers, selling through assemblers and wholesalers to processors/millers • Large-scale farmers also sell to National Cereals and Produce Board (NCPB), only in years of excess production • Formal imports of maize sold primarily to NCPB and large-scale millers • Informal imports solid to traders and millers (both small- and large-scale)	• Posho/Hammer mills account for 60% of milling in Kenya • A grading system within East Africa (EAS2:2005) has been implemented in Kenya (KS-EAS2:2005) but only applies to formal marketing channels • Annual shortfalls met through importation of maize
Animal Feed	• Livestock feed demand continues to grow as consumer demand increases	• Yield priority
Post-harvest Loss	• Substantial amount of post-harvest loss due to a lack of proper post-harvest management	• n/a

Source: Kenya Country Stat (viewed in March 2016), USAID (2013), AGRA (2013), World Bank (2015), FAO (2011), expert analysis (2016)

Demand for maize is projected to continue increasing over time, requiring significant imports, as shown in Figure 21. The country imported 900,000 MT in 2014-2015 through formal channels, primarily from sources inside the East African Community (EAC). Imports from outside of the EAC are subject to a 50% ad-valorem tariff, but a country can apply for a food security waiver (i.e. Kenya 2008). The projected trend in increasing maize consumption will likely require Kenya to import from countries outside the EAC in order to meet overall demand, as EAC countries tend to be impacted by similar adverse weather conditions leading to regional deficits (MAFAP SPAAA, 2013). Field interviews and published reports indicated that historically there has been significant cross border trade in the informal market, primarily with Uganda and Tanzania, with estimates ranging from 250,000-500,000 MT annually (Food Security and Nutrition Working Group, 2015). However, the GoK has taken steps in recent years to formalize this trade, beginning with an agreement with Tanzania to import 200,000 MT during 2014 and 2015. The formal sector is estimated to now account for the

Figure 21: **Projected maize production, consumption, and deficit.**



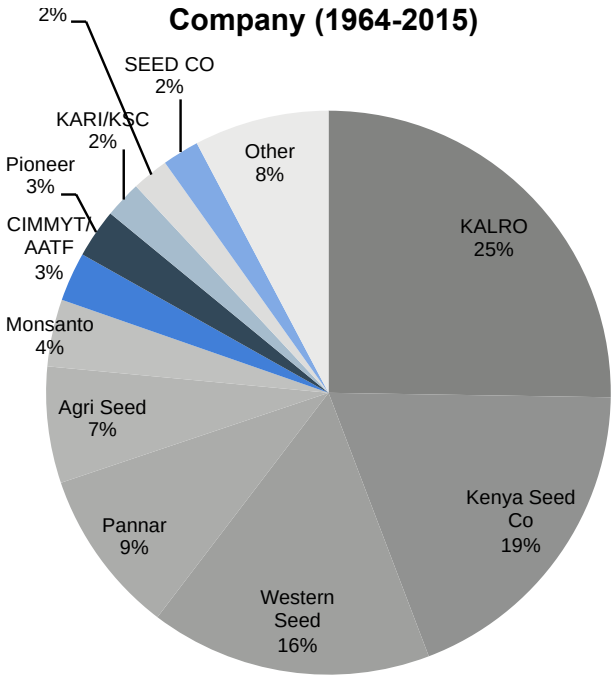
Source: Sihlobo (2014).

majority of trade and expectations are for further increases in volume as consumption continues to increase over time.

ADOPTON OF IMPROVED VARIETIES AND QUALITY SEED

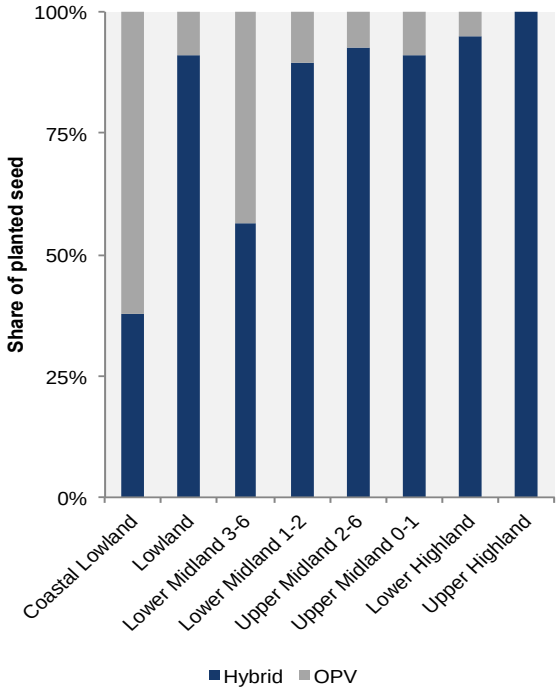
Within Kenya, both hybrid and OPV maize have improved varieties and quality seed supplied by the formal seed system. Hybrid maize has been heavily adopted within Kenya, with the first hybrids introduced in the mid-1960s. Overall, improved varieties of hybrid and OPV seed combined represent approximately 80% of the planted area in Kenya, with the informal sector (local OPVs) accounting for the balance. According to KEPHIS, there were more than 275 listed varieties in Kenya as of 2015, representing a substantial increase from the 164 listed in 2009. As Figure 22 illustrates, sources of improved varieties of maize seed (both hybrid and OPV) include public sector organizations, local seed companies and international seed companies. The average age of the listed varieties is more than ten years. According to KEPHIS, KALRO has released the most varieties since 2009 (32).

Figure 22: **Registered varieties by company.**



Source: KEPHIS (2016).

Figure 23: **Seed by type by agro-ecological zone.**



Source: Tegemeo (2012).

Seed use varies by region, as shown in Figure 23, and is dependent upon local agroclimatic conditions. Hybrids have a higher share in the midlands and highlands, with OPV having a higher share in the lowland and dryland areas.

STRUCTURE OF EGS VALUE CHAIN

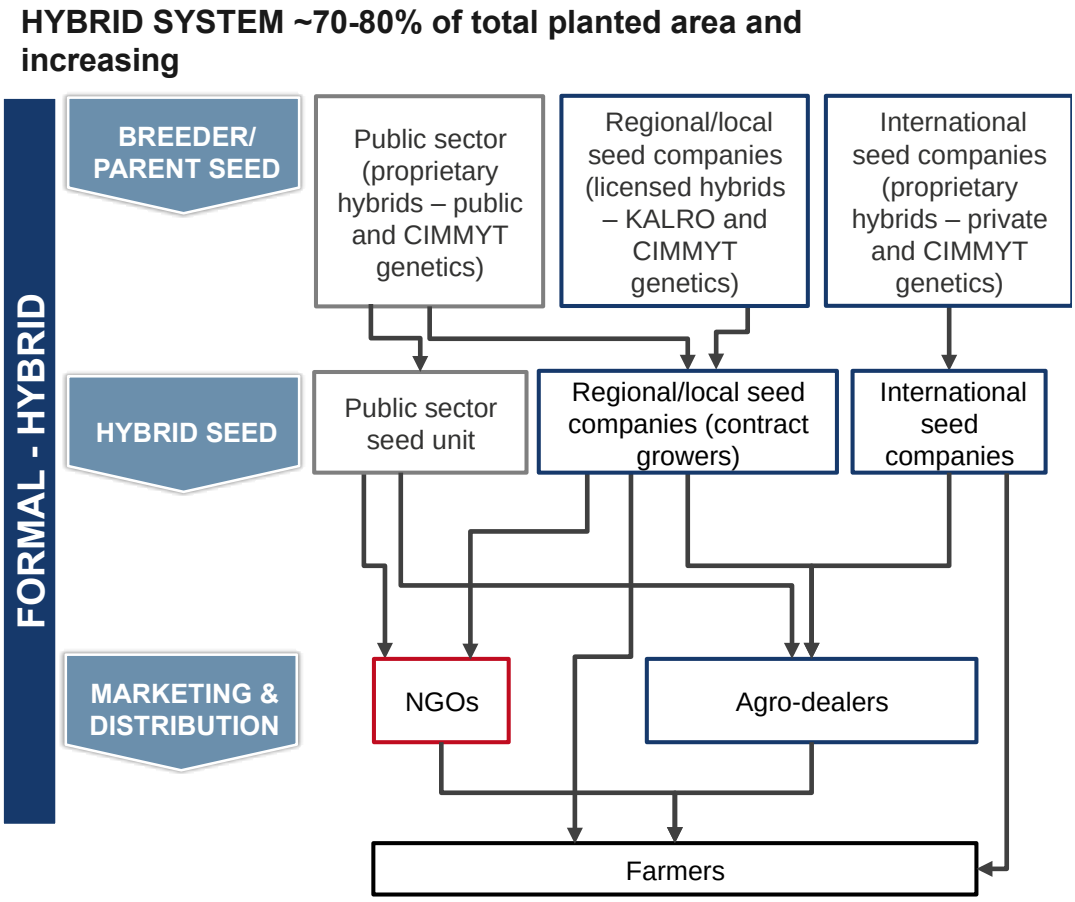
The production and delivery of hybrid maize seed to farmers requires a formal seed system. As noted previously, approximately 80% of the Kenyan maize area is planted with improved, certified varieties (both hybrid and OPV) and therefore serviced through a formal seed system. Of this segment of the market, hybrids account for the vast majority, making up an estimated

75% of planted area overall. The use of certified OPV has been in decline for several years, and is estimated to represent approximately 10% of total planted area. The remaining 20-30% is sourced from the informal OPV market. Although some private seed producers and local seed companies produce certified OPV maize, it is clear from interviews conducted for this study that this segment of the market has declined and is expected to decline more over the next five years.

HYBRID FORMAL SYSTEM

Public institutions (e.g., KALRO and universities), regional and local seed companies (e.g., KSC), and international seed companies (e.g., Monsanto and Pioneer) all have their own breeder/parental seed stock and production. The varieties outlined above are all targeted for different regions and growing conditions, resulting in certain companies having better suited hybrids for one region as compared to another. This requires significant demand planning, a skill which is lacking by many seed producers.

Figure 24: **Structure of hybrid maize seed chain.**



Source: Expert analysis (2016).

Most seed production occurs through contracted seed growers, who grow for seed companies at an agreed or competitive price. Seed companies access EGS from KALRO, AATF, or WEMA at a fixed cost. However, according to interviews with private sector companies, this arrangement tends to be more costly than if private seed companies were responsible for their

own EGS production. Additionally, there is a lack of trust in the quality of seed produced by contract growers and there is variability in the predictability and timeliness of delivery.

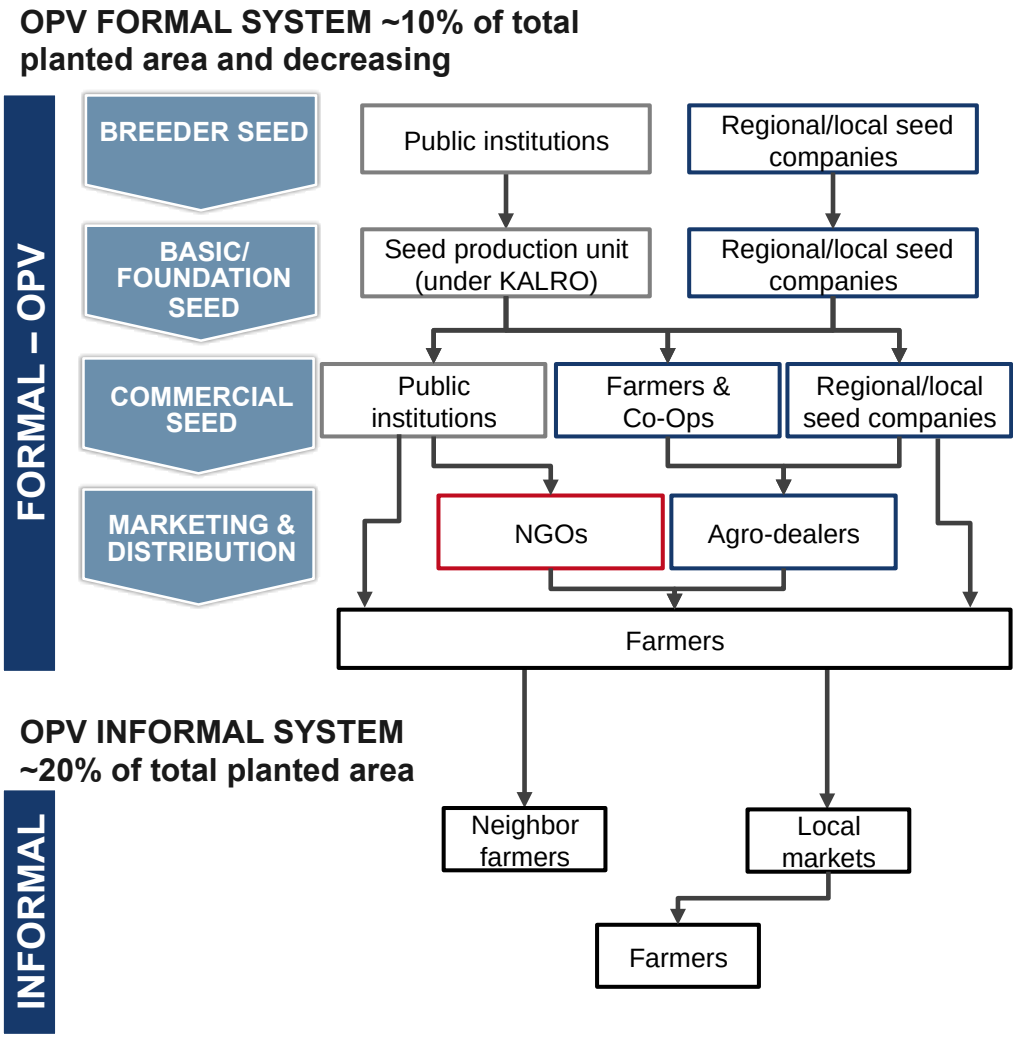
Primary marketing and distribution of hybrid seed is through agro-dealers, private seed companies, and NGOs, depending on the source of the seed, as shown in Figure 24. There is direct selling to farmers as well, primarily in the form of international seed companies selling to large commercial farmers. Regional and local seed companies utilize this direct pathway much less frequently than international seed companies.

KEPHIS is responsible for all inspection, certification, and verification duties in the maize industry. All production must be certified through KEPHIS' process prior to advancing to the next step in the seed production process or being introduced into the market, which creates bottlenecks at multiple steps in the commercialization process. At the breeder seed level, the testing and certification consists of checking for genetic purity as compared to the descriptions provided by breeders, a process which takes three growing seasons. Due to KEPHIS' lack of capacity, only one season can be processed per year, creating a three-year timeline. If KEPHIS' capacity could be increased, the time line could be shorted to one and a half years, with two growing seasons per year. At the commercial seed level, the lack of available inspectors can result in a delay in getting seed to market, causing shortages at planting time.

OPV FORMAL AND INFORMAL SYSTEMS

Currently, 10% of the maize area is planted with seed from the formal OPV market with another 20% planted with seed from the informal OPV market. However, the market share of OPVs is steadily declining, and interviews indicate that the formal sector is likely to convert to 100% hybrid, leaving only an informal system for OPV seed. This projection is underscored by the lack of new OPV varieties, as both CIMMYT and KALRO are no longer developing OPVs. In addition, WEMA is developing hybrids that are expected to supplant OPVs in dryland regions exposed to drought. Farmers are expected to continue to utilize landrace varieties, but these are exclusively in the informal sector of the market.

Figure 25: **Structure of OPV maize seed chain.**



Source: Expert analysis (2016).

Historically, there have been many OPVs produced by public Institutions (e.g., KALRO and universities) and regional and local seed companies (e.g., KSC). However, these entities have deemphasized OPVs in recent years in favor of the higher potential profits, higher yields, and better agronomic performance found in hybrid seed and are not expected to continue to invest in the OPV market.

Public institutions, farmers, cooperatives, and local seed companies produce commercial seed, either selling directly to farmers or through agro-dealers or NGOs. Significant demand in certain regions for specific varieties has helped maintain private company involvement (e.g., KSC in the Lowlands and Coast), but these areas are also expected to transition to the informal market over the next five years.

The informal market consists primarily of seed that is sold or traded with neighbors or sold in local markets. There is no quality assurance system in place for the informal market.

