Tanzania Early Generation Seed Study

July 2016

This publication was produced by AGRA - SSTP for the United State Agency for International Development Development Development

FOREWORD

The United States Agency for International Development (USAID) and the Bill and Melinda Gates Foundation (BMGF) recognized that many bottlenecks hinder projects targeting smallholder farmers in sub-Saharan Africa (SSA), including the unsustainable supply of Early Generation Seed (EGS); poor functioning of national variety release systems; outdated seed policies, laws and regulations, and misplaced subsidies that limit access to publicly developed improved varieties by private seed companies. These bottlenecks have resulted in the continuing presence of obsolete varieties in seed markets, as well as counterfeit seeds.

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 development of a methodology to analyze seed value chains by specific market, crop, and economic dimensions. Applying this methodology leads to identifying the actors and actions along the seed value chain that are required to produce adequate EGS on a sustainable basis. Technical experts from African regional organizations, research and technical agencies, and development partners vetted the methodology.

The Context Network contracted by AfricaLead II led 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.

AGRA through the SSTP program contracted country consultants and coordinated the study implementation in Ghana, Malawi, Mozambique and Tanzania.

Each country study required careful consideration of appropriate private, public, donor, NGO, and informal sector roles in seed distribution to end-users. 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 (QDS)), were consulted. The country studies aim to understand farmer requirements, such as demand, independently of the policy and technical parameters affecting EGS supplies.

The studies will create incentives for greater government and private investments in the respective seed sectors, laying the basis for increased scale-up and adoption of more productive technologies. With short-term increase in the 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 the constraints hindering seed quality and supply.-

ACKNOWLEDGEMENTS

The Tanzania EGS study was developed by Emmarold Mneney and Oswald Mashindano under the technical guidance of Latha Nagarajan, an agricultural economist with IFDC, who was contracted by The Rutgers University Feed the Future Policy Research Consortium with logistic and technical support from SSTP staff based both at AGRA headquarters and in Tanzania.

The team would also like to thank all key stakeholders in Tanzania who participated in the planning and validation workshops as well as those who accorded the research team interviews for this study.

SSTP acknowledges the work of the Context Network in developing the infographics and templates, and in allowing these to be modified and used in this report.

This report was made possible through support provided by USAID, under the terms of Cooperative Agreement No. AID-OAA-A-13-00040 managed by AGRA. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID.

ABBREVIATIONS

AGRA	Alliance for a Green Revolution in Africa
ARI	Agricultural Research Institute
ASA	Agricultural Seed Agency
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
BMGF	Bill and Melinda Gates Foundation
CAADP	Comprehensive Africa Agriculture Development Program
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
DRD	Division of Research and Development
EGS	Early Generation Seed
EGS-PPP	Early Generation Seed Public Private Partnership
GDP	Gross Domestic Product
Ha	Hectare
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
INTSORMIL	International Sorghum and Millet
ISTA	International Seed Testing Association
MALF	Ministry of Agriculture, Livestock and Fisheries
MLND	Maize Leaf Necrotic Disease
MT	Metric Ton
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Cooperation and Development
OPV	Open Pollinated Variety
PPP	Public Private Partnership
PVP	Plant Variety Protection
QDS	Quality Declared Seed
SADC	South African Development Cooperation
TARI	Tanzania Agricultural Research Institute
TASTA	Tanzania Seed Trade Association
TOSCI	Tanzania Official Seed Certification Institute
UPOV	International Union for the Protection of New Varieties of Plants
URT	United Republic of Tanzania
USAID	United States Agency for International Development
WEMA	Water Efficient Maize for Africa
WFP	World Food Program

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. 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.

Pre-basic seed: is the progeny of the breeder. Pre-basic seed is a class of seed 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 Tanzania.

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. However, in the case of Tanzania, the FAO QDS system was modified and adopted in the year 2000. The QDS was incorporated into the formal seed system in the national Seeds Act of 2003, along with its seed rules, regulations & procedures (2007).

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. Quality seed must meet the four basic parameters of seed quality which are: physical, physiological and genetic.

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.

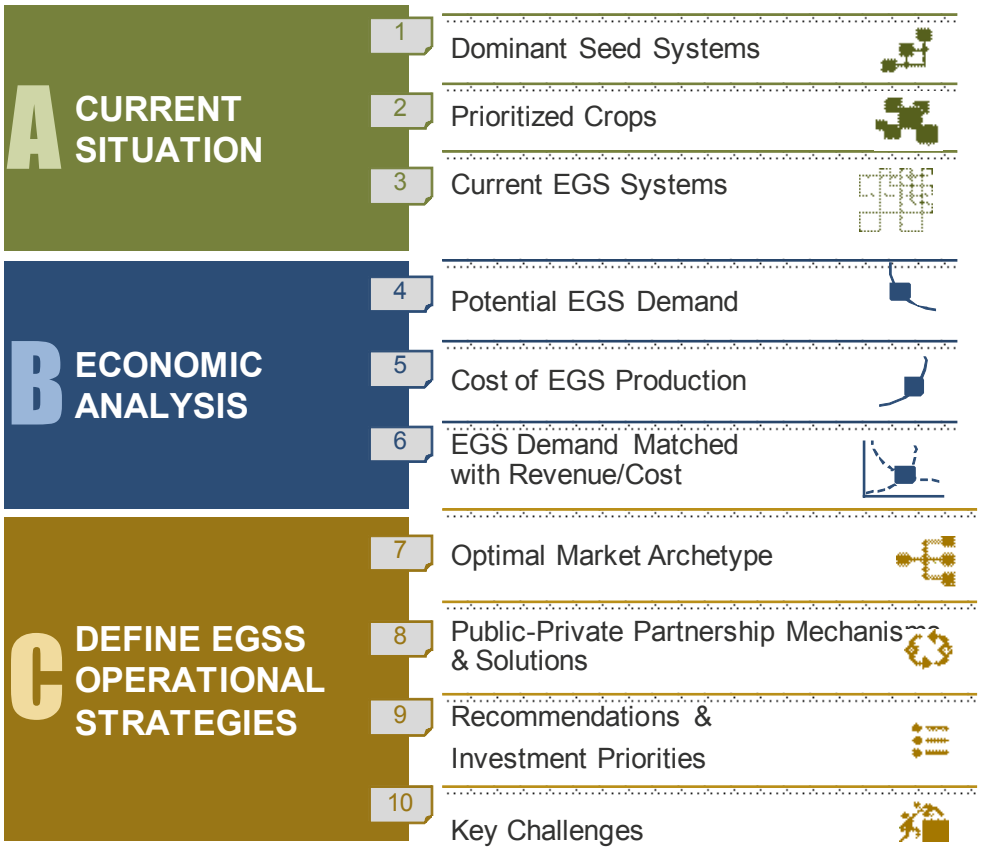
Formal seed system: The formal seed system is a deliberately constructed system that involves a chain of activities leading to genetically improved products: certified seed of verified varieties. The chain starts with plant breeding or a variety development program that includes a formal release and 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 seed system also referred to as a local seed system, is based on farmer saved seed or QDS. 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 (USAID and BMGF, 2015). The first six steps of this ten-step process were used to analyze specific crops within Tanzania 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.

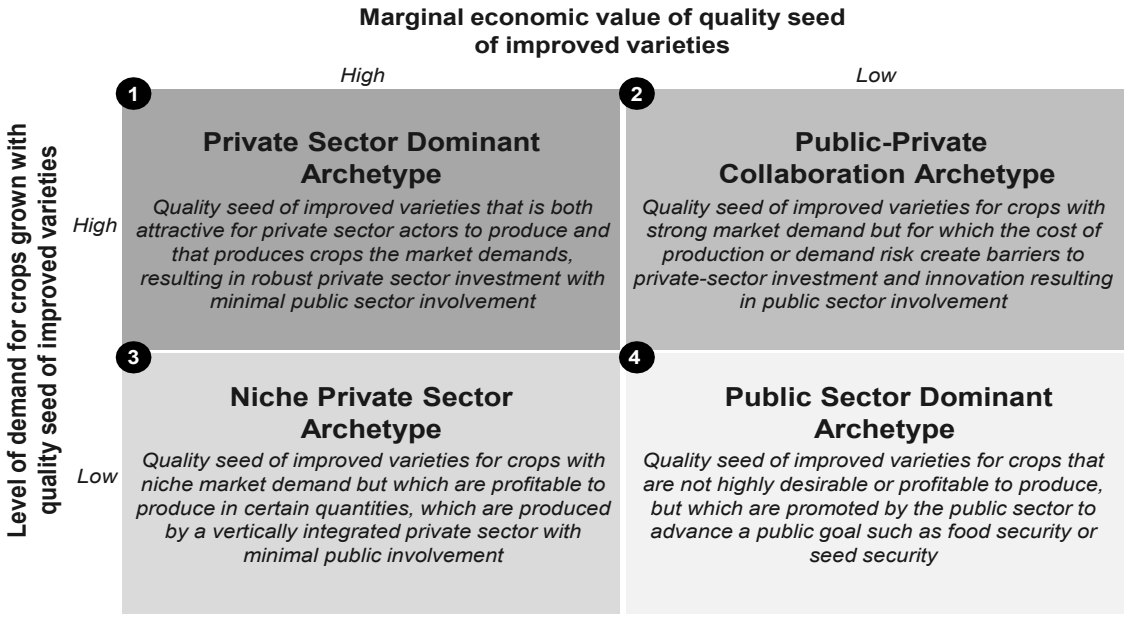


Figure 2: Market archetype framework
Source: Framework developed by Monitor Deloitte for EGS study (USAID and BMGF, 2015).

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

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

EXECUTIVE SUMMARY

The Tanzanian seed system has grown over the years as observed from the increase in seed enterprises, improved seed support services and overall increased volumes of certified seed. There are five identified dominant seed systems in Tanzania, which include farmer-saved, public–private (local seed businesses), public (government driven), private international and private local. The farmer-saved and public seed system accounts for the majority of seed volume while the private sector companies and public seed system contribute the majority of EGS.

Despite the recent increase in use of certified seed in maize, rice, beans, sorghum, groundnuts and sesame production, the formal sector contributes only 25% of the seeds available in Tanzania. The informal seed system, which is estimated at about 75% of the seed market share (USAID 2013, URT 2013), still dominates most crops in Tanzania with the exception of hybrid maize.

Early Generation Seed system by crop

Hybrid maize: All hybrids planted in Tanzania are produced and delivered through a formal system by either public or private sector institutions. It is difficult to get correct and consistent figures on the maize area planted with hybrids but Lyimo *et al*. (2014) and MALF (2013) estimated the area to be 18% and 12%, respectively. There are three different systems for hybrid maize depending on the owner of the materials. The systems are: (i) Public and unprotected hybrids, (ii) Public and protected hybrids and (iii) Private hybrids. The sector is growing rapidly especially due to increased demand from lowland farmers.

OPV Maize: Although improved maize hybrids have diffused rapidly in high potential areas of the southern and northern highland zones of Tanzania, a large proportion of resource poor farmers in marginal areas still use local varieties and prefer improved open-pollinated varieties (OPVs) over hybrids. Recent reports estimate the area under improved OPVs to be 9%. It was evident from the interviews conducted for this study that this market segment will in the long run decline as hybrid varieties adaptable to marginal areas become available. Unlike hybrids, improved OPV maize in Tanzania is supplied through both informal and formal systems. The formal seed system has two categories (i) certified seed system and (ii) QDS system. It is public driven, but the private sector is also involved in breeding and production of EGS.

Common beans: It is estimated that only 1-5% of the planted area for common beans is supported by the formal seed system, while 99-95% of the area planted with common beans consists of recycled or seeds informally sourced by farmers. While there are several reasons for the dominance of the informal system, the primary factor is the limited demand for quality seed.

Sorghum: It is estimated that only 4% of the sorghum seed originates from the formal seed system, with the balance of 96% being seeds sourced by farmers from informal systems. While there are several reasons for the dominance of the informal system, the primary factor is the low demand for quality seeds due to limited promotion and marketing of the new varieties. The production of EGS is public driven but there are private companies such as Namburi Agricultural Company that breed and produce their own EGS.

Cassava: Despite the release of several new cassava varieties, cassava landraces remain predominant in Tanzania. The majority of farmers still grow old varieties and practice recycling. It is estimated that only 2% of cassava is planted with improved planting materials while 98% is planted with recycled or shared stem cuttings. This practice has led to severe yield decline due to the spread of diseases especially CBSD and CMD that are common in most of the cassava growing ecologies. On the one hand, disease has acted as a disincentive to seed investment in areas with high disease pressure, although on the other hand, demand for improved seed in these areas is rapidly increasing. EGS can be produced using conventional cuttings or through tissue culture. The normal cutting system is well established in Tanzania but the possibility of using tissue culture is currently being evaluated. Certification of cassava is a challenge, but Tanzania is currently developing standards and protocols for inspection and certification. Since the seed certification protocol for cassava is not ready yet, the only commercial seed material available in Tanzania is quality declared planting material (QDPM).

Early Generation Seed system bottlenecks/constraints by crop

The supply of EGS of priority crops is largely constrained by both supply as well as demand side factors. These include:

Hybrid maize

Supply bottlenecks

- Absence of an adequate EGS demand forecasting system
- Lack of policy for maintenance breeding
- Insufficient land for EGS seed production
- Outbreak of maize lethal necrosis disease
- Limited institutional capacities
- Limited effectiveness of the licensing agreement

Demand bottlenecks

- Prevalence of counterfeit/fake seeds
- Limited access to credit
- Limited promotion and insufficient distribution of certified seeds
- Limited availability of maize hybrids adapted to marginal areas

OPV Maize

Supply bottlenecks

- Lack of policy and limited capacity of breeders to maintain seed varieties
- Absence of an adequate EGS demand forecasting system
- Limited infrastructural capacities
- Limited private sector participation
- Limited investment in OPV maize as compared to hybrid maize

Demand bottlenecks

- Limited technological knowledge and lack of business skills among members of the farming community
- Perceived high cost of seeds
- Lack of policy or guidelines for replacing obsolete varieties
- Limited farmers' access to credit

Sorghum

Supply bottlenecks

- Low-level of private sector involvement in EGS production
- Limited capacity to forecast demand
- Infrastructure challenges

Demand bottlenecks

- Low income and limited purchasing power
- Limited access to credit and financial exclusion

Beans

Supply bottlenecks

- Inadequate private sector involvement in EGS production
- Frequent changes in consumer taste and preferences
- Limited infrastructure

Demand constraints

- Lack of information and awareness
- Lack of access to credit
- Limited promotion of improved seed varieties

Cassava

Supply bottlenecks

- Limited private sector involvement in EGS production
- Lack of protocols for certification system
- Inadequate land for seed production
- Limited private sector involvement
- Lack of virus indexing facility and
- Limited tissue culture capacity

Demand constraints

- Limited demand building and awareness activities
- Distortion of markets by give-away programs
- Inadequate inspection and certification facilities

Public-Private Partnership

The most significant challenges confronting EGS for bean, cassava, OPV maize and sorghums in Tanzania are the absence of efficient systems for EGS supply due to an under-resourced public sector (MALF/DRD) and limited interest from the private sector due to low marginal economic value and the farmers' current practice of saving/recycling seed, which lowers demand and reduces profitability.

Furthermore, because the crops have low market pull, the country's priority and indeed the private sector's is in the production of seeds for high value crops such as hybrid maize. This trend has shifted both public and private sector focus away from food security crops such as cassava, common bean and sorghum. This disproportionately affects smallholder farmers in areas where these crops are grown.

The challenges and opportunities identified in the crops recommended for EGS-public-private partnerships (PPP) are not identical, but in all cases PPP could be established as the foundation for building an efficient EGS systems. The differences in the crops warrant slightly different approaches, but the end product is the same – a high-performance of EGS-PPP systems. An effective EGS-PPP would significantly reduce or even eliminate government responsibility for the production of EGS for certain crops and stimulate the development of a robust private seed sector. This would allow the government to redirect resources away from EGS production and provide additional support for research and extension services to ensure a steady supply of improved varieties and enable farmers to realize more of the potential inherent in improved varieties.