KEY MAIZE SYSTEM BOTTLENECKS AND CONSTRAINTS

Maize EGS supply bottlenecks stem from the certification system inefficiencies discussed earlier in this chapter as well as production issues, with several smaller demand constraints. These include:

Supply bottlenecks

- **Absence of an adequate EGS demand forecasting system:** There is no formal centralized process in which demand for different varieties of commercial seed is captured and informs how much basic and breeder seed needs to be produced in a set time horizon for each variety. Without a formal process for forecasting demand, EGS and commercial producers are unable to budget and plan seed production to supply the market which prevents them from reaching economies of scale which would in turn lower production costs.
- **Insufficient land for seed production:** Without enough land available for seed production existing parcels have to be subdivided, limiting the producer's ability to ensure the appropriate level of isolation. This lack of isolation, in turn leads to contamination of seed. Additionally, the continuous use of the same land on an annual basis can result in accumulation of diseases such as Maize Leaf Necrosis.
- **Lack of irrigation for seed production:** Reliance upon seasonal, rain fed production causes supply fluctuations based on the rain in a given season, leading to oversupply in good years or shortfalls in production if rainfall is low during a given season.

Demand constraints

- **Lack of yield benefits from hybrids in low-input conditions:** Current hybrids require high levels of non-seed inputs, such as fertilizer, to achieve yield benefits as compared to OPVs, which makes hybrids less appealing to many farmers who can't afford high-quality, non-seed inputs.
- **Lack of affordable credit options for smallholder farmers:** Hybrid seed is much more expensive than non-hybrid.
- **Presence of counterfeit seed:** Counterfeit seed comes into the market in times of undersupply and also as a way of taking advantage of smallholder farmers who want to buy small volumes in small packages not sold by most seed companies and agro-dealers. Counterfeit seed is most often sold in local markets, typically being marketed as smaller quantities from larger packages (e.g., volumes <1 kg from 50 kg bag). Experiences with counterfeit seed lower farmers' demand because of bad previous experiences, reinforcing longer-term doubts about the value proposition of hybrid seed.
- **Lack of supply of appropriate varieties:** Variability in supply of appropriate varieties can lead to lower demand due to farmer frustration in having access to the variety one season and not having access to it in the next season. Interviews indicate this can lead to farmers leaving the formal sector or using older varieties with more stable supply.
- **Lack of farmer awareness:** Limited availability of information about best agronomic practices and a lack of current market data for farmers can lead to a low level of awareness about the appropriate varieties and potential level and source of supply of these varieties.

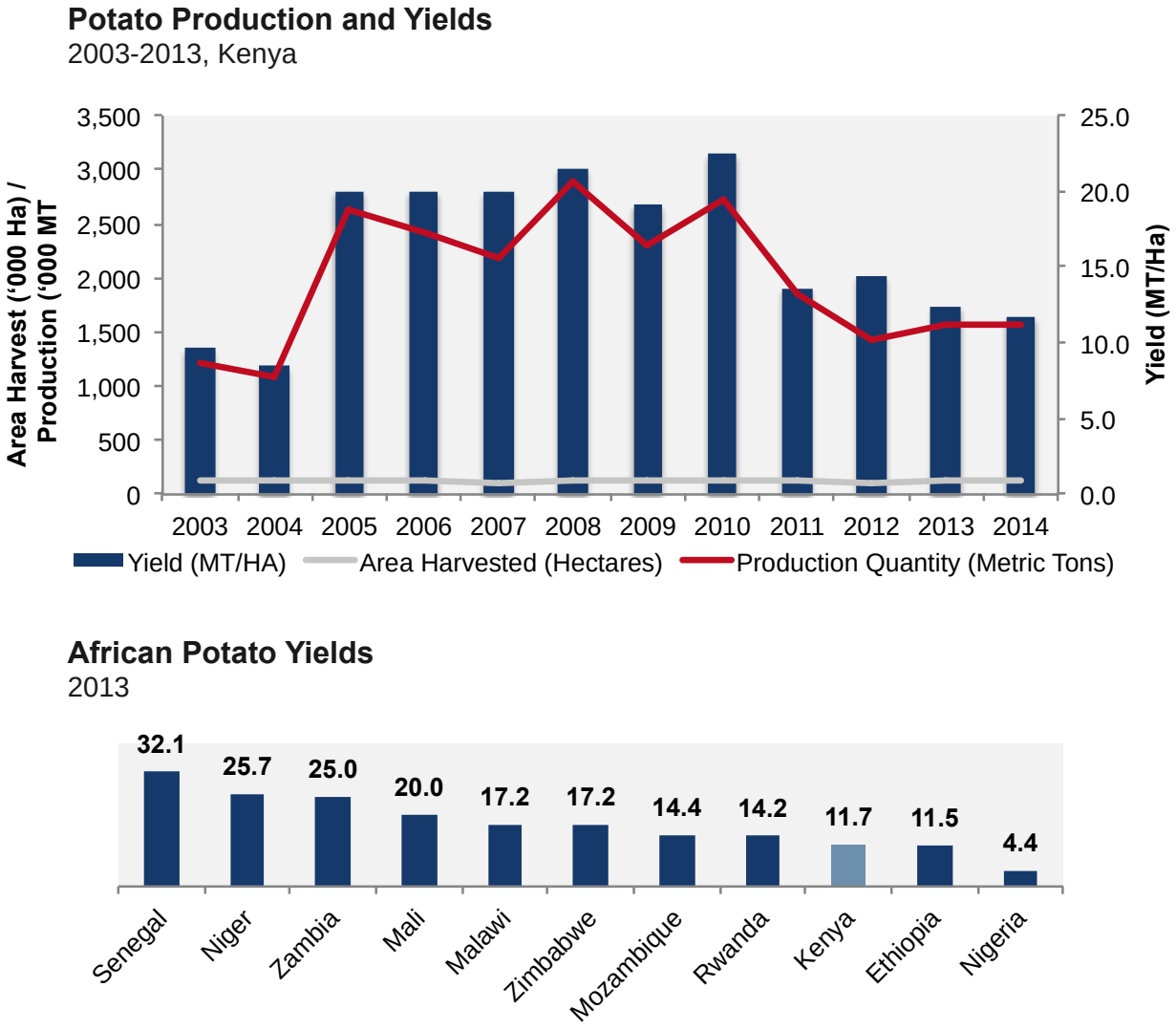
3.3 POTATO

SUPPLY

Potato *(Solanum tuberosum)* is an extremely important staple crop in Kenya, but yields and production levels are well below overall potential for the crop. Potato is produced primarily by smallholder farmers, with estimates of smallholder production as a percentage of total production to be greater than 90%. Production is concentrated in a small number of counties situated in the mid to higher altitudes, often being grown season after season, which has resulted in soil degradation.

Potato yields are suppressed by limited supply of high quality, certified seeds, which account for only 3-5% of potato planted area in the country. Additionally, disease and pest pressure contribute to low yields, with late blight, brown rot, viruses, and potato tuber moth causing significant damage. These limiting factors combine to significantly impact yields, with current national averages of 8-12 MT/Ha being well below potential yields of up to 40 MT/Ha. Yields have varied significantly over the past decade, ranging from greater than 20 MT/Ha to the current lows, as Figure 26 represents.

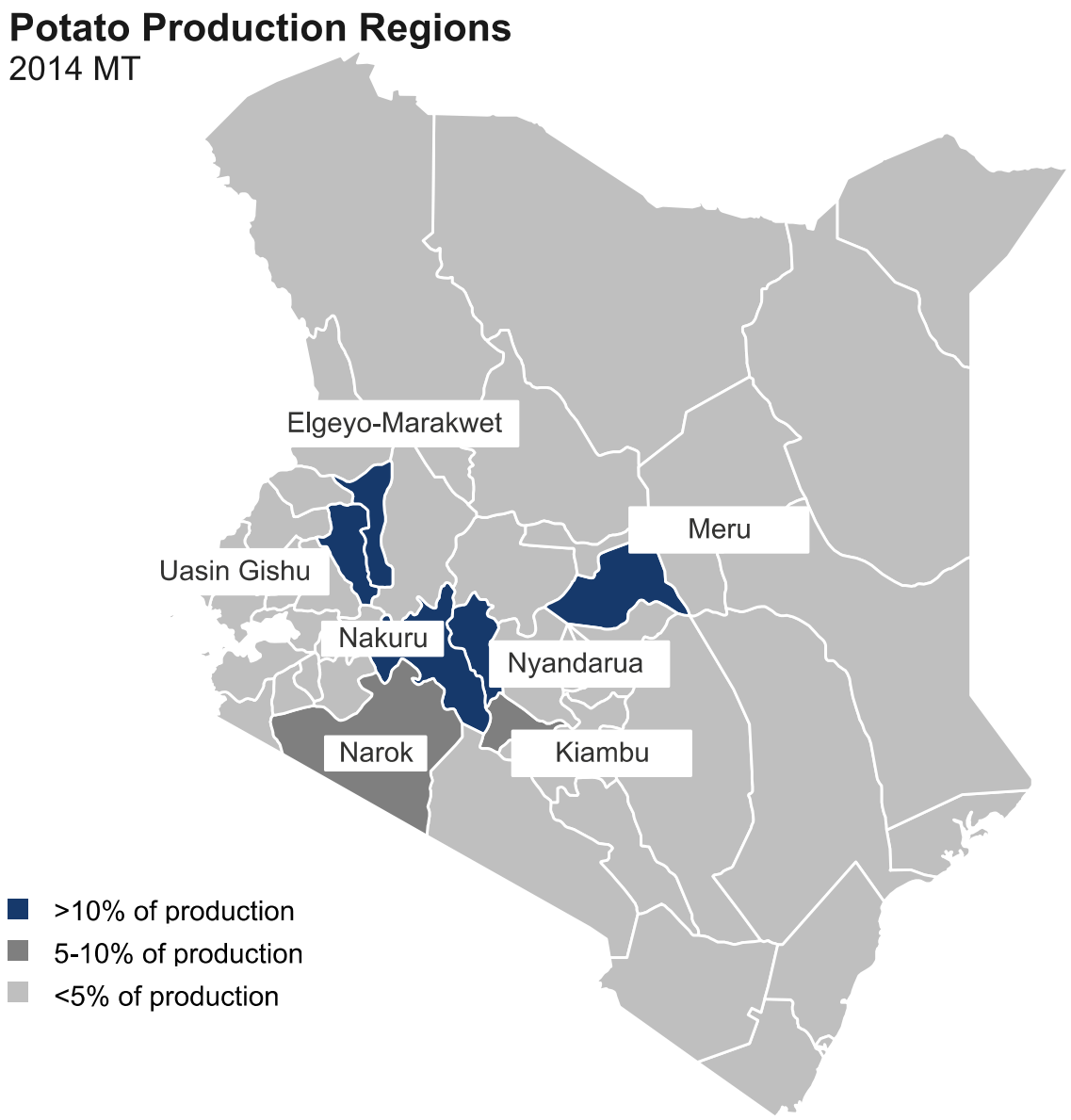
Figure 26: **Potato area, production, and yield.**



Source: Kenya Country Stat (viewed in March 2016), FAO Stat (viewed in March 2016), Ministry of Agriculture (2015).

As shown in Figure 27, potato production is concentrated in a small number of counties in the central and western portion of Kenya. Nakuru and Nyandarua counties were responsible for approximately 45% of potato production in 2014, equal to the production of the next five largest counties. There is a wide range of average yields across counties, from lows of approximately 5 MT/Ha to highs of greater than 15 MT/Ha. Generally, cultivation is concentrated in highland areas from 1,200 to 3,000 meters above sea level due to comparative advantages of potato over maize at these altitudes; more than 70% of potato production is at an elevation greater than 2,100 meters (Janssens, 2013).

Figure 27: **Potato production by county, 2014.**

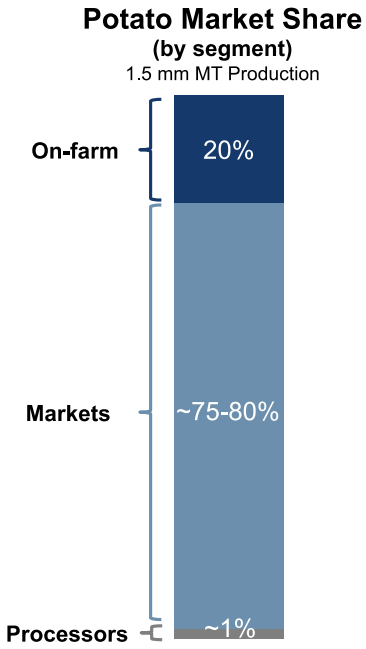


Source: Ministry of Agriculture (2015).

DEMAND

The majority of potato is sold in rural and urban markets across Kenya, as can be observed in Figure 28's illustration of potato demand segments. Kenya's current varieties generally are not suitable for processing, with an estimated 1-2% of total domestic production utilized by this sector. When production levels were higher (pre-2000), Kenya was an exporter of potato to India, the Middle East, and Europe, but lower production and increased demand have restricted export potential. Trade overall is limited now, with domestic production being consumed in country and only a small volume of processing potatoes imported from Egypt, according to field interviews.

Figure 28: **Comparison of potato demand segments.**



	Segment Description	Segment Needs
On-farm consum.	• ~20% consumed on-farm (including seed uses) • Estimated per person annual consumption at >110 kg in high production regions (country-wide average of ~30 kg/person)	• Small tubers used for replanting • Quick preparation times are a key in selecting varieties (Shangi)
Local markets	• Traders and brokers buy from growers and sell to the wholesale or retail markets, depending on their size/scale and position in the value chain • Urban demand is greater than rural demand and also increasing • Outside of household consumption, restaurants, hotels, and canteens are primary end users	• To meet growing urban demand, storage loss will need to be addressed, as this is a primary roadblock to increasing penetration in this market • Currently there is no grading system and limited branding of potato • Consumers prefer local varieties
Processors	• Only 1-2% of Kenyan potatoes are suitable for processing, leaving a large unmet demand • Demand is fulfilled through imports from other African countries • These processors produce products such as chips and crisps	• Limited scale but segment is growing, with a need for a consistent, quality supply • Lack of grading and branding is a limiting factor for processor expansion, as is capital availability

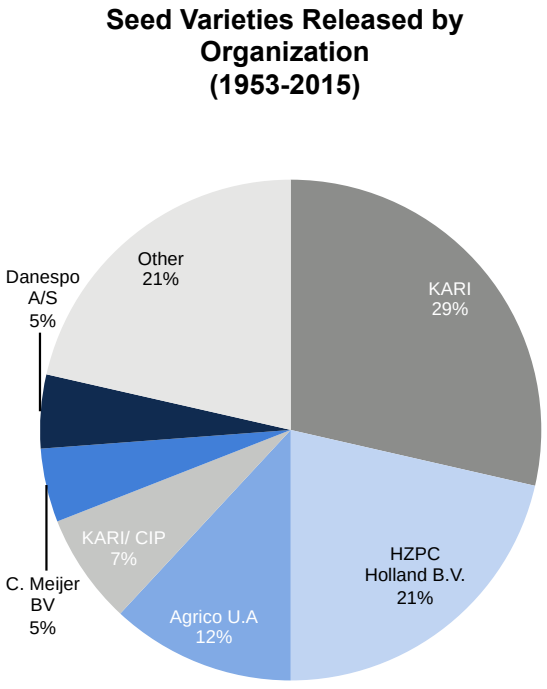
Source: Kenya Country Stat (viewed in March 2016), FAO (2014), Janssens (2013), Ministry of Agriculture (2015), expert analysis (2016).

IMPROVED VARIETIES

As of 2015, KEPHIS listed 30 varieties of potato for conventional management and 19 for high-input, intensive management. Given ecological and agronomic conditions, attractive characteristics include drought tolerance, resistance to diseases such as late blight, and a short dormancy period.

Seed varieties have been sourced from both domestic and international organizations, with the highest percentage of currently registered varieties coming from the former Kenya Agricultural Research Institute (KARI), as shown in Figure 29. KARI is now formally contained within KALRO, but variety ownership is still listed with the original organization. Recently registered varieties have primarily come from Agrico U.A. and HZPC Holland.

Figure 29: **Seed varieties by organization.**



Source: KEPHIS (2016).