The EGS-PPP would have three key strategic objectives:

- Produce enough EGS to meet current and future demand
- Produce seed at the most cost effective way while continuing to meet quality standards
- Stimulate demand for improved varieties and quality seed at the farm level

The EGS-PPPs should be established under a legal and administrative structure that allows it to generate and retain operating profits for use in improving its operations and pay royalties. Private sector partners would expect to benefit financially from the operations of the EGS-PPPs.

The EGS-PPPs should develop an efficient and 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 another crucial requirement for the success of the EGS-PPPs. The Tanzania private seed sector is rather weak. Although there are a few promising companies, the majority are not sufficiently established to be key private partners. The Government of Tanzania needs to be innovative in the search for private sector partners with proven expertise and interest in seed and seed-related products.

Recommendations

An analysis of operational strategies and future seed needs suggests that the crops that fit into the proposed EGS-PPP framework are OPV maize, cassava, sorghum, public hybrids and common beans. To build an innovative and successful EGS-PPP system for these crops/crop groups the study has made the following cross cutting and crop specific recommendations:

Cross cutting recommendations

- Establish a steering committee/working group comprised of both public and private sectors to develop EGS plan of action and oversee production of EGS to meet the current and future seed demand in Tanzania.
- Laying the groundwork for establishing a vibrant and successful EGS production system through PPP:
    - Conduct stakeholders mapping to identify key EGS-PPP potential partners. Ensure involvement of a diverse set of players including representation from legal, finance, planners, industry and regional and international organisations.
    - Convene a roundtable discussion to conceptualise the EGS-PPP idea and agree on the mission and principles
    - Identify each partner's strengths and weaknesses
    - Conduct technical and financial feasibility study
    - Develop implementation strategies and business road map
    - Identify the shared costs/resources
    - Develop benefit sharing modalities based on win-win arrangements
    - Recruit and train partners
    - Formalise the partnership by preparing a contractual arrangement/Memorandum of Understanding (MoU)
- Strengthen the quality control and seed certification process
- Address the challenges of licensing varieties
- Strengthen linkages and coordination of seed development efforts
- Sign up to the international seed certification standards of ISTA and OECD

Crop specific recommendations

The following recommendations are specific to the selected EGS-PPP:

Public hybrid and OPV maize

Market analysis on OPV maize and maize hybrids developed from public varieties has shown that the seeds from the two maize categories are less attractive to private sector. The priority objective is to expand and enhance EGS production capabilities to meet current and future demand through public-private collaboration. This can be achieved through increasing the marginal economic value of the crops and building a robust and cost effective system that ensures sustainable demand and profitable EGS production without compromising quality. In order to achieve these objectives, the following are specific recommendations:

- Increase farmer's adoption of improved varieties and quality planting materials
- Enhance the marginal economic value of public hybrids and OPVs
- Facilitate establishment of molecular biology lab for disease diagnostics and DNA fingerprinting

Common bean and OPV sorghum

Common bean and OPV sorghum will attract the same investment strategies as they are both constrained by low margins, are unattractive to private sector and have potential for processing industries. The priority objective is to expand and enhance EGS production capabilities to meet current and future demand through public-private collaboration. This can be achieved by increasing the marginal economic value of the crops and building a robust and cost effective system that ensures sustainable demand and profitable EGS production without compromising quality. For the EPP to be attractive to the private sector, the government could consider including other leguminous crops such as pigeon peas, groundnuts and soybeans in the long run. To achieve these objectives, the following are specific recommendations:

- Stimulate farmers' adoption of improved varieties and quality seed
- Increase marginal economic value of common bean and sorghum

Cassava

Quality planting materials of cassava and other root and tuber crops are relatively expensive to produce and deliver because they are bulky and perishable. Production and delivery of EGS is also challenged by low marginal value, catastrophic diseases such as CBSD and CMD and the absence of protocols for certification and quality control. The priority objective is to expand and enhance EGS production capabilities to meet current and future demand through public-private collaboration. This can be achieved through increasing the marginal economic value of cassava and build a robust and cost effective system that ensures sustainable demand and profitable EGS production without compromising quality. While the current study focused on cassava, the government could consider including other RTB crops such as sweet potato. In order to achieve these objectives, the following are specific recommendations:

- Increase farmers' adoption of improved varieties and quality planting materials
- Increase marginal economic value of cassava
- Facilitate establishment of EGS PPP facility for production of certified cassava

In conclusion, this study has analysed the supply systems, enabling environments and key bottlenecks affecting production of EGS of the priority crops and suggested strategies for building an effective and efficient systems for production and delivery of EGS. The study findings will guide and help the government and private sector make informed investment decisions for the benefit of the seed industry and the agriculture sector in general.

CHAPTER 1: CURRENT SITUATION – DOMINANT SEED SYSTEMS

1.1 Country overview

The United Republic of Tanzania is the largest of the East African countries with a total area of 945,078 km^2. The country is situated on the east coast of Africa on longitudes 29º and 41º east and latitude 1º and 12º south of the equator. Tanzania is bordered by Kenya and Uganda to the north, Rwanda, Burundi, and the Democratic Republic of the Congo to the west, and Zambia, Malawi, and Mozambique to the south. The country's eastern borders lie on the Indian Ocean. (Figure 3). The United Republic of Tanzania is a union of Tanganyika (Tanzania Mainland) and Zanzibar (Tanzania Zanzibar). Administratively, Tanzania has 30 regions (25 in Tanzania Mainland and 5 in Tanzania Zanzibar (Figure 3) According to the 2012 Population and Housing Census (PHC) the United Republic of Tanzania has a population of 47,421,786 (Table 2).

Figure 3: Map of Tanzania showing regional and national boundaries

Source: Political Map of Tanzania | Tanzania Regions Map

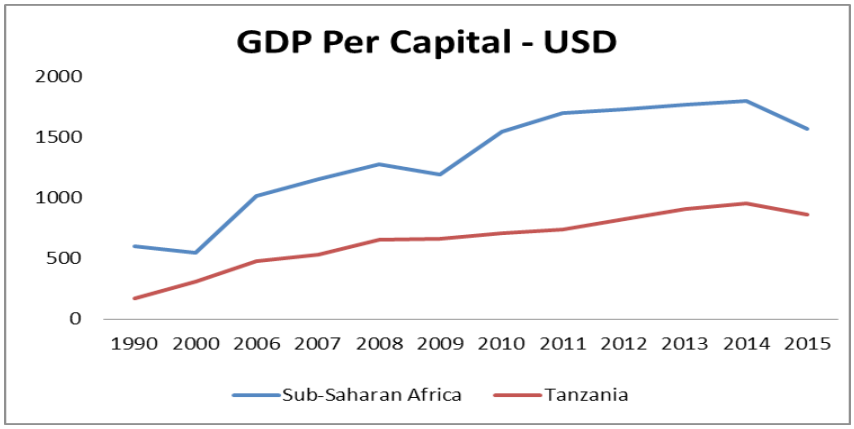
Table 2: Population of Tanzania by region and % share

Region	Population	% share
(A) Tanzania Mainland		
Dodoma	2,172,962	4.6
Arusha	1,788,318	3.8
Kilimanjaro	1,700,206	3.6
Tanga	2,137,203	4.5
Morogoro	2,327,577	4.9
Pwani	1,148,089	2.4
Dar es Salaam	4,881,795	10.3
Lindi	880,357	1.9
Mtwara	1,301,723	2.7
Ruvuma	1,435,952	3.0
Iringa	962,175	2.0
Mbeya	2,857,630	6.0
Singida	1,435,159	3.0
Tabora	2,428,467	5.1
Rukwa	1,070,931	2.3
Kigoma	2,232,562	4.7
Shinyanga	1,600,643	3.4
Kagera	2,620,480	5.5
Mwanza	2,943,951	6.2
Mara	1,833,238	3.9
Manyara	1,519,321	3.2
Njombe	713,421	1.5
Katavi	601,920	1.3
Simiyu	1,642,226	3.5
Geita	1,832,379	3.9
Total Tanzania mainland	**46,045,889**	**97.1**
(B) Tanzania Zanzibar		
Kaskazini Unguja	199,844	0.4
Kusini Unguja	120,305	0.3
Mjini Magharibi	645,701	1.4
Kaskazini Pemba	217,309	0.5
Kusini Pemba	199,456	0.4
Tanzania Zanzibar	**1,378,652**	**2.9**
Total Tanzania	**47,421,786**	

Source: NBS (2012), Population and Housing Censuses 2002- 2012

The GDP per Capita in Tanzania is equivalent to 7% of the world's average. In Tanzania, GDP per capita averaged 582.20 USD from 1988 until 2015, reaching an all-time high of 842.44 USD in 2015 and a record low of 457.53 USD in 1994. The Gross Domestic Product per capita in Tanzania was last recorded at 842.44 US dollars in 2015 (Trading Economist, 2015). As illustrated in Figure 4, between 1990 and 2015, the per capital GDP gap between Tanzania and sub-Saharan Africa (SSA) has been widening despite an increasing trend.

Figure 4: Per capita GDP of Tanzania compared with Sub Saharan Africa



Source: World Bank (2016)

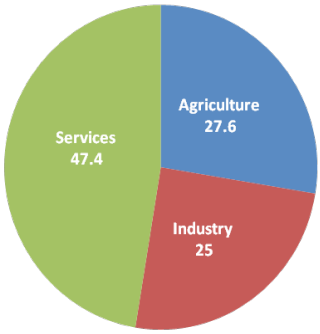
According to the World Bank (2015), the overall macroeconomic performance remains strong with a high rate of growth and a low rate of inflation. Real gross domestic product (GDP) growth was projected at 7% for 2015 (World Bank, 2016). Despite these impressive statistics, approximately 28.2% of the population lived below the poverty line in 2012, a reduction from 34% in 2007. During the 2007-2012 period, there were improvements in living conditions, access to basic education, health and nutrition and labor force participation in non-agriculture employment. Nevertheless, these benefits were not distributed equitably and as a result, inequality has increased between urban and rural populations and approximately 12 million Tanzanians are still living in poverty (World Bank 2016).

1.2 Agriculture sector

Overview

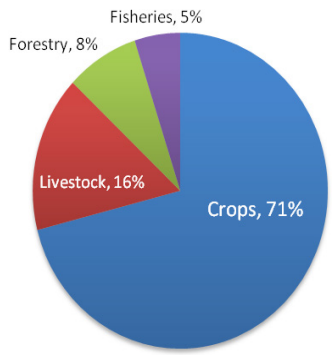
Agriculture is the backbone of the Tanzanian national economy. It accounts for 27.6% of the GDP (Figure 5), 24% of all exports and serves as a livelihood source to over 80% of the population (CIA World Fact book, 2014). The sector is therefore important to Tanzania's immediate and long-term economic and social development goals. Agricultural GDP is mainly contributed by the crop sub-sector (71%). The relative contribution to agricultural GDP by livestock, forestry and fisheries for the same period averaged 16%, 8% and 5%, respectively.

Figure 5: Tanzania GDP composition



Source: CIA World FactBook (2015)

Figure 6: Key Agricultural Sectors, 2010



Source: Bank of Tanzania –BoT (2010)

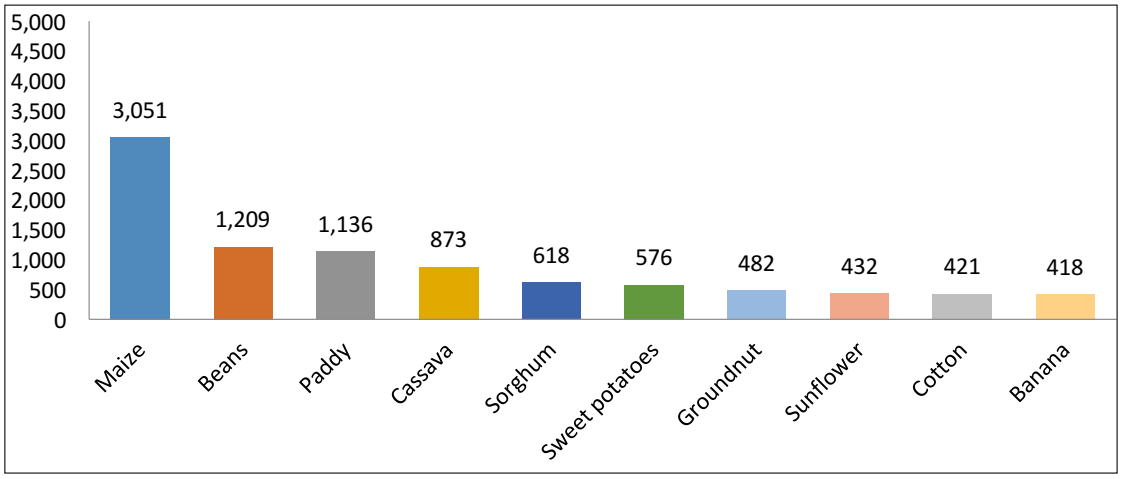
The country has a land area of 95.5 million hectares (ha), of which 44 million hectares are classified as arable land, but only 27% of the arable land is under cultivation (URT 2013). Likewise, of the 50 million ha suitable for livestock, only 26 million ha is utilized while the rest cannot be accessed due to tsetse fly infestation, unsuitable vegetation and hostile terrain. About 29.4 million ha are assessed as potential for irrigated agriculture, of which 2.3 and 4.8 million ha are regarded as high and medium potential, respectively. However, although it has been on the increase and has doubled over the past 10 years, the area under irrigation by 2012 was less than 400,000 ha, which is about 1.2% of the potential area for irrigation.

The country's agriculture sector employs 74% of the population and is dominated by small-scale subsistence farmers who operate on an average of 0.2 to 2 ha per famer, as well as traditional agro-pastoralists and fishers. Over 80% of the arable land is used by smallholders and only about 1.5 million ha is under medium and large scale farming.

Key Crops

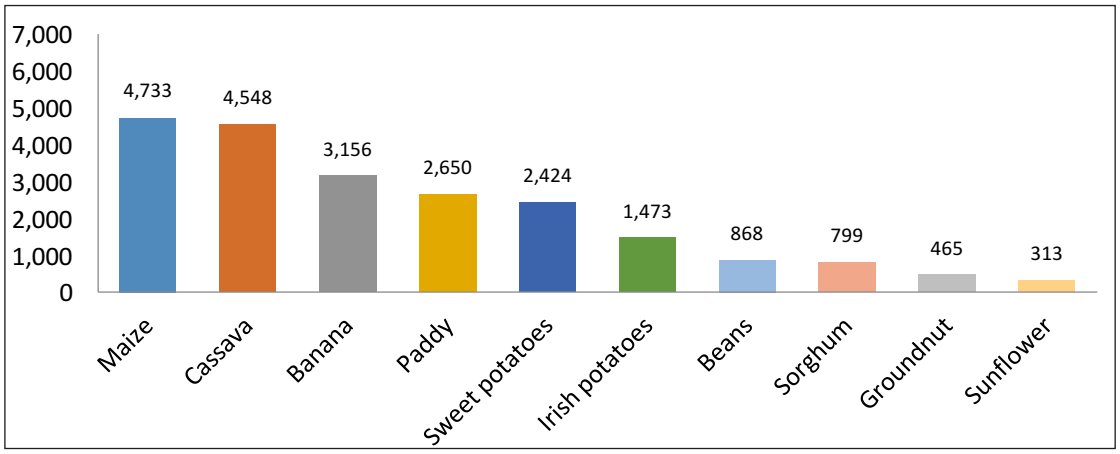
The top ten food crops grown in Tanzania, based on area harvested (ha), production (MT) and the number of varieties generated are presented in Figure 7 and Figure 8, respectively. Maize is by far the most important crop in Tanzania. It is produced by 4.5 million farm households representing about 82% of all Tanzanian farmers and occupies 41% of farm land. Combined with rice (9%), it accounts for half of the total planted area and contributes significantly more to national food security. Maize and rice production in Tanzania has increased from year to year due to the priority accorded by the government. Beans, cassava, sorghum, groundnuts, sunflower, banana, cotton and sweet potato bulrush millet are the most important crops.