Currently consumers tend to favor local varieties, with Shangi being the most popular variety according to one survey of traders (Janssens, 2013), with short cooking time mentioned as a valuable characteristic for home consumption. Shangi also offers characteristics valued by small holder farmers, including rapid germination. Other key potato varieties identified during field interviews are listed in Table 6, with their special attributes noted.

Table 6: Key potato varieties.

Key potato varieties

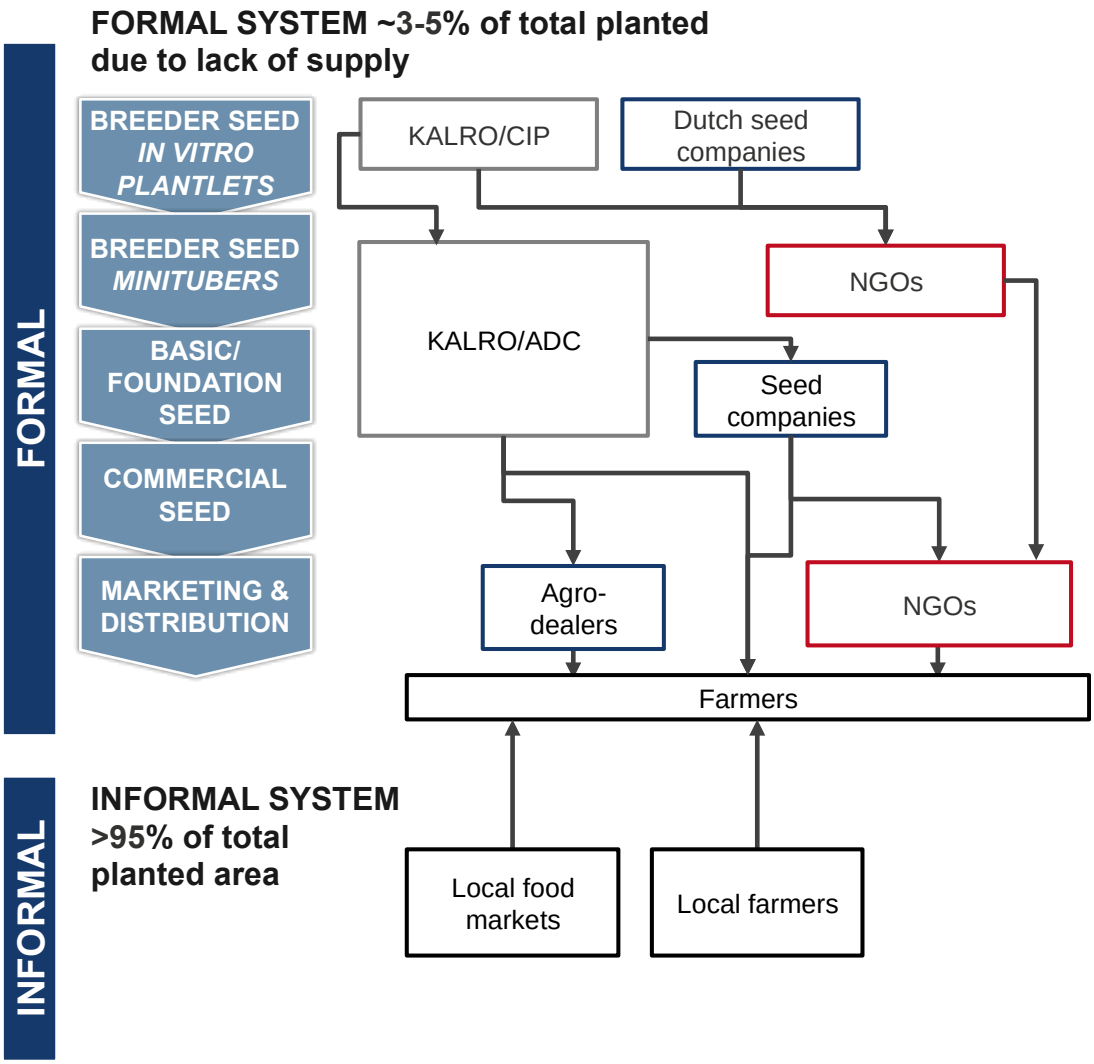
Variety Name	Developer	Year of Release	Special Attributes
Dutch Robijn	KARI	1960's	Good storage and crisping qualities
Tigoni	KARI	1998	Good chipping, boiling and mashing quality; tolerant to late blight
Asante	KARI	1998	Good chipping, boiling and mashing quality; fairly tolerant to late blight
Kenya Sifa	CIP	2006	Medium late to late maturity, high yields with good tuber and culinary characteristics
Kenya Karibu	CIP	2006	Medium late to late maturity, high yields with good tuber and culinary characteristics
Kenya Mpya	KARI/CIP	2010	Resistant to late blight; good storability; short dormancy; good for table, chips, and mashing; wide adaptability
Sherekea	KARI/CIP	2010	High tubers per plant; highly resistant to late blight/viruses; good storability; good for table, crisp, and mashing
Shangi	KALRO	2015	Early maturity, short dormancy, highly prolific, fast cooking, versatile use

Source: KEPHIS (2016), Field research team interviews (2016).

STRUCTURE OF EGS VALUE CHAIN

It is estimated that only 3-5% of the potato planted area is supported by the formal seed system, while more than 95% of potato area is planted with seed sourced by farmers through informal means, as shown in Figure 30. However, current EGS demand is estimated to be significantly greater than supply due to supply bottlenecks beginning at the plantlet level and extending throughout the system. The formal system is dominated by the public sector but there is growing private sector participation, specifically from international seed companies, NGOs, and private seed companies, such as Kisima.

Figure 30: **Structure of potato seed system.**



Source: Expert analysis (2016).

FORMAL SYSTEM

KALRO and CIP work together to provide the necessary research support for the industry, with Dutch seed companies beginning to play a larger role in this step in the seed production process. KALRO and Agricultural Development Corporation (ADC), along with private seed companies, produce breeder seed for the potato industry, with the same group of actors responsible for production of basic and commercial seed as well. Additionally, NGOs are involved in seed production on an as-needed basis, primarily to supply their outreach efforts to farmers.

NGOs and agro-dealers lead the marketing and distribution of commercial seed, with some direct selling from KALRO, ADC, and seed companies to farmers. KEPHIS is responsible for inspection and certification at all steps in the value chain, as well as for the oversight and regulation of imports and exports.

EGS supply bottlenecks are primarily caused at early stages in the value chain, with a lack of sufficient plantlet and breeder seed production volume causing supply shortfalls throughout the chain. In recent years, private seed companies such as Kisima have attempted to rectify this supply issue, but there is still a significant shortfall in annual seed production when compared to overall market demand. Other limiting factors include insufficient, inappropriate storage for seed, difficulty in distributing potato seed due to its bulky and perishable nature, and a lack of inspectors in the certification system.

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. As with many other crops, much of the informal seed need is filled with farmer-saved seed. However, due to high disease pressure, farmers cannot re-use their own seed indefinitely and must either refresh it through the formal or, more often, the informal system.

Informal seed sources include positively selected seed (farmer saved seed), seed sourced from local markets, and seed purchased from other farmers, neighbors, and relatives. Positively selected seed consists of tubers selected in the field by the farmer to be saved for planting the following season. This is in contrast to negatively selected seed, which consists of tubers that do not meet specifications and are not retained for planting. There is no quality assurance system in place for the informal market.

Although certain 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 significantly greater than supply due to issues that include:

Supply bottlenecks

- **Inadequate *in vitro* production capacity:** The limited amount of annual plantlet production has a ripple effect throughout the EGS system, with each step facing restricted supply due to an inadequate initial supply of plantlets.
- **High cost of production:** Current production techniques rely upon aeroponic[1] techniques which require significant electric power; this requirement results in higher costs due to the high costs of power and also a higher risk due to frequent power interruptions, thus restricting the ability of smaller actors to enter the seed production process.

[1] 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).

- **Lengthy payback period:** High up-front costs and long cycles result in lengthy paybacks on initial investments. This has been a continuous problem in the industry, as there has never been a source of affordable capital for investments of this nature.
- **Lack of capacity in the certification system:** Demand for certification exceeds the capacity of the current KEPHIS certification process at harvest times, particularly for commercial seed growers. The resulting delays lead to additional plant growth while a farmer waits for inspection, which can create tubers that are too large to sell as seed.
- **Lack of adequate supply information in the market:** Farmers do not have consistent, reliable information on the availability and location of high-quality seed, resulting in market confusion and a lack of alignment of supply and demand.
- **Lack of adequate distribution system:** Distribution of commercial seed is difficult due to the bulky and perishable nature of potato, poor handling of seed during transit, and inadequate roadways and transportation options, resulting in significant loss due to damage.
- **Lack of storage for EGS and commercial seed**: Absence of storage requires just-in-time seed production, which significantly increases risk for seed producers.

Demand constraints

- **Fluctuating prices for ware (non-seed) potatoes:** Much of what farmers produce is sold as ware potatoes in local markets. Due to pricing fluctuations for ware potatoes, farmers are faced with uncertain projected profits, which can limit their desire to purchase higher cost certified seed, and instead rely upon saved seed or seed source from other informal sources.
- **Limited farmer knowledge of agronomic best practices:** While farmers are generally aware of the benefits of adopting improved varieties, there is a lack of training and demonstration trials to educate farmers on the agronomic best practices to achieve the yield potential of improved varieties.

3.4 COMMON BEAN

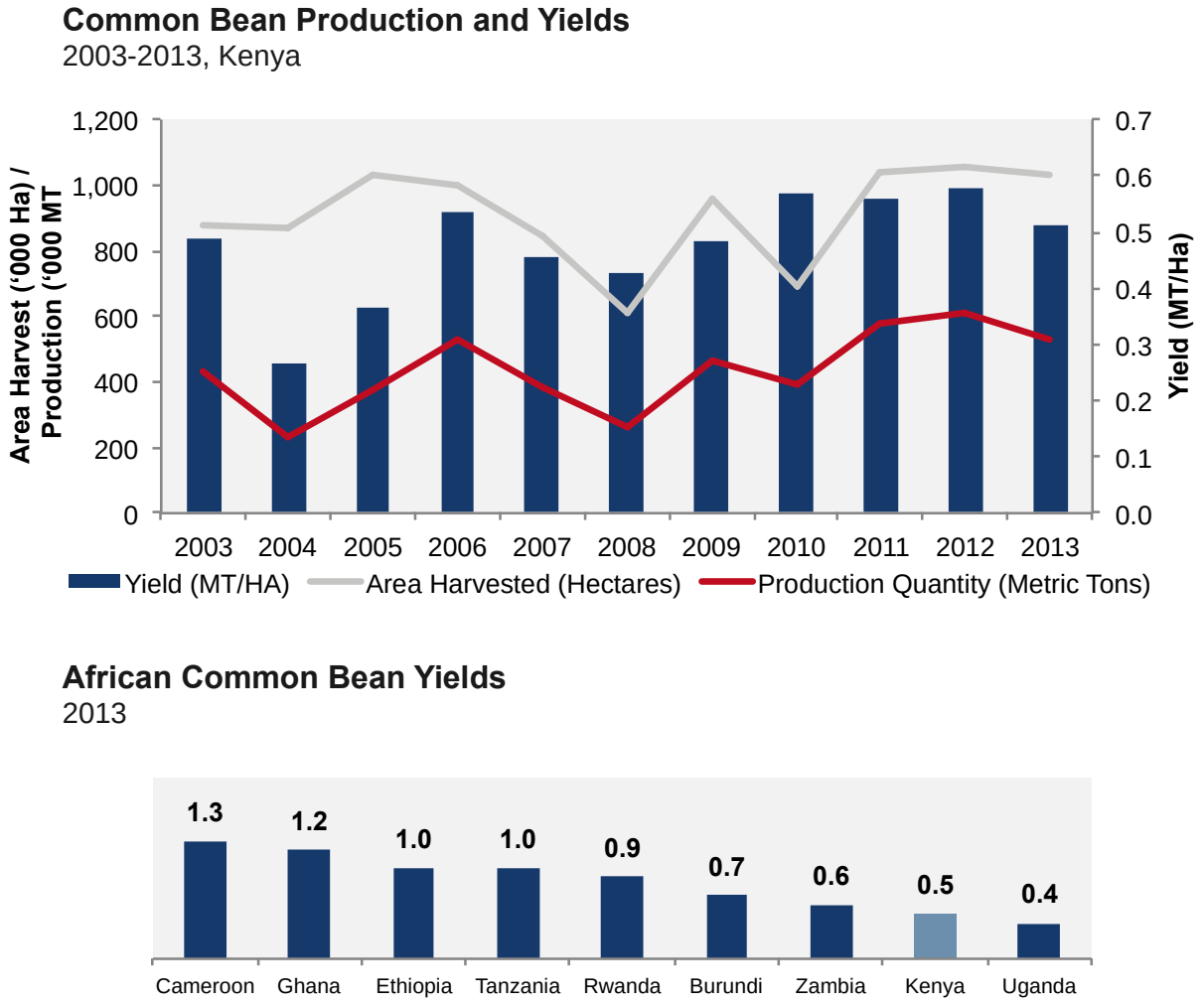
SUPPLY

Common bean (*Phaseolus vulgaris)* is Kenya's second-largest crop by area and represents a significant staple crop across the country. KARI estimates that 1.8 million households are involved in the production of pulses in general, with common bean estimated to contribute 85% of that total, or 1.5 million households countrywide.

Yields have been relatively flat at around 0.5 MT/Ha for the past decade, well below potential yields and those of comparable countries, as shown in Figure 32. Most regions grow common bean during two seasons, both the long and short rains, with the vast majority of production coming from intercropped production. Typically farmers will intercrop with maize, which restricts potential yields and limits the application of agronomic best practices for common bean. As a result of low yields, production is not adequate to meet current demand, resulting in the need to import common bean from surrounding countries such as Uganda and Tanzania (USAID, 2013), which occurs through both formal and informal channels. Common bean imports represent a significant source of supply depending on the region, with those close to the border having a larger reliance upon cross border trade.

As seen in Figure 31, area harvested has increased slightly since 2003, with production fluctuations based on yield variations. Rainfall variability is a crucial constraint to common bean in Kenya, accounting for more than 50% of yield loss. Yield is also restricted due to the consistent intercropping mentioned previously, as well as a high reliance on saved seeds and pest and disease pressures (Katungi et. al, 2010).

Figure 31: **Common bean area, production, and yield.**

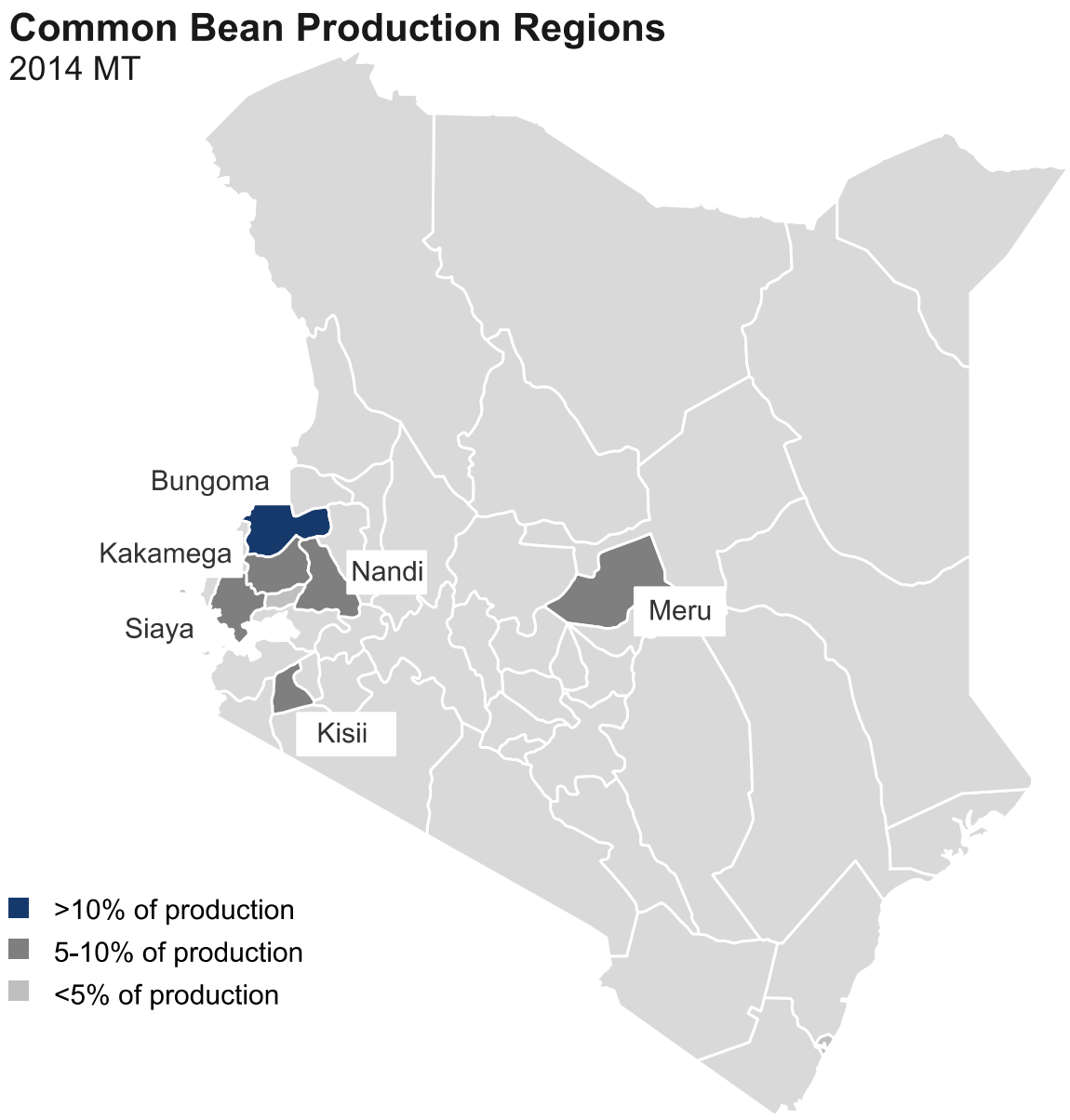


Source: Kenya Country Stat (viewed in March 2016), FAO STAT (viewed in March 2016).