Figure 7: Top 10 crops in Tanzania by area - 2010 ('000 Ha)



Source: URT (2010), Agricultural statistics MALF

Figure 8: Top 10 crops in Tanzania by production- 2010 ('000 MT)

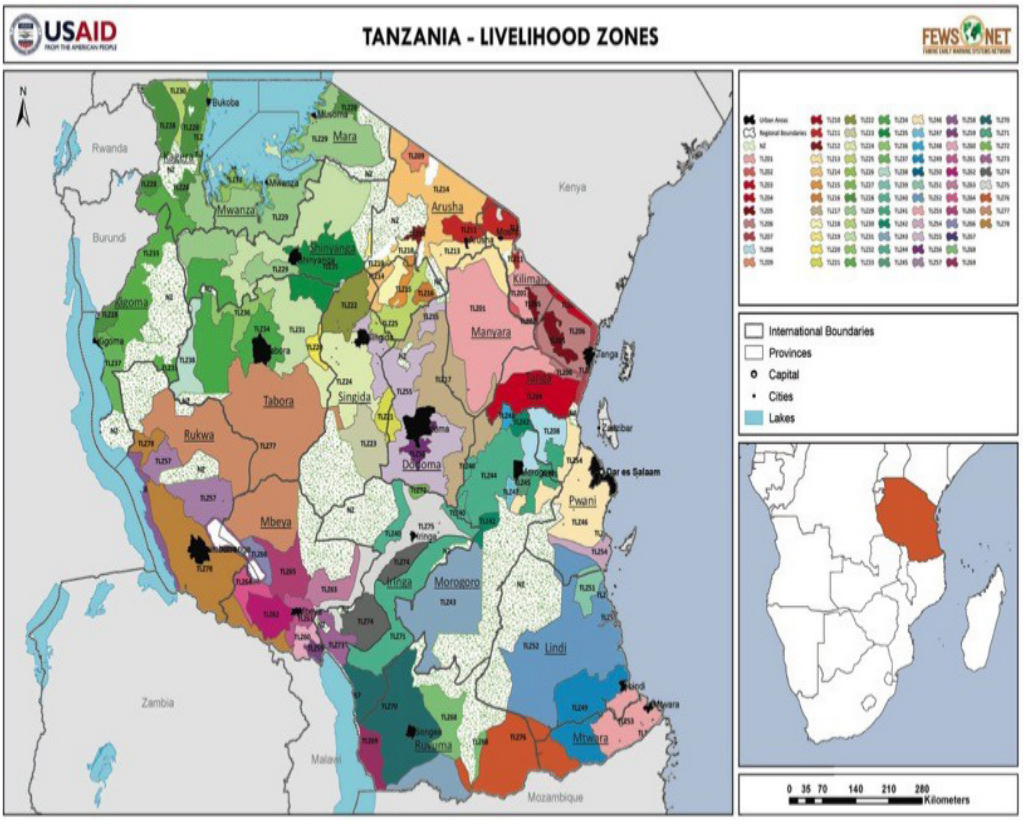


Source: URT (2010), Agricultural statistics MALF

Growing conditions

Geographically and topographically, Tanzania has diverse and complex climatic and environmental conditions. Climatic conditions vary considerably from tropical at the coast to temperate in the highlands (Rowhani *et al*., 2011). In a country as large and varied as Tanzania, it is not surprising to find that 78 livelihood zones (Figure 9) have been distinguished by the USAID's Famine Early Warning System (FAWSN, 2014).

Figure 9: Tanzania's Livelihood Zones



Source: Famine Early Warning Systems Network –FEWSN (2014)

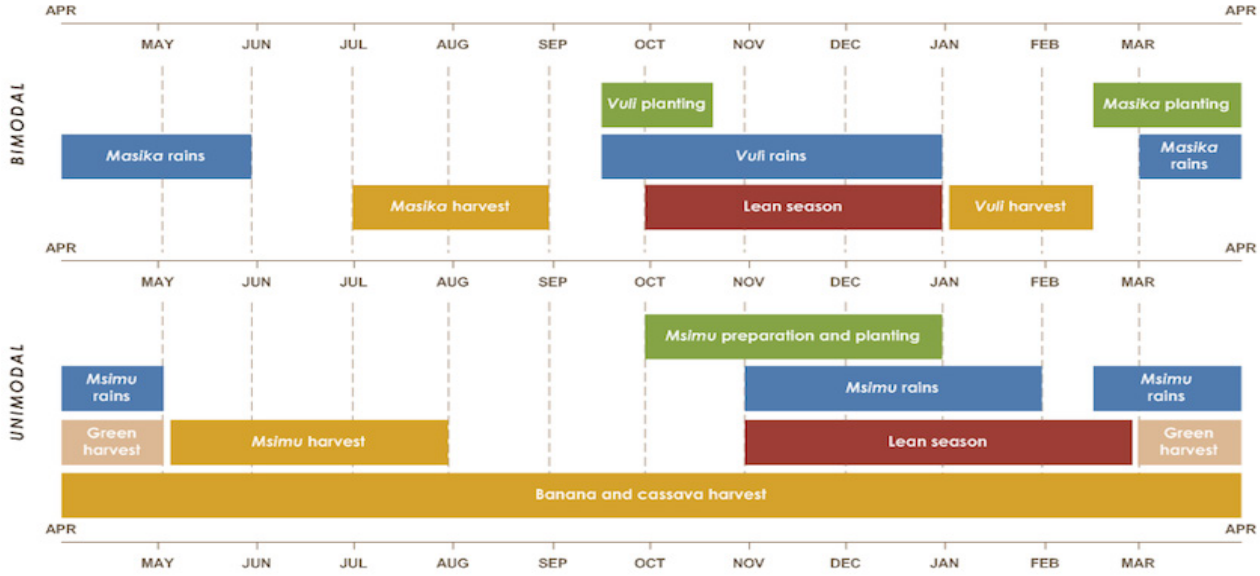
Generally livelihood zones in the coastal, lakeshore (Lakes Victoria, Nyasa, and Tanganyika), and highland areas of Kilimanjaro, Kagera , Iringa, Mbeya, Mara and Kigoma receive comparatively high quantities of rainfall. These zones have comparatively fertile soils with good potential for growing a variety of perennial and annual crops for food and the market. The area receives high rainfall of over 1250 mm/year and have a long growing period of between 250 and 300 days. Livelihoods in these zones are based on the sale of coffee, banana, tea, beans and maize crops as well as fishing and dairy cattle products, including milk (FEWSN, 2014). In these areas, even if the population density is relatively high, the majority of households are able to meet their annual food and income needs and are capable of withstanding production setbacks. These areas suffer perennial problems with crop pests and livestock disease, as well as high input prices, notably for chemical fertilizers. But household food security is not threatened.

The livelihood zones of the central parts of the country - Shinyanga, Tabora, Dodoma, and central/ southern Singida consist of arid and semiarid areas and are more prone to serious rainfall irregularities than the other zones. Rainfall ranges from 200 to 800 mm per year and the length of the growing period is short, usually less than 200 days per year. Livelihoods are based on the production of annual drought resistant crops including sorghum, OPV maize, cassava, bulrush millet, groundnuts, sunflower, sesame, pigeon peas and finger millet. Small numbers of cattle contribute to community livelihoods in particular among Barbaig and Nyiramba tribes (FEWSN, 2014).

A unique, but unfortunately failing region is that of the Hadzabe hunter-gatherers living in the lowland forest and peripheries around Lake Eyasi (livelihood zone 19 below). This is an area with a small population, but it is distinguished as a zone (FEWSN, 2014) because that population is discrete and has exceptional food security problems.

The country receives two predominant rainfalls (Figure 10). One is unimodal (December-April) and the other is bimodal (*Vuli*) October-December and (*Masika*) March-May (www. tanzaniatrade.co.uk, FEWSN, 2014).

Figure 10: Typical year cropping season calendar, Dec 2013



Source: Famine Early Warning Systems Network (2014), Viewed by Research Team (2016).

Gender roles in crop and seed production

Agriculture is a principal source of livelihood for the Tanzanian population and women play an essential role in agricultural production. The sector is characterized as female-intensive, meaning that women comprise a majority (54%) of the labor force in agriculture (FAO, IFAD, ILO, 2010). Agriculture also comprises a greater part of women's economic activity compared to men's: 81% of women, compared to 73% of men, are engaged in agricultural activity (Leavens and Anderson, 2011). In Tanzania, the share of the adult population working in agriculture is higher than regional averages, especially for women: 81% of the female population works in agriculture in Tanzania, compared to 55% in the rest of sub-Saharan Africa (Leavens and Anderson, 2011).

Cropping by Gender

The broad generalizations between gendered divisions of labor is that cash crops are for men while food crops are women's. However, in Tanzania, as in the rest of sub-Saharan Africa, categorizations of men's and women's crops are fluid, largely because the decision by men and women to farm a certain crop depends on the crop's profitability. Men's crops are those that are marketable and profitable, almost by definition. One case study in Rukwa region, Tanzania showed that groundnut yields would determine whether men or women controlled the crop. When yields were high, men sold the produce, and when yields were low, women retained control (Leavens and Anderson, (2011); World Bank, FAO, IFAD Report (2009).

Crop production responsibilities by Gender

Categorizing of agricultural responsibilities by gender is equally difficult. Tanzania is one of several countries in sub-Saharan Africa where men and women farmers jointly grow food and cash crops to some extent (FAO, IFAD, ILO Report, 2010) and the heterogeneity of tribal societies further complicates attempts at generalizations of men's and women's specific agricultural responsibilities (Leavens and Anderson, 2011). However, there are patterns in men's and women's agricultural tasks, many of them tied to differing responsibilities for cash and food crops (Table 3).

By most accounts, women in Tanzania take charge of weeding, harvesting, processing and storing less profitable food crops such as beans, sweet potato, banana and millet. Our study also found that tasks in which men tend to contribute time and resources include site clearing and land preparation, as well as heavy-labor tasks like construction of fences and profitable activities such as marketing of high value food crops and cross-border trade (Table 3).

Gender and Seed industry

Information gathered during this study suggests that women are poorly represented in the ownership and upper level management of the seed companies, accounting for only 3%. Of the 65 registered seed companies, only 2 are owned by women. Although gender was not the focus of the study, research is needed to fully understand the root causes of the gender disparities and to suggest interventions that will empower and motivate women entrepreneurs.

Agriculture and enabling environment constraints

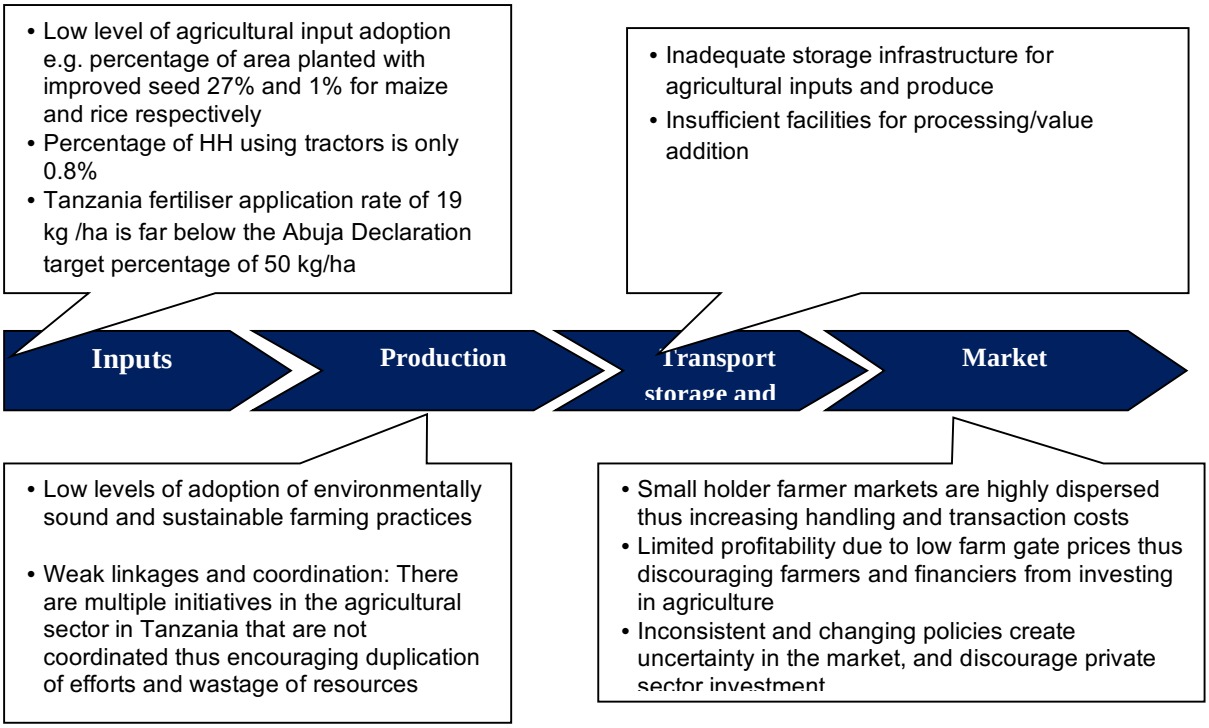
While this study focuses primarily on seed system-related constraints, it is critical to review a more comprehensive set of constraints across multiple crop value chains to better inform the seed situation. Figure 11 and Figure 12 provide a high-level but not exhaustive list of key constraints across all agricultural value chains and the enabling environment in Tanzania. Critical value chain constraints include; limited adoption of agricultural inputs, limited access to agro-enterprise finance, high costs and inefficient transport system, policy inconsistencies, as well as limited resources to finance research and extension.

Table 3: Gender roles in crop production

Crop	Bush Clearing	Input selection	Land preparation	Planting	Weeding	Harvesting	Processing	Marketing
Maize								
Rice								
Beans								
Cassava								
Sorghum								
Ground nuts								
Sunflower								
Banana								
Sweet potato								
Bulrush Millet								
Cashew								
Coffee								

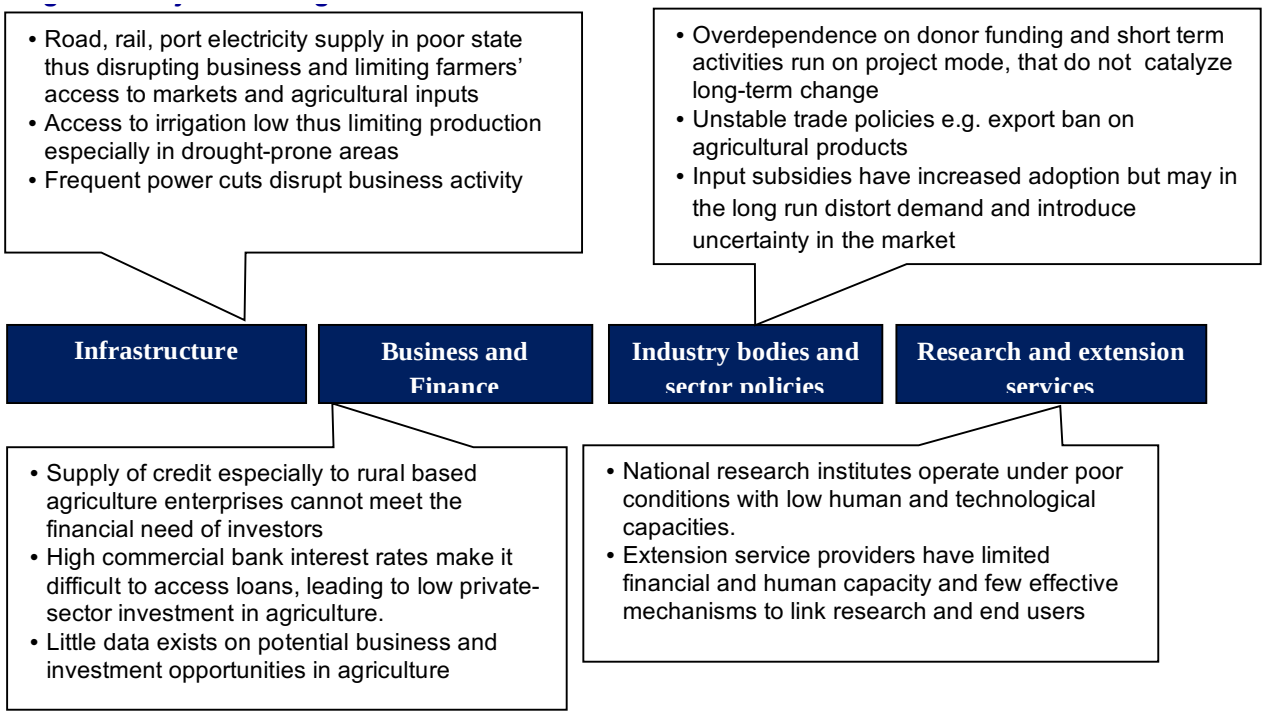
Source: Lyimo *et al*. (2012), Leavens and Anderson (2011), Research Team analysis (2016)