Common bean production occurs across the country, with counties within Rift Valley (25%) and Nyanza (25%) provinces contributing approximately 50% of total production, while counties within Western province account for 23%, Eastern for 18%, and Central for 12%. This spread reflects the staple crop nature of common bean for smallholder farmers, with limited concentration in any one region, which is a differentiating factor when compared to maize and potato.

Due to differences in agroclimatic conditions and agronomic practices, there is a wide range of average yields across counties, with some Rift Valley and Western counties averaging more than 1.0 MT/Ha, more than twice the national average. Most regions grow common bean during both the short rains (Sep/Dec) and long rains (Feb/June) seasons, but this is changing due to shifting climatic patterns.

Figure 32: **Common bean production by county, 2014.**



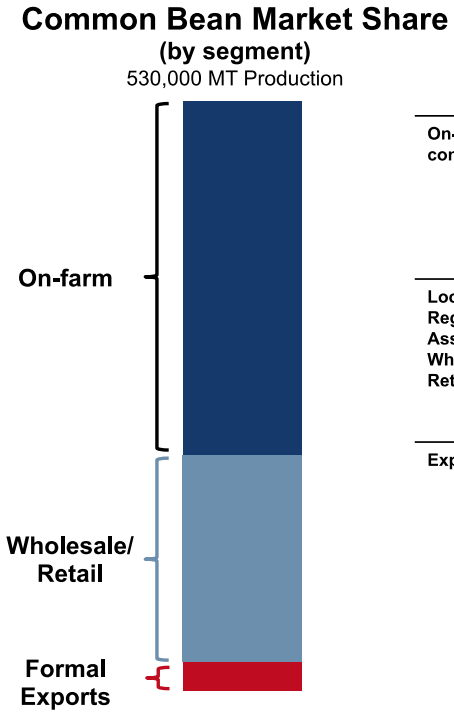
Source: Ministry of Agriculture (2015).

DEMAND

Common bean is an important staple food crop in Kenya and is primarily grown for on-farm consumption and also as a source of revenue through sale in local markets. According to various estimates, on-farm consumption accounts for around 60% of demand, with 35% going

to local markets and a very small proportion for commercial processing or export, as depicted in Figure 33.

Figure 33: **Comparison of common bean demand segments.**



	Segment Description	Segment Needs
On-farm consum.	• Majority of production is used for on-farm consumption, which also includes farm-saved seed	• High protein content (cheaper than animal protein) and desired as a source of iron, potassium, selenium, thiamine, vitamin B6, folate, and dietary fiber • Fast cooking, sweet taste, cooking texture, shelf life after cooking • More than 90% of bean production is used for human consumption either as stew (green/dry) or in the form of traditional dishes • Limited use as seed (~10%)
Local and Regional Assembling/ Wholesale/ Retail	• Primary purchasers of production are assemblers, either farm gate agents/brokers (local residents) or regional agents/traders who are often non-residents • Most purchases on a cash-basis	
Exports	• Imports have historically outweighed exports, but there have been years of excess production • From 2005-2011, formal exports of common bean averaged 5% of annual production with formal imports varying significantly according to government data	• Unknown

Source: Kenya Country Stat (viewed in March 2016), USAID (2010), and expert analysis (2016).

Kenya has typically been a net importer of common bean, with fluctuations depending upon annual production levels. Historically, formal sector exports have averaged approximately 5% of annual production, primarily to neighboring countries through cross border trade (USAID, 2010).

ADOPTION OF IMPROVED VARIETIES

As of 2016, KEPHIS listed 37 common bean varieties, with several varieties having been released over the past five years. According to the most recent market data, which do not include these new varieties, the most commonly utilized varieties include Nyayo/Marina, Katumbuka/Mwitemania/Katinga/Maddu, Kayellow/Kathika/Ka-green, and Nyayo Short/Salitoti/Short Maina (Katungi, 2011). However, as mentioned earlier, this study did not include many new varieties released since 2008, several of which are profiled in Table 7. Additionally, there are releases from 2015 that have not yet reached commercialization that are judged to have high commercial potential.

Studies have found that varietal adaptation to environmental stresses that also strive to reduce cooking time and enhance the keeping quality and grain color will greatly benefit the poor (Katungi, 2011).

Table 7: **Key common bean varieties.**

Variety Name	Developer	Year of Release	Special Attributes
Mwezi Moja	KARI/KSC	1982	Good performance in dry areas, early maturity, tolerant to drought and bean fly
Kat/Bean2	KARI	1987	Tolerant to shading
KK8	KARI	1997	Tolerant to root rot
Kat Bean 9	KARI – Katumani	1998	Tolerant to heat
Wairimu Dwarf	Kenya Seed Company	2008	Early, heat tolerant, good for maize intercropping, excellent cooking qualities
Kenya Wonder	University of Nairobi	2008	Large grains, moderately resistant to halo blight, angular leaf spot, anthracnose, common mosaic virus, and common bacterial blight
Chelelang	Egerton University	2008	n/a
Tasha	Egerton University	2008	n/a
Kenya Sugar Bean	University of Nairobi	2008	Early, large grains, moderately resistant to halo blight, common mosaic virus, and common bacterial blight
Kabete Super	University of Nairobi	2008	Large grains, resistant to floury leaf spot, halo blight, angular leaf spot, anthracnose, common mosaic virus, and common bacterial blight

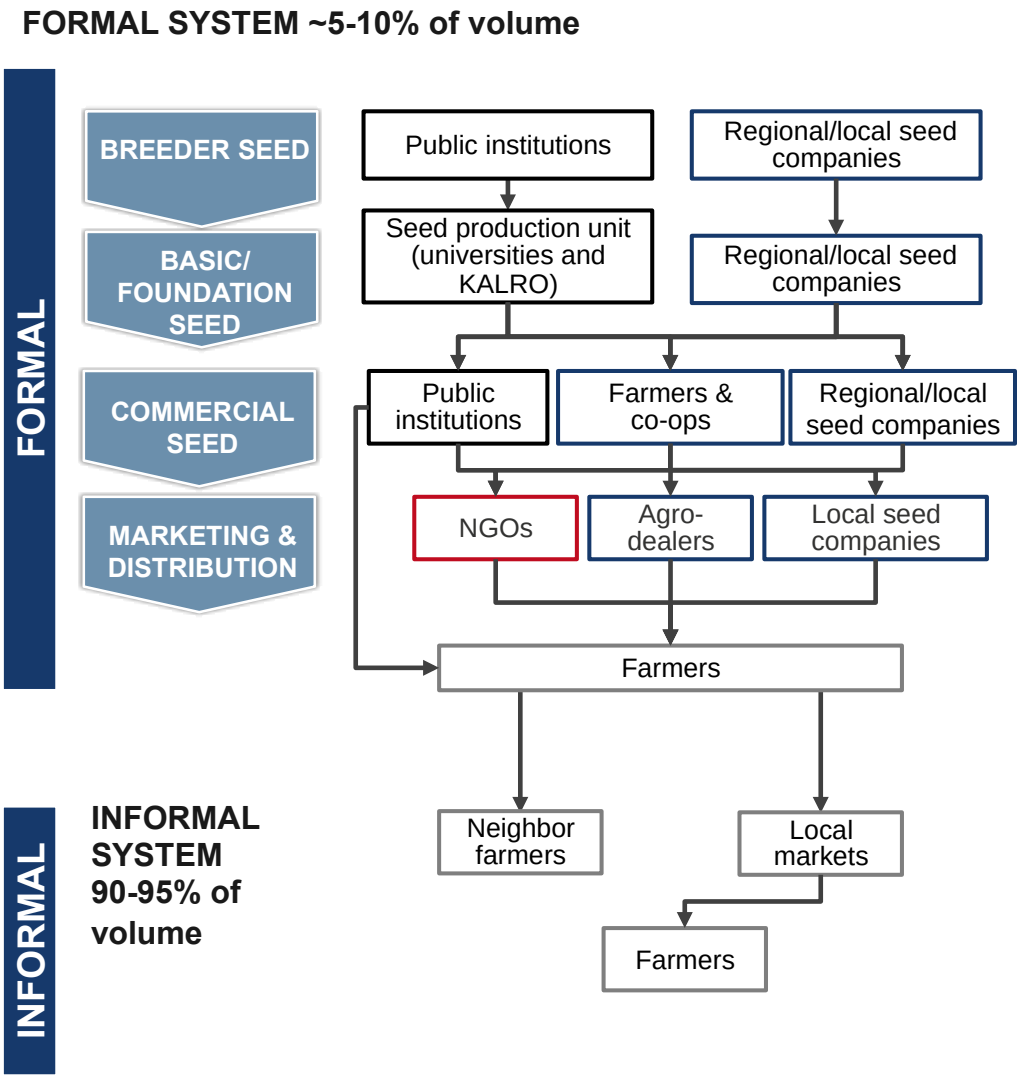
Source: KEPHIS (2016), Field research team interviews (2016).

STRUCTURE OF EARLY GENERATION SEED VALUE CHAIN

It is estimated that only 5-10% of the common bean seed is sourced through the formal seed system, with the balance of 90-95% of seed sourced by farmers through informal means, as illustrated in Figure 34. 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.

Comparing the formal and informal markets there is a large difference between the planting rates, with the formal planting rate estimated to be 25 kg/ha, with the informal rate estimated to be twice that rate at 50 kg/ha. Interviews indicate this variance is due to farmers compensating for lower quality of seed in the informal market and the resulting poor germination.

Figure 34: **Structure of common bean seed system.**



Source: Research team analysis (2016).

FORMAL SYSTEM

Generally, CIAT provides common bean genetics to KALRO. The primary roles for KALRO and public universities are to research and select suitable varieties for Kenyan agricultural needs and to produce breeder seed, with private seed companies providing additional support when needed due to capacity shortfalls.

Basic and commercial seed is typically produced by a combination of public institutions, such as universities and KSU, and regional seed companies. Farmer groups and cooperatives also play a small role in commercial seed production. Marketing and distribution of common bean commercial seed occurs through NGOs, agro-dealers, and local seed companies. As with maize and potato, KEPHIS is responsible for all inspection and certification in 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 are too low to justify saving grain for seed or when disease pressures intensify. Interviews with farmers indicated that there is an unmet need in the market for certified seed, and to fill this gap farmers are turning to the informal system. Many of the farmers interviewed indicated that they purchase the maximum volume available of certified seed and buy the balance from whatever source is available, whether it is local markets, other famers, or saving it.

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

- **Lack of production of breeder (including pre-basic) and basic seed:** Public sector breeder and basic seed production capacity is inadequate when compared to the demand for commercial seed and will need to be expanded to meet even the limited current demand for high-quality seed.
- **Lack of private sector involvement at breeder and basic seed levels:** Private company involvement in breeder and basic seed production is limited by the lack of profit potential. Private companies prefer to be involved only at the commercial seed production level.
- **Lack of GoK investment in non-maize crops:** Public sector breeders lack the requisite long-term incentives and funding required for development of varieties outside of the core focus on maize.
- **Lack of support for the commercialization of new varieties:** There are a significant number of varieties within the common bean market in Kenya, but often they become orphaned during the commercialization process due to a lack of support from the initial breeders and variety owners. Incentives for these public breeders from both public institutions and donors are not aligned with the timelines and support requirements for successful commercialization of new varieties, resulting in a proliferation of unsupported varieties, which increases confusion in the market.

Demand constraints

- **Lack of demand generation:** Demonstration trials are a very effective method for educating farmers on the value of buying certified seed but the number of trials is limited by the shortage of extension staff.
- **Limited awareness among smallholder famers of the business case to invest in improved seed:** Farmers are generally not aware of the potential return on investment associated with certified seed, as well as the benefits that could come from improved agronomic practices.
- **Limited availability of and access to credit for smallholder farmers:** Smallholder farmers lack access to the affordable credit options that would allow them to purchase

certified seeds and invest in other high quality inputs, often resulting in the need to purchase lower quality seed and inputs.

- **Lack of institutional support from breeders:** Breeders need to provide institutional support to seed producers in the value chain to ensure high-quality seed is produced and commercialized as intended and also in order to help provide farmers with the confidence that the seed they are purchasing is backed by the public sector.

3.5 PROMISING MODELS

POTATO SEED PRODUCTION AND POST HARVEST BEST PRACTICES – KISIMA

Kisima is a Kenyan-owned and operated agribusiness based in Timau, working with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), CIP, and USAID to produce high quality seed. Kisima has grown and developed its operation to become Kenya's leading provider of certified potato seed, utilizing 70 hectares per season to provide high-quality commercial seed to farmers. Kisima is committed to using the benefits of scale in seed production, storage, and handling and the associated lower cost per unit to benefit smallholder food production systems through the production and sale of affordable, high-quality seed.

Kisima has invested in a range of capabilities including aeroponics and cold storage systems, which allow for higher annual yields and lower post-harvest losses. These investments, combined with the cost reductions realized through large-scale production, have allowed Kisima to become the leading provider of high-quality commercial potato seed. Kisima has worked with providers of genetics such as CIP and end-users such as industrial processors to determine appropriate varieties.

Several obstacles remain for Kisima to overcome, both internally and externally. The regulatory and certification process remains complex and costly, making it difficult to get new varieties to market. The lack of storage and distribution infrastructure is a serious obstacle.

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 do not exist, 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 anecdotal, (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 modeled 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).

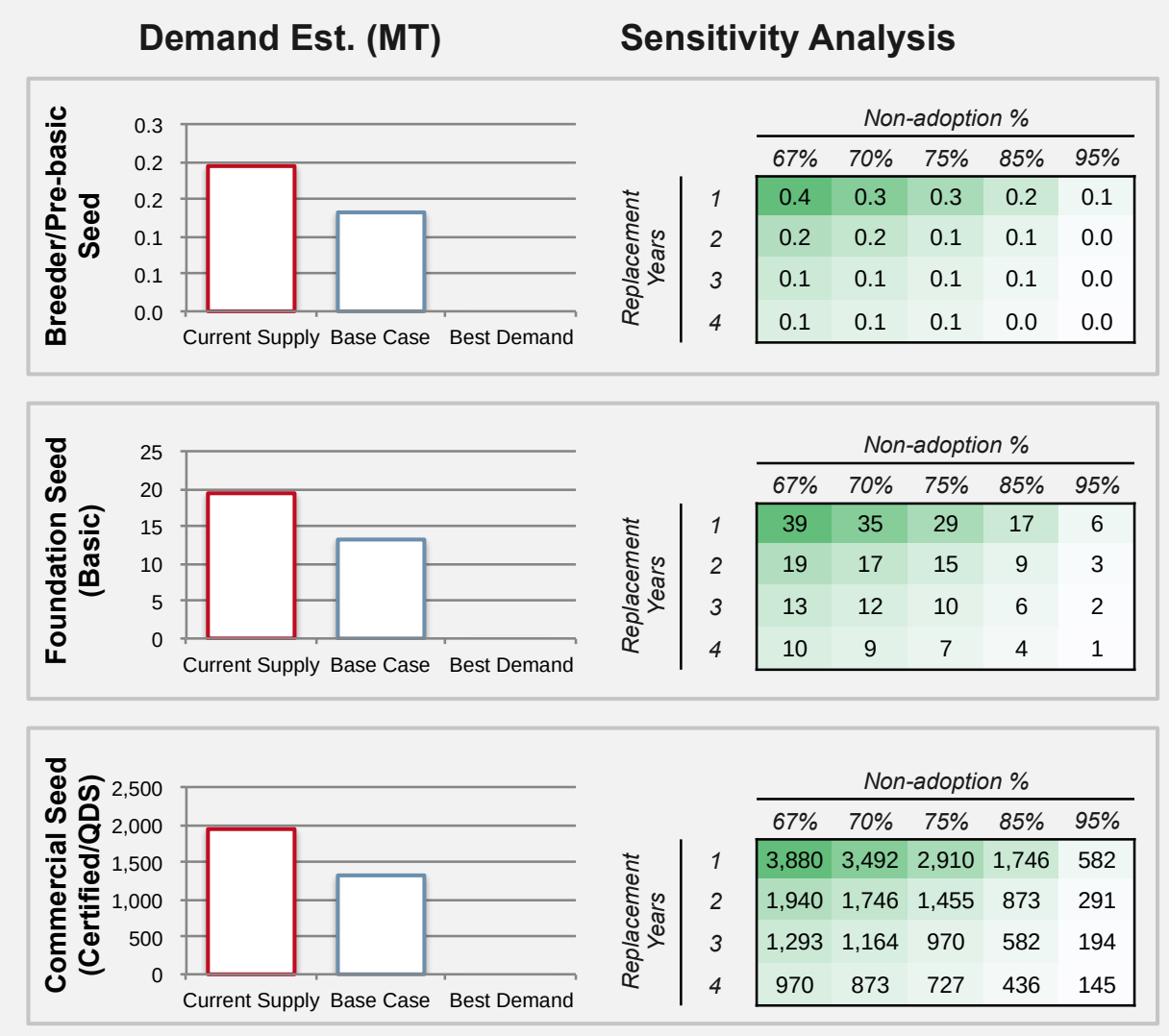
The potential EGS demand cases are based on a five to seven-year timeline for implementation of the recommendations. It is critical to note that these models are not seed production plans or detailed bottom-up evaluations of demand, but rather a high-level analysis to inform the selection of crop archetypes.

MAIZE

As previously mentioned, there are two key subsegments of maize, OPV and hybrids. OPV use is currently estimated at 22% penetration and is projected to decline, reaching an estimated 5% within 5-10 years. Interviews indicate it is expected that there will be no OPV EGS produced in Kenya within this same time period. This will result in the OPV market being completely served by the informal market, as shown in the best case where demand for OPV in the formal sector ceases. EGS demand for OPV is detailed in Figure 35.

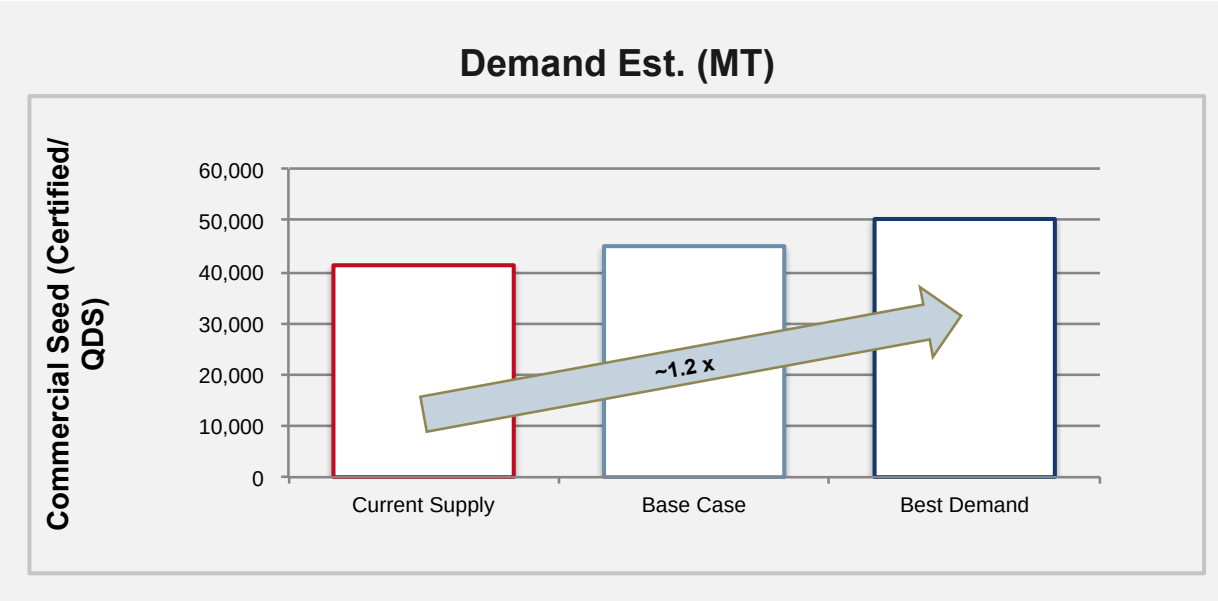
Conversely, hybrid maize seed demand is expected to continue to increase, reaching 95% adoption over the next 5-10 years This will necessitate approximately 50,000 MT of commercial, certified seed to be produced annually, requiring an increase in production capacity and policy changes around certification, which are addressed in Chapter 5. The field research team found that this scenario is realistic and that the projected level of penetration is achievable. Estimated demand for commercial hybrid maize seed is detailed in Figure 36.

Figure 35: **OPV maize - potential EGS demand.**



Source: Field research team interviews (2016).

Figure 36: **Hybrid maize - potential commercial seed demand.**



Source: Field research team interviews (2016).

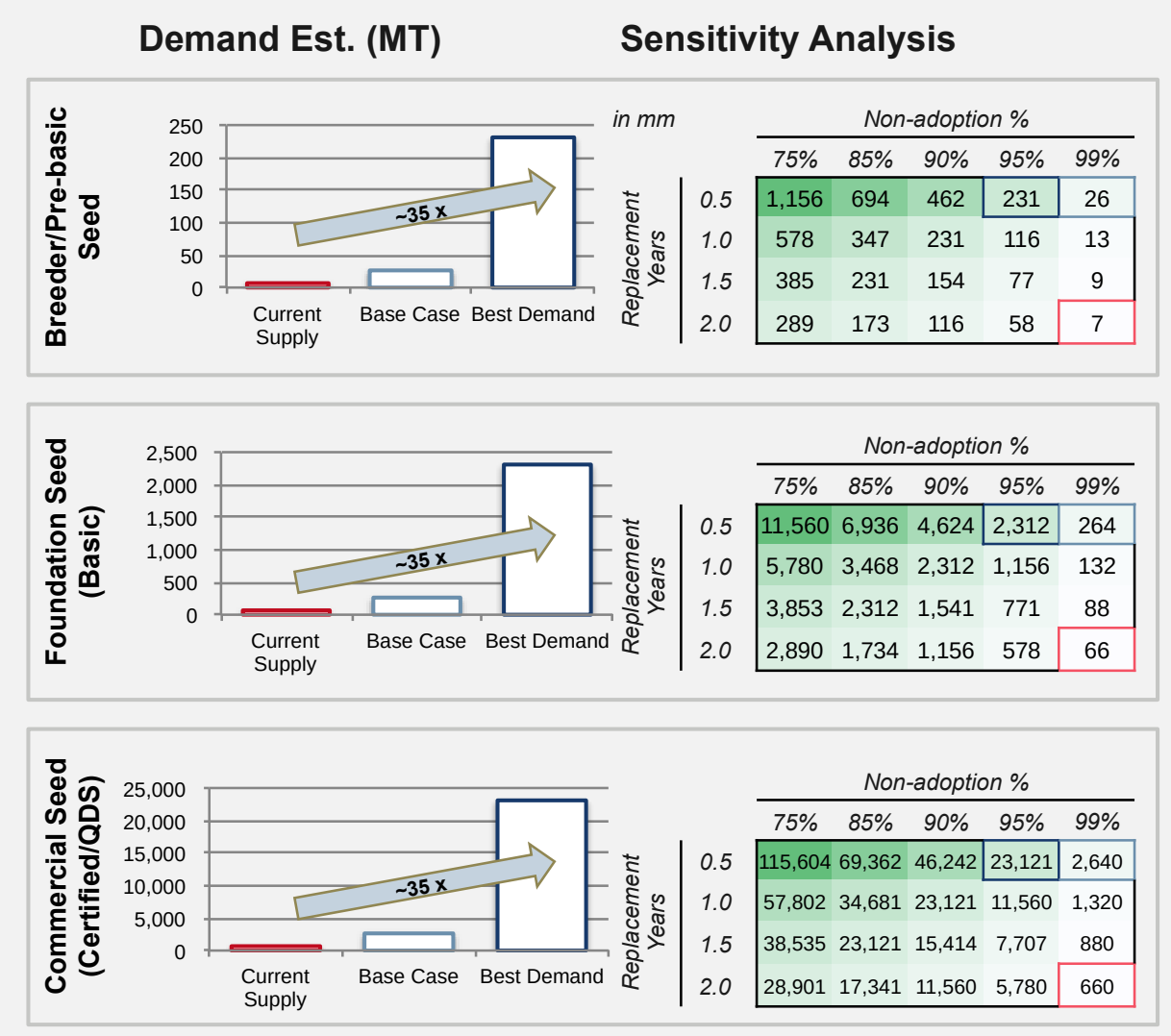
POTATO

The current supply of early generation potato seed does not satisfy current market demand. The informal sector accounts for more than 95% of the overall market, with most of this seed coming from local food markets, farmer saved seeds, seed from other farmers through trade or purchase, or seed that is gifted to farmers from neighbors or relatives.

The current supply of certified potato seed is known and can serve as the basis for the current supply case. The seed replacement rate and non-adopter percentage implied from this known quantity provides a baseline for developing the base and best case scenarios. It is assumed that farmers replace their seed every 3-4 seasons, or 1.5-2 years and that the non-adoption rate is >95% in the market today. This implies a demand of 44,000 mini-tubers, breeder seed demand of 7 MT, basic seed demand of 66 MT, and commercial seed demand of 660 MT.

In the base case, the non-adopter percentage is held constant while the seed replacement rate increases to every season, as is recommended in agronomic best practices. For the best case, this seed replacement assumption remains the same and the non-adoption rate is decreased to 95%.

Figure 37: **Potato - potential EGS demand.**



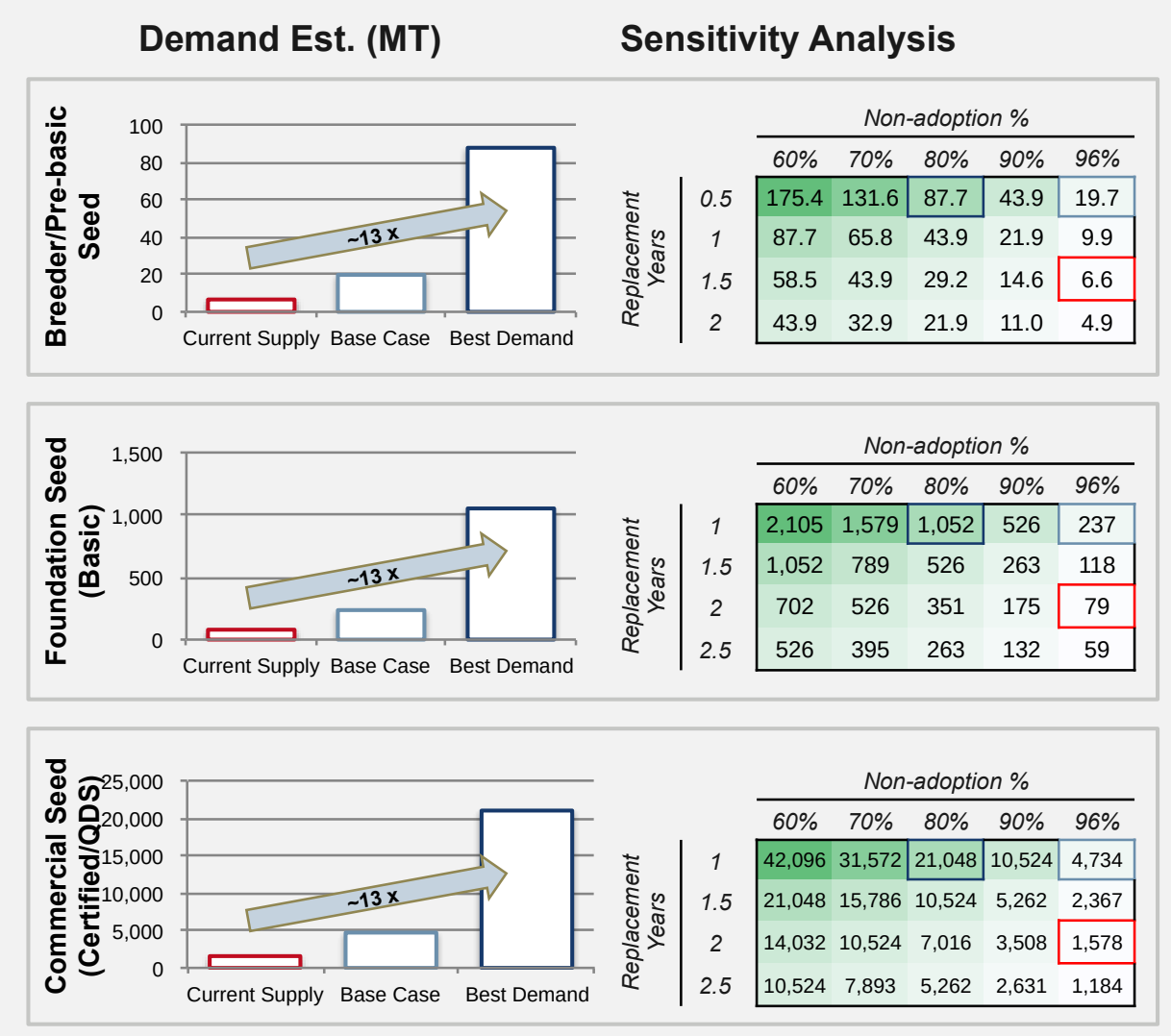
Source: Field research team interviews (2016).

COMMON BEAN

Common bean is currently viewed as a supply-constrained market, with supply falling short of the demand for improved seed. Given this primary constraint in the market, the assumptions used to build the base case and best case potential demand estimates were conservative (Figure 38). Current breeder seed supply, estimated at 6.6 MT, implies a basic seed supply of 79 MT and commercial seed supply of 1,578 MT, based on seed replacement every three seasons (one and a half years) for approximately 4% of the market. The current volume of seed certified by KEPHIS is known and can serve as the baseline for the current supply case. Based on field interviews indicating that current adopters of high-quality seed would use new seed every season if it was available, the base case assumptions increase seed replacement to every season for the same 4% of the market. The best case assumptions increase the market share to 20%, with this portion of the market still replacing seed every season. This is a

substantial increase over the current market size, but it still shows a relatively small certified seed market compared to overall seed use.

Figure 38: **Common bean - potential EGS demand.**



Source: Field research team interviews (2016).

4.2 PRODUCTION COST OF EGS

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 official data and obtaining best estimates of the cost of production through interviews with seed producers, farmers and KALRO personnel engaged in seed production.

Due to the lack of official cost information and the diversity of actors in the Kenyan 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, 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.

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 an interest in making research and variety development programs whose end product is financially sustainable breeder seed, 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.