Figure 11: Major value chain constraints



Source: World Bank (2012), URT (2013a), USAID 2013, Research Team analysis (2016)

Figure 12: Major Enabling Environment Constraints



Source: World Bank (2012), URT (2013a), USAID 2013, Research Team analysis (2016)

National agricultural strategy

Since attaining national independence in 1961, Tanzania has adopted a series of agricultural strategies (Coulson 1972; URT 2001). The most recent major agricultural strategies include the first Agricultural Sector Development Strategy I (ASDS I) in 2001, Kilimo Kwanza in 2012, and the second Agricultural Sector Development Strategy II (ASDS II) adopted in 2014. All of them put emphasis on transformation from subsistence to commercial agriculture. During ASDS I commendable progress in transforming the agricultural sector was made including: improvement in crop and livestock production and productivity in certain areas, small scale irrigation projects, livestock dipping, charco dams, shallow wells and feeder roads. More progress was recorded in Farmer Field Schools, Ward Agricultural Resource Centres, supply of farm power and small scale agro-processing, empowerment of human capacity to farmers, private sector service providers, extension personnel and national level staff improvements.

After seven years of ASDS I and its implementation, i.e. 2006/07-2012/13, and given a number of policy and institutional changes since 2006, a successor agricultural programme was inevitable to continue and build on the achievements of ASDS I. This gave rise to ASDS II. An evaluation of ASDP I conducted in 2011 revealed a number of challenges, including inadequate funding of the sector which needed to be addressed under ASDS II and ASDP II (Lunogelo, 2013). Thus, in 2014 ASDS II and ASDP II were formulated into the sector programme to provide a framework for coordinating the implementation of the agricultural sector policies and sub-strategies. Thus, ASDS II and ASDP II address agricultural challenges and contribute to the growth and poverty reduction objectives of the National Strategy for Growth and Reduction of Poverty II (NSGRP II) or MKUKUTA II in Kiswahili[1], the second Five Year Development Plan (FYDP II) 2016/17-2020/21) and the Tanzania Development Vision (TDV) 2025 (URT, 1999; 2016).

Vision 2025 envisages raising the standard of living of Tanzanians to f typical medium income countries by ensuring food security, improving incomes and increasing export earnings (URT 1999). The overall purpose of the ASDP II is to implement ASDS II whose main goal is to contribute to national economic growth, household income, food security and export earnings in line with national and sectoral development aspirations. More specifically ASDP II is designed to facilitate agricultural sector growth and reduce rural poverty. The transformation will be private sector-led through an improved enabling environment for enhancing the productivity and profitability of agriculture. The implication is for policy and public expenditure to be a means of inducing private sector investments in the agricultural sector. Core features of the strategy include strengthening PPP across all levels of the sector and the implementation of District Agricultural Development Plans (DADPs) as the comprehensive tool for agricultural development at local government level. Thus, in view of the TDV 2025, ASDS II is anchored to and aligned with Tanzania's social and economic development aspirations as well as with the associated national policy frameworks; namely the FYDP II as well as the United Nations Sustainable Development Goals (SDGs), the Africa Union's Comprehensive Africa Agriculture Development Program (CAADP) that was ratified by Tanzania in 2010. CAADP aims 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 centre of the development agenda (URT, 2014).

1.3 Dominant seed systems in Tanzania

The Tanzanian seed system has grown over the years as observed from the increase in seed enterprises, improved seed support services and overall increased volumes of certified seed.

Seed sytsems overview

Analysis of the existing channels through which farmers' access seed has identified five distinct seed systems (Table 4). At the most basic level, the farmer-saved seed system is the major source of seed for producers in Tanzania. This is an informal system that serves mainly the under-resourced and food security crops that are difficult to commercialize. Farmers multiply and exchange seed from important local crops and varieties, both in-kind, and in some instances, on a cash basis. The farmer-to-farmer seed system is important for all crops, but plays an almost exclusively dominant role in food crops that are predominantly cultivated by women (ASARECA KIT, 2014), who are also responsible for seed supply.

Another important source of seed for Tanzania farmers is the local seed business system through which seed of most crops is produced. The main players are individuals, farmers' groups, community

1 MKUKUTA was concluded in June 2016

based associations and or NGOs who multiply seed in a semi controlled manner for their own needs, and sell the surplus to the local markets for profit. The farmer-saved seed and local seed businesses constitute the informal seed sector and accounts for about 75% of the seeds available in Tanzania while the formal sector contributes only 25% (USAID 2013, URT 2013b,c)

The public seed system is another important source of seed in Tanzania, whose main players are public research institutes and the Agricultural Seed Agency (ASA), which produce seed at certified seed level. The seed is then marketed through different outlets, ranging from agro-dealers to agents of the Ministry of Agriculture, Livestock and Fisheries (MALF). Table 5 shows production of improved seeds of 4 selected crops from 2007-2012.

Parallel to the public seed system is the private seed company system in which private enterprises perform the production, marketing and distribution functions. A private seed company distinguishes itself from a local seed business by aiming at a large geographical area for marketing its products. This could extend throughout the whole country depending on the distribution networks of the companies. In Tanzania the private sector is divided into two distinct systems – the private international producing seed using their own varieties and private local producing seeds using own, licensed or government varieties.

Table 4: Dominant seed systems in Tanzania

	FS	PP	PU	PR	PR
	Seed systems				
	Farmer saved	**Public-Private** *NGOs/community based groups producing mainly QDS*	**Public** *(ASA and government agencies producing public bred varieties)*	**Private International** *(mainly own varieties)*	**Private Local companies** *(Producing own, or licensed public varieties*
Type of crops	Local food and cash crops	Local food and cash crops	Local food and cash crops	Highly demanded/ marketable food and cash crops	Local food and cash crops
Crops	Maize (OPV), common beans, cassava, sorghum millets, banana, sweet potato, rice, soybeans, groundnuts, , pigeon peas,	Maize (OPV), Cassava common beans, sorghum millets, banana, sweet potato, rice, soybeans, groundnuts, pigeon peas,	Maize, rice, common beans, sorghum, soybeans, pigeon peas, cassava	Maize hybrid, common beans, sorghum	Maize, rice, common beans, sorghum, soybeans, pigeon peas, vegetables
Type of varieties	Local and improved	Local and improved	Local and improved	Improved	Improved
Quality assurance	Farmer/self-controlled	Self-controlled and QDS (Certified by TOSCI/local inspector)	Certified by TOSCI	Certified by TOSCI	Certified by TOSCI
Seed distribution	On farm sales, farmer to farmer exchange, local markets	Local markets	Government (ASA) Agro-dealers	Agro-dealers	Agro-dealers

Source: **Research Team interviews (2016), ASARECA KIT (2014)**

The four priority cereal crops in Tanzania are maize, rice, beans and sorghum. These crops are also leading in terms of volumes of commercial seed production (certified and QDS) and the number of varieties registered, Table 5 and 12, respectively.