MAIZE

Based on interviews with seed producers across the OPV and hybrid maize sectors, as well as the field research team's expertise, it is assumed that cost of production is approximately the same across basic and commercial seed production for OPV maize, with higher costs at the breeder seed level due to the fixed costs associated with breeder salaries.

Hybrid maize seed production is more expensive than OPV due to more intensive management needs and the associated higher variable costs. Hybrid maize is assumed to decrease in cost per kg from breeder to basic and basic to commercial production steps due to higher yields from breeder to basic seed and significantly lower fixed costs from basic to commercial seed.

***Table 8*: OPV maize- EGS cost of production**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT	0.2		19		1,940	
Variable Cost $ per Ha	$867	*Inspection costs represent 24% of total variable costs; inputs represents 17% of total variable costs*	$867	*Inspection costs represent 24% of total variable costs; inputs represents 17% of total variable costs*	$867	*Inspection costs represent 24% of total variable costs; inputs represents 17% of total variable costs*
Fixed Cost $ per Ha	$4,887	***Breeder salaries $4,747***	$847	***Breeder salaries $747***	$847	***Breeder salaries $747***
Total Costs	$5,754		$1,714		$1,714	
Margin	*$575*	*10% base assumption*	*$171*	*10% base assumption*	*$171*	*10% base assumption*
Cost + Margin $ per Ha	$6,330		$1,885		$1,885	
Cost + Margin $ per Kg	$2.53	***2,500 Kg/Ha yield***	$0.75	***2,500 Kg/Ha yield***	$0.75	***2,500 Kg/Ha yield***

Source: Field research team interviews (2016).

***Table 9*: Hybrid maize- EGS cost of production.**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT		*Not estimated*	4,144	*Parent seed required for triple cross production*	41,264	
Variable Cost $ per Ha	$2,313	*Shelling costs represent 14% of total variable costs; inputs represent 11% of total variable costs*	$2,669	*Inspection costs represent 12% of total variable costs; inputs represent 17% of total variable costs*	$3,162	*Inspection costs represent 23% of total variable costs; inputs represent 16% of total variable costs*
Fixed Cost $ per Ha	$5,164	***Breeder salaries $4,000***	$6,904	***Technician salaries $5,440***	$927	***KALRO per diem $747***
Total Costs	$7,477		$9,573		$4,088	
Margin	*$748*	*10% base assumption*	*$957*	*10% base assumption*	*$409*	*10% base assumption*
Cost + Margin $ per Ha	$8,224		$10,531		$4,497	
Cost + Margin $ per Kg	$8.22	***1,000 Kg/Ha yield***	$5.27	***2,000 Kg/Ha yield***	$2.25	***2,000 Kg/Ha yield***

Source: Field research team interviews (2016).

POTATO

Costs of EGS production for potato decrease at each successive step in the EGS value chain even as yields remain constant at the basic and commercial seed production levels. This improvement is the result of lower variable costs in each step.

***Table 10*: Potato - EGS cost of production.**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT	7		66		660	
Variable Cost $ per Ha	$7,364	*Seed costs are 28% of total variable costs*	$6,798	*Seed costs are 22% of total variable costs*	$3,154	*Personnel costs are 30% of total variable costs*
Fixed Cost $ per Ha	$375	***All land costs***	$375	***All land costs***	$375	***All land costs***
Total Costs	$7,739		$7,173		$3,529	
Margin	*$774*	*10% base assumption*	*$717*	*10% base assumption*	*$353*	*10% base assumption*
Cost + Margin $ per Ha	$8,513		$7,890		$3,882	
Cost + Margin $ per Kg	$0.71	***12,000 Kg/Ha yield***	$0.39	***20,000 Kg/Ha yield***	$0.19	***20,000 Kg/Ha yield***

Source: Field research team interviews (2016).

COMMON BEAN

Common bean EGS production costs per kg improves at each stage in the production process, resulting from higher yields for basic and commercial seed as compared to breeder seed as well as lower fixed costs. Inputs and inspection and certification costs are the largest portion of variable costs for common bean.

***Table 11*: Common bean- EGS of production.**

	Breeder/Pre-basic Seed	Assumptions	Basic Seed	Assumptions	Commercial/ Quality Seed	Assumptions
Demand MT	6.6		79		1,578	
Variable Cost $ per Ha	$1,431	*Inputs and Inspection/ Certification costs both represent approximately 21% of total variable cost*	$1,576	*Inputs and Inspection/ Certification costs both represent approximately 19% of total variable cost*	$1,566	*Inputs and Inspection/ Certification costs both represent approximately 19% of total variable cost*
Fixed Cost $ per Ha	$4,550	***Breeder salaries $4,370***	$544	***Salaries and overhead $394***	494	***Salaries and overhead $344***
Total Costs	$5,981		$2,120		$2,060	
Margin	*$598*	*10% base assumption*	*$212*	*10% base assumption*	*$206*	*10% base assumption*
Cost + Margin $ per Ha	$6,579		$2,332		$2,266	
Cost + Margin $ per Kg	$10.97	***600 Kg/Ha yield***	$2.33	***1,000 Kg/Ha yield***	$2.27	***1,000 Kg/Ha yield***

Source: Field research team interviews (2016).

4.3 EGS MATCHED WITH REVENUE/COST

When matching revenues and costs of the selected crops in this study, the key finding is that potato is a much more commercially attractive crop than common bean or OPV maize (Table 12). Hybrid maize was not included in Table 12, as it does not fit the same structure as common bean, potato, and OPV maize. OPV maize is slightly profitable at the basic and commercial seed levels, while potato is shown to be profitable throughout the EGS value chain. This consistent profitability reveals an opportunity for more private sector involvement in potato seed systems while OPV maize and common bean likely requires a greater level of public sector support due to either low levels of profit (OPV maize) or potential for loss (common bean). Tables 13, 14, and 15 provide summaries of hybrid maize, potato, and common bean 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 12: **EGS 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)
Common Bean	$4.00	$10.97	50	6.6	$200	$548	($348)
OPV Maize	$1.57	$2.53	25	0.2	$39	$63	($24)
Potato	$1.04	$0.71	2,000	6.6	$2,079	$1,419	$660
Crop	**BASIC SEED**						
	Price/Kg	**Cost + Margin/Kg**	**Seed Rate (Kg/Ha)**	**Demand (MT)**	**Total Revenue (Ha)**	**Total Cost (Ha)**	**Contribution (Ha)**
Common Bean	$1.70	$2.33	50	78.9	$85	$117	($32)
OPV Maize	$1.57	$0.75	25	19.4	$39	$19	$20
Potato	$0.76	$0.39	2,000	66.0	$1,513	$789	$724
Crop	**COMMERCIAL SEED**						
	Price/Kg	**Cost + Margin/Kg**	**Seed Rate (Kg/Ha)**	**Demand (MT)**	**Total Revenue (Ha)**	**Total Cost (Ha)**	**Contribution (Ha)**
Common Bean	$1.58	$2.27	50	1,578	$79	$113	($34)
OPV Maize	$1.49	$0.75	25	1,940	$37	$19	$18
Potato	$0.51	$0.19	2,000	660	$1,027	$388	$639

Source: Field research team interviews (2016).

Table 13: **Summary of hybrid maize assessment.**

Hybrid Maize	Assessment	Comments
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES		
Differential performance of improved varieties	**High**	Hybrids clearly outperform OPVs, especially in the higher input environments
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; multiple different regional needs exist, allowing for matching of grower needs to variety capabilities
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 Kenya**
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES		
Total demand for seed	**High**	Maize represents largest area in Kenya and is the most important crop to most smallholder farmers; hybrid maize adoption has reached 78% and expected to increase
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 Kenyan processors are mostly lower-value hammer mills; demand is high across all varieties in the market due to caloric importance
Overall Demand for Hybrid Maize	**High**	**Demand for hybrids will continue to grow due to clear the economic benefits of hybrids versus OPVs and country-level production deficit; import replacement should drive further demand**

Source: Research team analysis (2016).

Table 14: **Summary of potato assessment.**

Potato	Assessment	Comments
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES		
Differential performance of improved varieties	**Med.**	Improved varieties have been adopted, with a significant number of new releases over the past ten years; growers look for certain characteristics such as as tolerance to late blight
Frequency of seed replacement	**Med.**	High disease pressure drives growers to buy seed every three to four seasons; recommended replacement would be every season
Differentiating characteristics	**Med.**	Consumer preferences differ in urban and rural areas; processing sector has to import potato due to a lack of suitability of Kenyan varieties
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 seed replacement, adequate storage and distribution, and high cost of production**
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES		
Total demand for seed	**Med.**	Current demand exceeds supply, but is still a relatively small portion of the market overall
Requirement for quality assurance	**High**	Inspection and certification from KEPHIS is a key component for marketing of quality seed. Farmers have shown that they are willing to buy and use seed from the informal market though and do not always believe in the value proposition of certified seed
Farmer demand for specific varieties	**Med.**	Farmers have a good understanding of benefits and issues with varieties but have not yet taken up varieties in demand by processors
Market demand for specific varieties	**Med./High**	While rural and urban markets have clear preferences, larger opportunity exists if industrial processing replaces imports with domestically produced potato
Overall Demand for Quality Seed	**Med.**	**Current high demand has the potential to further grow with increased availability of varieties that meet farmer and market needs, with an opportunity for processing varieties to drive additional growth**

Source: Research team analysis (2016).

Table 15: **Summary of common bean assessment.**

Common Bean	Assessment	Comments
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES		
Differential performance of improved varieties	**Med.**	Potential yield benefits 2-3x for improved varieties when combined with advanced agronomic practices; variety commercialization has held back adoption rates
Frequency of seed replacement	**Low**	Farmers plant saved seed for 3-4 years, only replacing when diseases dictate
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	**Med.**	Production costs high as compared to other priority crops; not excessive when compared to regional comparables
Overall Value of Improved Varieties	**Low/Med.**	**Marginal economic value of improved varieties is low to medium as cost of production is relatively high and opportunities to command premium pricing are minimal to non-existent**
MARKET DEMAND FOR QUALITY SEED OF IMPROVED VARIETIES		
Total demand for seed	**Med.**	Current demand exceeds supply, but is still a relatively small portion of the market overall
Requirement for quality assurance	**Low/Med.**	Inspection and certification from KEPHIS is a key component for marketing of quality seed. Farmers have shown that they are willing to buy and use seed from the informal market though and do not always believe in the value proposition of certified seed
Farmer demand for specific varieties	**Low**	Farmers have preferences for certain varieties based on specific qualities and characteristics, but preferences vary by region
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
Overall Demand for Quality Seed	**Low/Med.**	**While an important staple crop in Kenya, demand will be below potential until value of improved varieties is demonstrated clearly to farmers**

Source: Research team analysis (2016).

CHAPTER 5: EARLY GENERATION SEED OPERATIONAL STRATEGIES

5.1 OPTIMAL MARKET ARCHETYPE

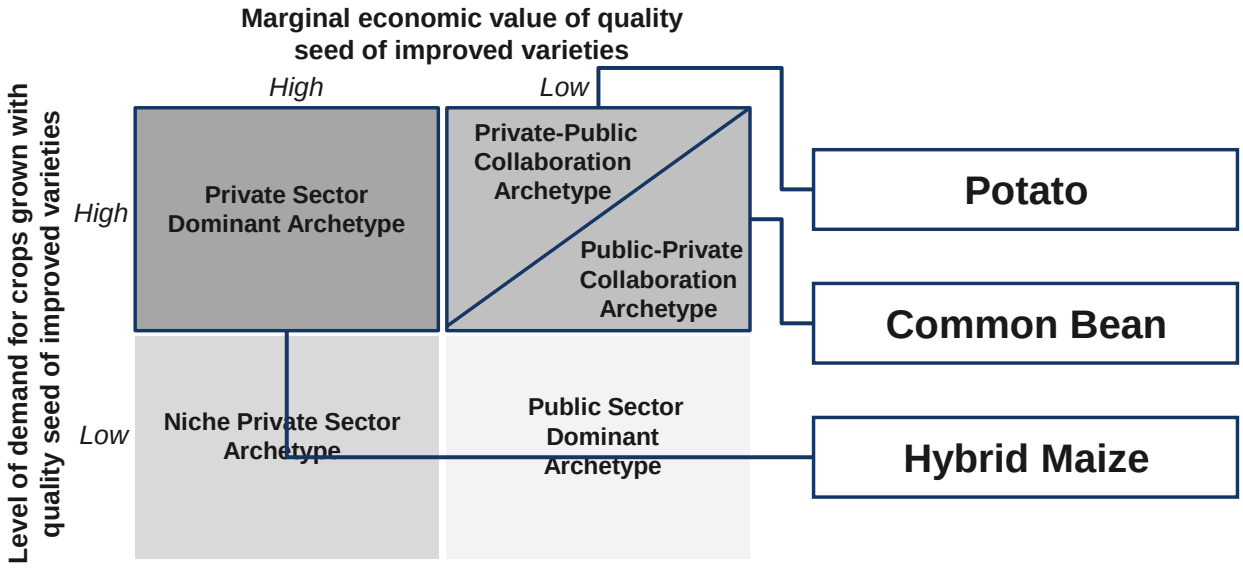
Hybrid maize, potato, and common bean have been classified into specific market archetypes based on their respective marginal economic value of quality of improved varieties and the level of demand for crops grown with quality seed of improved varieties.

Table 16: **Summary of crop assessments.**

	Common Bean	Potato	Hybrid Maize
MARGINAL ECONOMIC VALUE OF IMPROVED VARIETIES			
Differential performance of improved varieties	**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	**Med.**	**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	**Med.**	**Med.**	**High**
Requirement for quality assurance	**Low/Med.**	**High**	**High**
Farmer demand for specific varieties	**Low**	**Med.**	**High**
Market demand for specific varieties	**Low**	**Med.**	**Low**
Overall Demand for Quality Seed	**Low/Med.**	**Med.**	**High**

Source: Research team analysis (2016).

Figure 39: **Optimal archetype classification.**



Source: Research team analysis (2016).

Hybrid maize: Private sector dominant archetype

- *Economic value*: Marginal economic value of hybrids highest of all crops in Kenya, but more intensive management requirements than OPVs 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.

Potato: Public-private collaboration archetype

- *Economic value*: Currently the marginal value of improved varieties is limited by lack of seed replacement, adequate storage and distribution, and the high cost of production.
- *Demand*: Current high demand has the potential to further grow with increased availability of varieties that meet farmer and market needs, with an opportunity for processing varieties to drive additional growth.

Common bean: Public-private collaboration archetype

- *Economic value*: Marginal economic value of improved varieties is low to medium as the cost of production is relatively high and opportunities to command premium pricing are minimal to non-existent.
- *Demand*: While an important staple crop in Kenya, demand will be below potential until the value of improved varieties is demonstrated clearly to farmers.

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 17.

Table 17: **Summary of key success factors and existing limitations.**

	Ideal State	Current State			
	Key Factors	**Obstacles to Overcome**	**Common Bean**	**Potato**	**Hybrid Maize**
Public Sector/ Regulatory	Fully funded national research and EGS production program	KALRO, KALRO Seed Unit, and public universities are currently underfunded as compared to their overall mandates	✓	✓	✓
	Strong national extension program	National extension program devolved to counties in reforms included in 2010 Constitution; lack of funding available at county level to support valuable educational programs such as how to avoid counterfeit seed	✓	✓	✓
	Simple and effective Quality Assurance system	Lengthy inspection and certification process extends commercialization timelines, increases costs, and restricts supply of certified seed		✓	✓
Technical & Mgmt. Capabilities	Adequate, trained staffing for certification and genetics labs	KEPHIS and national labs face a shortfall in the number of adequately trained staffers causing bottlenecks at peak demand times		✓	✓
	High level of engagement with farmers to increase education	County level extension services lacking resources to implement valuable programs and trials that could increase adoption of improved varieties and educate farmers on agronomic best practices	✓	✓	✓
Demand Creation & Market Linkages	Utilization of improved varieties to increase yields	Current adoption of approved varieties leaves yields lower than theoretical level, with common bean and potato far worse than maize	✓	✓	✓
	Small packages of certified seed are available for smallholder farmers to match with demand	Smallholder farmers do not have access to the small seed package sizes they prefer through the formal system; they instead buy through the informal system, increasing the potential for counterfeit seed	✓		✓
	Robust demonstration trial platform driving grower adoption	Demonstration trials constrained by seed availability, trained personnel, and number of plots	✓	✓	✓
	Accurate projections of annual demand for important varieties	There is no national system for collecting input on demand and sharing it with EGS producers to help them plan and budget for annual production		✓	✓
Incentives & Access to Capital	GoK, donors, and impact investors structure appropriate and affordable financing alternatives for investment in production assets	Investment in production assets with a long payback timeline is limited due to the lack of affordable capital sources and view of agriculture as a high-risk industry		✓	
	Micro-financing loans available for farmers to afford high quality inputs, paired with agronomic recommendations and best practices	Many farmers are unable to afford high-quality inputs needed to achieve the best yields and also need further education around best practices to utilize inputs correctly	✓	✓	✓

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, private sector companies, NGOs and other stakeholders. 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.

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 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 may contribute to better infrastructure and greater cost and time savings.
- Project risks are shared among the partners.
- Access to private sector finance allows increased investment.
- PPPs provide the private sector with access to reduced risk, secure, long-term investment opportunities that are in some sense sanctioned by government.

Potential Disadvantages

- Accountability and transparency issues may be distorted under PPPs as private sector financed components may fail to appear in public accounts and reports. Similarly, evaluation is made more difficult as private sector data on profits, costs, or lessons learned may be considered commercially confidential.
- 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 implemented successfully.

There are many examples of successful PPPs within many sectors. An example from the Congressional Research Service of the Malawi Dairy Association Development Alliance summarized in Table 24 below. The objective was to build the capacity of small dairy farmers, local milk processing plants, and farmer-owned milk bulking programs in order to improve production and profitability. The partners collaborated on improving the entire dairy value chain and included loan program that enabled farmers to purchase new heifers, improve feed and cattle health, loan guarantee programs for local milk processing facilities, and improved milk bulking practices. The PPP provided rural dairy farmers, feed producers, and small and medium-size dairy processing facilities with the resources and tools required for a successful dairy industry.

Table 18: **Partners, contributions, and motivations for Malawi dairy PPP.**

Source: Congressional Research Service (2013).

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

RATIONALE

The field research team's review of prior work and historical reports concerning the seed system in Kenya revealed that many of the problems, obstacles and recommendations have remained relatively consistent over the last several decades. While there have certainly been significant changes in the seed industry over time, many of the same underlying issues related to government involvement, low supply of quality seed, and overall farmer education continue to be factors limiting successful change. These are all addressed within the recommended PPP structures, but the success of these PPPs will require significant buy-in from key stakeholders as well as adequate financial commitments.

With a heavy reliance upon KALRO, the KSU, and university seed units, the public sector plays an important role in the development and commercialization of varieties. However, a common theme that emerged through interviews with key stakeholders is the belief that the current public system is underfunded when compared to what it is being asked to do. This lack of capital investment and operating funds restricts the public sector's ability to support private sector

activities, and often creates insurmountable obstacles for these private companies. These financial shortfalls will need to be reversed as a precondition to the development of PPPs, as these will not serve as substitutes for adequate public resources in terms of personnel operating costs and infrastructure.

Some specific areas for increased funding that surfaced during our field research relate to the KALRO technology licensing unit and the KSU. The KALRO technology licensing unit will need to be expanded with additional staff in order to properly handle the volume of royalty payments that will be moving throughout the seed system. The KSU will need additional funding and likely will need to be restructured in order to implement the requirements proposed in the PPP details below. Specifically, the KSU would need to shift its focus from commercial seed production to EGS production and ensure funding is available to support production.

Additionally, as previously mentioned, during the field interviews there were a number of private seed companies that indicated a preference for producing their own EGS, as they believe they could produce at lower cost and at the same quality as KSU and contract growers.

Each crop's early generation seed-PPP (EGS-PPP) will have different responsibilities, dictated by the specific support needs of the given crop. By limiting the scope of involvement for public partners, the public sector would be able to better focus on specific portions of each seed system, where they may have the largest impact. This focus should also free up resources that can be utilized in other areas, such as the reestablishment of a national extension service or new research activities.

MECHANISMS AND SOLUTIONS

Each EGS-PPP would have four 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 improved varieties and quality seed at the farm level.
- Facilitate receipt of licensing revenue to foster sustainable public sector breeding efforts.

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 KSU or private seed company facilities, and would engage farmers, cooperatives, and local seed companies as contract producers of EGS to add capacity to the system. Using existing KSU infrastructure would 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.

Cost and quality: The EGS-PPP would strive to increase efficiency and productivity of seed production to meet the low-cost objective. This would include leveraging seed production resources already in place, as KALRO, the KSU, and public universities have built out infrastructure within the current EGS system that can and should be used as a foundation for these new PPPs. Contract growers would play an important role in the production of seed at the basic and commercial levels, and as such, the EGS-PPP would need to evaluate and select the most appropriate partners based on crop, region, cost, and quality needs.

Stimulate Demand for Quality Seed: The EGS-PPP could play an important role in stimulating demand for quality seed by conducting 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 limited data to confirm or refute the hypothesis in Kenya especially for common bean. The EGS-PPP could play a central role in generating data showing the value of quality seed. Furthermore, 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 farmer training in use of agronomic best practices.

Foster sustainable public sector breeding programs: The EGS-PPP can play an important role in stimulating demand for public varieties by increasing the access to, and availability of, EGS for the private sector seed companies. Increasing the demand for these varieties will provide additional licensing revenue to help to fully fund national research efforts and lead to continued investment in new varieties.

OPERATING PRINCIPLES

The EGS-PPPs should be established under a legal structure that allows it to generate and retain operating profits. The only way to ensure the EGS-PPPs can meet their 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 KALRO and university 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-PPPs. This could come in the form of royalties on sales of proprietary varieties (a distinct possibility in potato) or expanded market presence for private sector partners or a growing and assured supply of raw product for processing partners.

The EGS-PPPs should develop an effective system to forecast product demand. A major limitation of demand forecasting in the current seed system is the absence of real-time information on the specific varieties and quantities needed to meet market demands. The EGS-PPPs 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 Kenyan private seed sector is well developed and can be a key private partner. Securing the right private sector partners will be crucial to the success of the EGS-PPPs.

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

HYBRID MAIZE

Maize is extremely important to Kenya, both in terms of value creation in the agriculture industry and as a dietary staple. Additionally, the government has a lengthy history of involvement in the development and production of hybrid varieties, dating back to the 1960s. This fact means it is

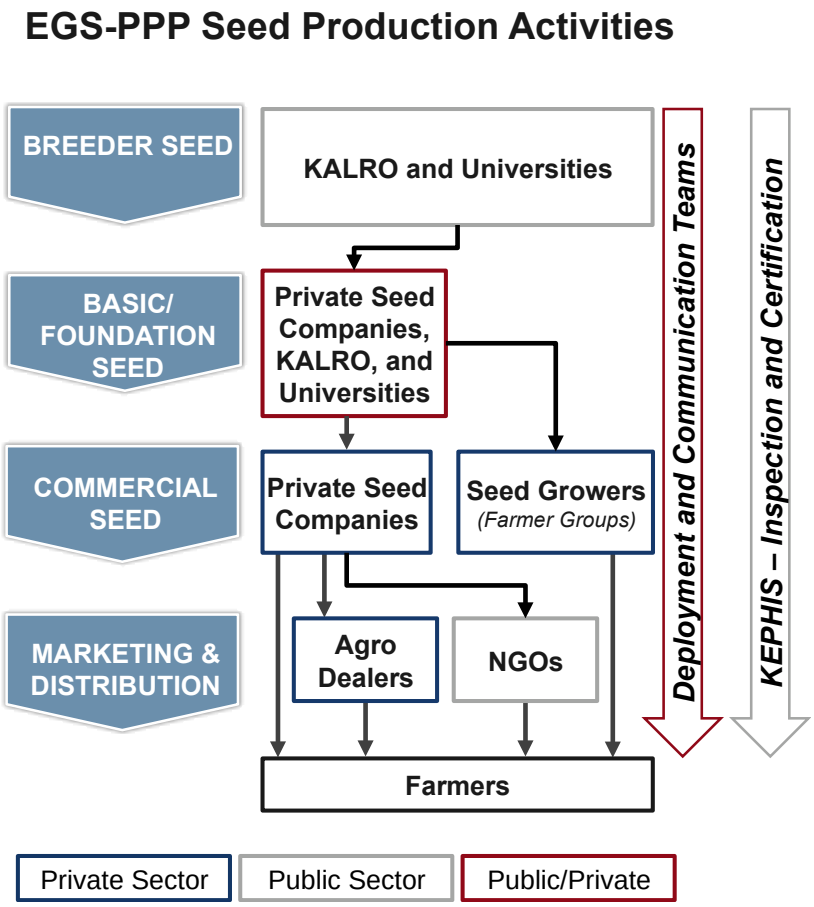
unlikely there could be a private sector-only solution, even though the characteristics of the market point to the private sector dominant archetype. Due to the unique circumstances in Kenya, the field research team recommends that a hybrid maize PPP be established at the basic seed level.

There is already significant private company involvement in hybrid maize. Many private and public sector participants have shifted their focus away from OPV, increasing the number of hybrid varieties in the market substantially over the past five years. The opportunity to partner with KALRO and KSU should be attractive to many of the market participants who currently struggle with EGS production as well as those companies that want to ensure they have the widest selection of appropriate varieties. Utilizing infrastructure, expertise and breeding capacity with both KSU and private seed companies (including the contract growers), should allow for supply of EGS to meet demand in the medium term.

The primary role of the PPP would be to produce basic seed for public varieties, with additional responsibilities including production of pilot hybrid seed for new varieties, technical support for commercial seed growers and private seed companies, and coordinating and guiding the Deployment and Communication working groups. Private seed companies have stated their preference for the public sector to provide technical support, but would prefer to own the actual production of commercial seed. Given the maturity of the private sector, this preference is reasonable and preserves the highest potential for profitability throughout the seed system.

Additionally, engaging agro-dealers and NGOs would help to further develop demand forecasting by improving the exchange of information.

Figure 40: **Hybrid Maize EGS-PPP Seed Production Activities.**



Source: Research team analysis (2016).

Table 19: **Hybrid maize EGS-PPP potential stakeholder list.**

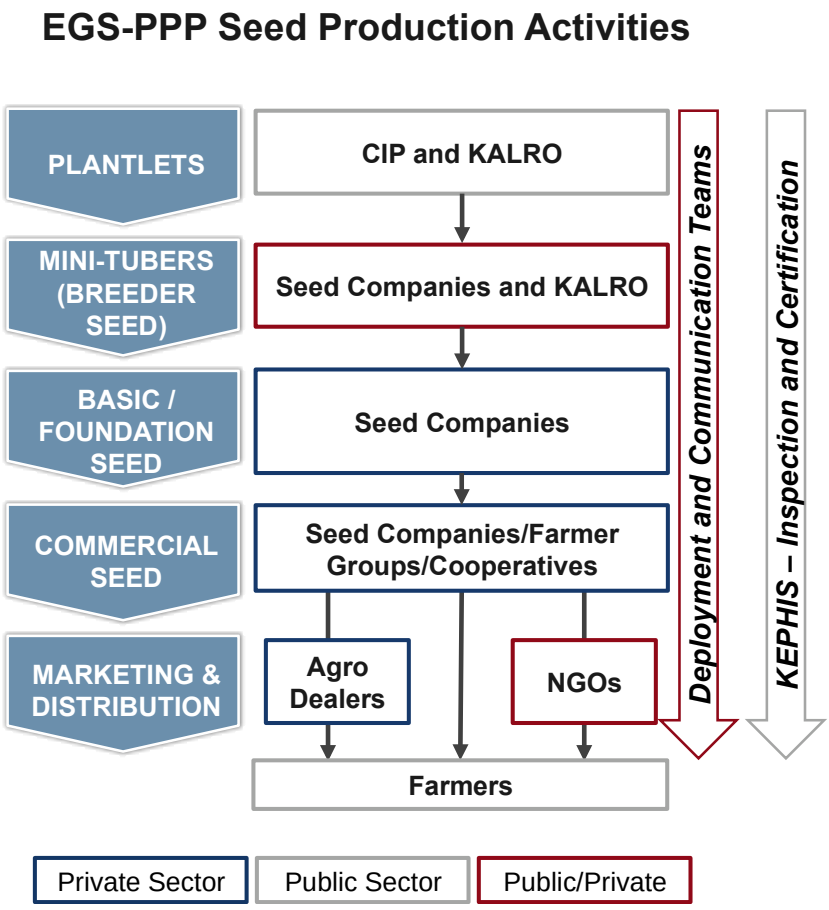
	Actors	Contribution	Motivation
Public	KALRO/Universities	Improved varieties, land for seed production	Additional bulking resources, increased funding, demand forecasting, increased revenue
	Ministry of Agriculture	Funding for extension services and enabling policies	Increased access to improved varieties and a stronger set of seed choices for farmers
	KEPHIS	Quality assurance/review of basic and commercial seed production to maintain required quality	Freed up resources (no breeder seed inspection) to focus on other crops
Private	Local Seed Companies, Seed Growers, Agro-Dealers	Funding for basic seed production, land and personnel for seed multiplication, seed distribution networks	Access to improved varieties, increased revenue
CGIAR	CIMMYT	Initial genetics, oversight and maintenance of varieties	Increased adoption of improved varieties
NGOs	One Acre Fund, AGRA	Seed producer training, agronomic best practices for farmers, execution of demonstration trials	Program benefits aligned with NGO objectives

Source: Research team analysis (2016).

POTATO

Potato has greater potential to become more financially attractive to the private sector than does common bean Because of potato's greater market opportunity, private partners are expected to be involved earlier in the production process, taking leadership roles at the basic and commercial seed production levels. Interaction with KALRO and KEPHIS would occur throughout the multiplication process, but the public sector would have no formal production responsibilities beyond the mini-tuber step. CGIAR, NGO, and agro-dealer partners would complete the partnership. CGIARs such as CIP would provide genetics and plantlet production resources. NGOs such as AGRA and One Acre Fund would provide farmer education efforts in best agronomic practices; as well as seed production training and distribution support for seed companies, cooperatives, farmer groups, and agro-dealers. These NGOs would also play an important role in execution of demonstration trials in the short term while Kenya national extension is reinstituted.

Figure 41: **Potato EGS-PPP Seed Production Activities.**



Source: Research team analysis (2016).

Table 20: **Potato EGS-PPP potential stakeholder list.**

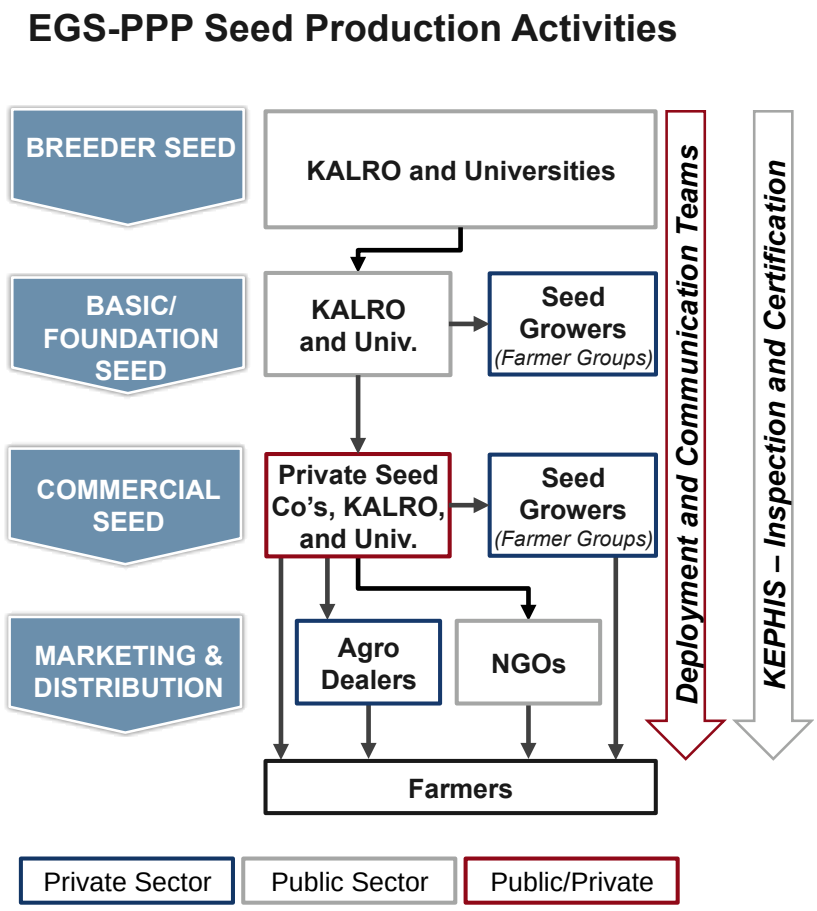
	Actors	Contribution	Motivation
Public	KALRO/ Universities	Improved varieties, land for seed production	Additional bulking resources, increased funding, demand forecasting, increased revenue
	Ministry of Agriculture	Funding for extension services and enabling policies	Increased access to improved varieties and potential expansion of processing industry
	KEPHIS	Quality assurance/review of basic and commercial seed production to maintain required quality	Freed up resources (no breeder seed inspection) to focus on other crops
Private	Local Seed Companies, Seed Growers, Agro-Dealers	Funding for mini-tuber (breeder seed) production, land and personnel for seed multiplication, seed distribution networks	Access to improved varieties, increased revenue
	Agro-processors	Consistent domestic supply of appropriate varieties for processing	Access to consistent supply and quality potatoes for processing (crisps and chips)
	Dutch Seed Companies	High quality genetics, experience, agronomic best practices	Additional adoption of improved varieties, access to necessary volumes of EGS, increased revenue
CGIAR	CIP	Initial genetics, plantlet production resources, oversight and maintenance of varieties	Increased adoption of improved varieties
NGOs	One Acre Fund, AGRA	Seed producer training, agronomic best practices for farmers, execution of demonstration trials	Program benefits aligned with NGO objectives

Source: Research team analysis (2016).

COMMON BEAN

The economics of common bean create a lack of private sector interest in the crop overall, making it difficult to get private sector involvement early in the EGS production process. Private sector partners prefer to become involved at a point in the production process when commercial viability has been established, which requires the public sector to be responsible for production of breeder and basic seed. Private partners would only have direct production responsibility at the commercial seed level.

Figure 42: **Common bean EGS-PPP Seed Production Activities.**



Source: Research team analysis (2016).

Table 21: **Common bean EGS-PPP potential stakeholder list.**

	Actors	Contribution	Motivation
Public	KALRO/ Universities	Improved varieties, land for seed production	Alignment with private sector throughout seed system, demand forecasting, increased revenue
	Ministry of Agriculture	Funding for extension services and enabling policies	Increased access to improved varieties, higher yields for important staple crop
	KEPHIS	Quality assurance/review of basic and commercial seed production to maintain required quality	Freed up resources (no breeder seed inspection) to focus on other crops
Private	Private Seed Companies, Seed Growers, Agro-Dealers	Funding, land, and personnel for commercial seed production, seed distribution networks	Access to commercially viable improved varieties, increased revenue
CGIAR	CIAT	Initial genetics, oversight and maintenance of varieties	Increased adoption of improved varieties
NGOs	One Acre Fund, AGRA	Seed producer training, agronomic best practices for farmers, execution of demonstration trials	Program benefits aligned with NGO objectives

Source: Research team analysis (2016).

ESTABLISHING HYBRID MAIZE, 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 from across the industry, including representatives from the Ministry of Agriculture, KALRO, KEPHIS, CGIARs, NGOs, a wide range of private seed companies encompassing a variety of sizes and viewpoints, agro-dealers, cooperatives, and banks and micro-finance institutions.

The Urban Land Institute outlined ten principles that could 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 would have different action items depending upon the crops, but could provide a framework for the public and private sector actors involved in the PPP.

1. **Prepare properly for a PPP**: Public actors led by MoA, KALRO, and KEPHIS; NGOs such as One Acre Fund; CGIARs such as CIP, CIMMYT, and CIAT; private sector seed companies; agro-dealers; and cooperatives will need to convene a series of 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 for each PPP.

2. **Create a Shared Vision**: Within each PPP, the founding organizers would need to 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**: At the outset, it would be important to get the Ministry of Agriculture, KALRO, and KEPHIS buy into the PPP purpose. The EGS-PPP concept would provide value for hybrid maize, potato, and common bean, but important differences between these three crops suggest that each should have an individual structure and vision. KALRO and KEPHIS would be the public partners in all three, 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 would 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 would 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, if necessary.
7. **Secure Consistent and Coordinated Leadership**: Focus on qualities such as integrity, discernment, and awareness of the human spirit, courage, compassionate sense of humor, intellectual energy and curiosity.
8. **Communicate Early and Often**: Emphasize both internal and external communication with internal communication ensuring that roles and responsibilities are clear and complexity managed and external communication ensuring the PPP is transparent to all stakeholders. This type of communication would be a critical to the success of the undertaking, especially aligning interests and consistent information sharing across a diverse set of organizations. To further this goal, one of the high level recommendations is that each PPP form Deployment and Communication working groups, with membership from both the public and private sectors. These groups would be charged with working across the seed system production chain to help communicate farmer needs to breeders and ensure that variety commercialization is successful. This structure is based upon the successful model deployed within WEMA, where these teams have been crucial to the success of the work done to date.
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 each 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

HYBRID MAIZE

The priority objectives for hybrid maize are to increase private sector access to public sector varieties and to support the development of a sustainable supply of high quality EGS to support market demand for hybrid seed. The combination of these objectives is intended to create additional choices for farmers and increase royalty payments to the public sector. In order to accomplish these objectives, the field research team recommends a PPP at the basic seed stage across KALRO, private seed companies, and public universities.

Hybrid maize is a sector in which private seed companies are already active and engaged, with a long history of hybrid adoption within Kenya. Removing any current barriers to the success of these private companies would be crucial for the success of the PPP, with specific areas of improvement coming from inspection and certification and reducing the cost of production.

Specific recommendations are as follows:

Ensure broad private sector representation within the PPP

There would need to be outreach to a broad set of private sector partners, as the objective of the hybrid maize PPP is to increase the availability of public varieties at the farm level. In order to do this, it would be important that a number of private seed companies be involved. By matching that increased access with market demand information, the PPP could help ensure that sufficient volume of appropriate varieties of improved seed is being supplied to the market.

Additionally, due to the wide range of varieties needed to support the industry, there would need to be strong coordination and communication from companies in different regions to ensure all growing regions are represented. The field research team recommends the Communication working group be tasked with facilitating this coordination and communication, as this team will have representatives from private sector partners.

Revise current inspection and certification system

KEPHIS should revise its current inspection and certification standards in order to streamline the overall process, decrease the associated costs for seed producers, and shorten certification timelines. One of the recommendations coming from a lot of stakeholders during field interviews was to utilize breeders as the primary source of inspection and certification for breeder seed, freeing up KEPHIS resources to focus on basic and commercial seed certification. Additionally, the field research team recommends that the GoK increase funding for KEPHIS so that it may increase capacity (i.e. number of inspectors) in the system at times of peak demand for certification.

Allocate required resources to national extension service

The national extension services were devolved to county control during the changes undertaken with the passing of the 2010 Constitution. The field research team recommends that a national level extension services be reinstated and operated in tandem with county level services to provide high-level national programming and local customization. Once this has been completed

and the national extension service is operational, it could combine with county level extension services to demonstrate the value of high-yielding hybrids to farmers still using OPVs.

Additionally, the field research team recommends that the new national extension service develop comprehensive recommendations for farmers including varietal needs by region and agronomic best practices to ensure the right seeds are being utilized in the best possible environments to produce yields closer to theoretical levels.

POTATO

The priority objective for potato is to expand and enhance EGS production capabilities to meet current and future demand through a PPP.

Kenya has strong demand for potato and the supply of EGS currently falls well short of what is needed to serve this current market demand. The primary need is a fully capable and scalable EGS system for potato. The overarching recommendation is to do so through a PPP anchored at the mini-tuber (breeder seed) production level between KALRO and private seed companies.

Specific recommendations are as follows:

Involve a diverse set of actors, including international seed companies and processors, in the creation and operations of the PPP

As indicated in the introduction to the crop level PPPs, the potato seed PPP should include an array of actors from the public and private sectors, including the Ministry of Agriculture, KALRO, KEPHIS, CIP, NGOs, Kisima and other private seed companies, agro-dealers, cooperatives, micro-finance institutions, and processors. An additional group of key stakeholders that should be included in the potato seed PPP is international seed companies, namely Dutch potato companies. These companies have significant experience that could be valuable assisting in the development of the PPP, high quality genetics and agronomic practices that could be incorporated into the PPP.

Align EGS production locations with demand centers

An important attribute of the PPP would be to remove one of the most important barriers to demand creation by moving EGS production closer to major producing regions. In addition to the proximity benefits of physical co-location of production resources with demand for seed, the field research team recommends that there be private investments made in the required storage and distribution infrastructure in order to get seed to farmers wherever needed. This would lower costs for the farmers, by reducing their travel time and costs, as well as the costs for seed producers as there would be lower levels of seed losses. Additionally, supply information could be collected and shared with farmers within a given region.

Realize the potential marginal economic value of potato

The potato industry overall needs to continue to work towards realizing the potential marginal economic value of potato. This could be accomplished through a variety of interrelated efforts led by the PPP covering both increasing the volume, and reducing the cost, of production.

By introducing new, high yielding varieties, smallholder farmers would be able to increase production and generate additional profit from the land area they currently allocate to potato.

Matched with this increased yield would be the need to expand storage capacity to enable smallholder farmers and traders the flexibility to store potato and to sell production at the most ideal time, as dictated by the market, rather than selling production immediately after harvest. The processing industry should also be engaged by the PPP to determine which varieties are in demand and to create an action plan for processors to obtain these varieties from farmers.

Beyond increasing production, costs could also be lowered within the seed system. Technology could play an important role in lowering system wide costs, and the field research team recommends that the PPP encourage utilization of technologies beyond aeroponics to lower costs and increase accessibility within the seed system. Another area of optimization could be the inspection process, wherein additional inspectors or a more streamlined process could be implemented to lower costs to farmers and decrease the risk of inspection delays.

COMMON BEAN

The priority objectives for common bean are to increase the supply of improved seed to meet current market demand, build farm demand for improved varieties and quality seed, and create a sustainable demand by increasing the marginal economic value of common bean. To facilitate meeting these objectives, there is a need for a robust and capable EGS system built as a PPP. The following are specific recommendations:

Facilitate the direct engagement with farmers through on-farm trials to stimulate adoption of improved varieties and quality seed

To increase pull-based demand from farmers in the market, the field research team recommends that the PPP design and execute on-farm trials to compare the performance of farmer-saved seed and quality seed. These comparative trials would serve to prove the value of improved seed which in turn would stimulate adoption from farmers.

As support for this effort from the PPP, the field research team recommends that there be increased budget support for extension services, with the goal of providing education to farmers related to the costs and benefits of improved varieties as well as agronomic best practices. Combining the aforementioned field trials run by the PPP and the renewed outreach and education efforts from the extension service would allow for the largest impact with farmers.

Enhance the marginal value of common bean for farmers

Duel priorities of increasing yield and decreasing costs should be pursued in order for the marginal value of common beans to be enhanced. As a part of the commercial seed PPP, there would need to be a promotion of the value of improved varieties, by educating farmers on higher yields and associated higher incomes through field trials and demonstrations. These two priorities would help to increase demand, but also would communicate and demonstrate the agronomic best practices that could result in higher yields for farmers. Supporting these efforts to increase yields would be cost reduction efforts within the seed system, where the PPP would 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 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.

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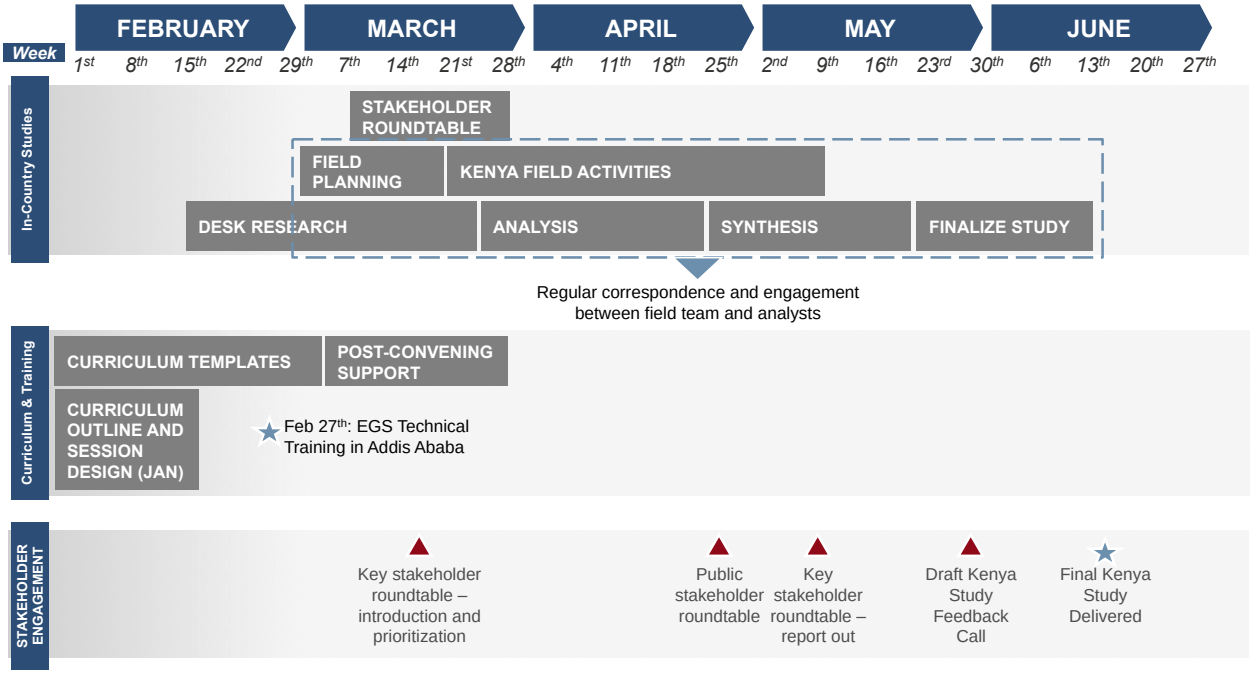
Data Sources

World Bank World Development Indicators, extracted March 2016

FAO Country Stat Food and Agriculture Data Network – Kenya country data, extracted March 2016

ANNEX A: STUDY TIMELINE



ANNEX B: FIELD RESEARCH TEAM

Kenya Field Research Team	Kenya Stakeholders	Project Management Team
Evans Sikinyi (CCN) **James Karanja** (CCN)	**Andrew Read, Samson Okumu** (USAID Kenya) KALRO, Ministry of Agriculture, selected seed companies, universities, 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, and Dan Creagh

ANNEX C: STAKEHOLDER INTERVIEW LIST

Interview	Role
CGIAR	CIMMYT
CGIAR	CIP
Farmer Group/Cooperative	Fresh Horticulture Cooperative
Farmer Group/Cooperative	Multiple Farmer Representatives
Farmer Group/Cooperative	Farmer Representative
Farmer Group/Cooperative	Multiple Farmer Representatives, Rift Valley
NGO	AGRA
NGO	AATF
NGO	Foundation
Private - Agricultural Inputs Company	Elgon Kenya Limited
Private - Seed Company	SEEDCO
Private - Seed Company	Drylands
Private - Seed Company	Kenya Seed Company
Private - Seed Company	Pioneer
Private - Seed Company	Pannar
Private - Seed Company	Faida Seed Company
Private - Seed Company	Kisima
Private - Seed Company	Syngenta East Africa
Private - Seed Company	ADC
Public	National Potato Council
Public	Agriculture, Fisheries, and Food Authority
Public	Council of Governors
Public - Breeding and Research	KALRO - Kitale
Public - Breeding and Research	KALRO - Katumani
Public - Breeding and Research	KALRO - Embu
Public - Breeding and Research	KALRO - Lanet
Public - Quality Assurance	KEPHIS
Public - Quality Assurance	KEPHIS
Public - Quality Assurance	KEPHIS - Nakuru
Public - University	Egerton University
Public - University	Eldoret University
Public - University	Maseno University
Public - University	University of Nairobi
Trade Association	Seed Trade Association