Table 5: Quantity of certified seed and QDS (in MT) from 2008-2012 for 4 selected crops

Crop	Seed type	2007/2008	2008/2009	2009/10	2010/2011	2011/2012
Maize	Certified	5993.1	7726.5	7780.9	15007.9	18,915.9
	QDS	20.9	22.3	79.5	114.1	111.8
Beans	Certified	62.2	111.8	219.9	110.6	223.8
	QDS	0	0	4	9	16.7
Sorghum	Certified	319.7	596.1	1507.4	2,374.4	1787.4
	QDS	11.7	6	20.1	35.9	38.2
Rice	Certified	149.5	784.9	951	950	821.7
	QDS	20.1	9.2	21	107	83,6

Source: **URT (2013c)**

1.4 Key actors in the seed systems

The seed sector in Tanzania is composed of both public and private organizations. The seed sector was dominated by public sector actors until 1989, when the Government launched the National Seed Industry Development Program which emphasized moving from a State controlled economy to the free market economy. This policy paved the way for more active participation by the private sector (USAID, 2013, ASARECA, KIT, 2014).

Public sector overview

Despite trade liberation policies allowing private sector participation, the public sector has remained a key player in Tanzania's seed sector. The main public sector organizations involved in the seed sector are:

Ministry of Agriculture, Livestock and Fisheries (MALF)

The entire seed sector activities are under the Ministry of Agriculture, Livestock and Fisheries (MALF) and coordinated by the Seed Unit Office. The MALFs mission is to deliver quality services to agriculture, livestock and fisheries, provide a conducive environment to stakeholders, build the capacity of local government authorities, and facilitate private sector contribution to sustainable agriculture. The Seed Unit Office of the MALF is responsible for seed policy development, variety registration, updating of the national variety catalogue, granting licenses for public genetics, registration of seed-related enterprises, granting of import/export permits, advising the MAFC on national seed availability for seed import recommendation, and issuing of business permits to seed companies and agro-dealers.

Division of Research Development (DRD)

The Division of Research and Development (DRD) is one of the Departments in the Ministry of Agriculture, Livestock and Fisheries (MALF). DRD is the lead institution of the Tanzanian National Agricultural Research Systems (NARS) with the public role of conducting, coordinating, and directing public agricultural research in the country. For operational purposes, agricultural research under the NARS is organized into seven agro-ecological zones managed under the DRD. The main role of DRD is to develop varieties and produce pre-basic seeds. The DRD works in close partnership with the Consultative Group on International Agricultural Research (CGIARs), such as the International Institute of Tropical Agriculture (IITA), Centro Internacional de La Papa (CIP), International Rice Research Institute (IRRI), International Center for Tropical Agriculture (CIAT), International Maize and Wheat Improvement Center (CIMMYT) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

The DRD's operations are constrained by limited financial resources but plans to transform it into a semi-autonomous body are at an advanced stage. The transformation will give the new organization (TARI) financial autonomy and a more active role in the supply of EGS. Although this will be an important move to save the varieties that are less attractive to the private sector, mechanisms should be put in place to ensure that TARI does not create unfair competition with the private sector. While a small number of private seed companies maintain and produce privately registered seed varieties, the vast majority of certified seed in Tanzania (Table 7 and 8) are produced from public varieties.

Sokoine University of Agriculture (SUA)

SUA is another institution apart from DRD that is actively involved in variety development and production of pre-basic seed.

Tanzania Official Seed Certification Institute (TOSCI)

Tanzania Official Seed Certification Institute (TOSCI) is a government institution under the Ministry of Agriculture, Livestock and Fisheries (MALF) established by the Seed Act No. 18, 2003 (TOSCI, 2015a). TOSCI is the sole seed certifying authority in Tanzania responsible for certification and promotion of quality agricultural seeds produced or imported into the country for sale. It is also entrusted with safeguarding the farming community from procuring poor quality or counterfeit seeds from vendors of farm inputs. This institution has three branches in Arusha, Njombe and Mwanza regions to serve the northern, southern highlands and lake zones, respectively. TOSCI, through its inspectors are responsible for certification of pre-basic, basic and certified seed classes. They also audit the inspection of quality declared seed (QDS).

Table 6: Number of released varieties for the top 10 crops in 2014

Crop	Total Varieties	First and Last year of release
Hybrid maize	111	1968-2014
OPV Maize	23	1950-2013
Beans	27	1997-2012
Cassava	20	2003-2014
Rice	17	1950-2012
Sorghum	12	1960-2014
Pearl millet	12	1994-2014
Sweet potatoes	12	2000-2014
Ground nuts	10	1976-2014
Pigeon peas	7	1999-2014
Cow peas	7	1978-2014

Source: **TOSCI (2015b)**

Agricultural Seed Agency (ASA)

The Agricultural Seed Agency (ASA) is a semi-autonomous institution of the MALF established in June 2006, under the Executive Agencies Act No 30 of 1997. The agency is designated as a semi-autonomous body. The aim of establishing ASA was to ensure high quality agricultural seeds were available to farmers at affordable price (ASA, 2016). Currently ASA produces basic and certified seeds of various crops although other actors are now producing their own foundation seed, either under contract with ASA or by licensing directly from the Ministry of Agriculture and ARIs. ASA is a trustee of 9 Government seed farms that are strategically located to serve farmers of the main agro-ecological zones. The seed farms are: Arusha Seed Farm (Arusha); Dabaga Seed Farm (Iringa); Kilangali Seed Farm (Iringa); Msimba Seed Farm (Morogoro); Mwele Seed Farm (Tanga); Bugaga (Kigoma); Mbozi Mbeya; Horti-Tengeru (Arusha) and Mpiji (Bagamoyo).

Plant Health Services (PHS)

The Plant Health Services (PHS) is a division of the MALF responsible for controlling imports and exports to ensure that phytosanitary requirements are met.

Tropical Pesticide Research Institute (TPRI)

The TPRI is a regulatory institution with the mandate of providing testing and quarantine services to imported seeds and planting materials.

National Plant Genetic Resource Centre (NPGRC)

The National Plant Genetic Resources Centre of Tanzania (NPGRC) is among the four divisions under the Technical Services Department of the Tropical Pesticides Research Institute (TPRI). The centre was established in 1991 with the mandate of coordinating plant genetic resources (PGRs), conservation and utilisation. The institute works closely with the SADC Plant Genetic Resources Institute (SPGRC); Bioversity International; and Other international institutions dealing with PGRs.

Plant Breeders Rights Office

The New Plant Breeders' Rights Act (PBRA) of 2012 introduced a Plant Breeders' Rights Registry in Tanzania headed by the Registrar of Plant Breeders' Rights ('Registrar'). The PBR system in Tanzania effectively began its operations in January 2005 when the PBR office was established with the appointment of the Registrar. The functions of this Registry are to grant plant breeders' rights; to establish a documentation centre for the purposes of dissemination of information on plant breeders' rights; to maintain a register and provide information on plant breeders' rights issued in Tanzania; to facilitate the transfer and licensing of plant breeders' rights; to collaborate with local and international bodies whose functions relate to plant breeders matters; and to perform such other functions as are necessary for the furtherance of the objectives of the Act.

Programs and NGOS

The government of Tanzania, in collaboration with various international partners, has embraced several projects to strengthen the national seed system and to achieve timely production and supply of quality seed to farmers in the country.

Between 1970 and 2010 there have been several seed projects including:

- USAID Seed Project (1971-1982)
- Netherlands Seed Project at HORTI-Tengeru (1984-1988)
- FAO/UNDP Seed Development Project (1988-1995)
- ASPS/DANIDA On-farm Seed Production Programme (1998-2008)

More recently, there have been programs and organisations supported by the Bill and Melinda Gates Foundation (BMGF), AGRA, USAID and other donors. These include:

Mennonite Economic Development Associates of Canada (MEDA)

The Mennonite Economic Development Associates of Canada (MEDA), an incorporated not-for-profit international development organization, creates business solutions to poverty. In 2012, with funding from the BMGF, MEDA began a new initiative - Commercially Sustainable, Quality-assured Cassava Seed Distribution System in Tanzania: Pilot Innovation Project, known locally in the Swahili language as *Muhogo Mbegu Bingwa* which roughly translates to "Cassava Seed Champion" in English. The intent is to bridge the gap between research laboratories developing new varieties, and farmers looking for new planting material. This project collaborates with the national seed certification authorities to establish compliance protocols that ensure production of quality-assured seed/stem planting material from seed-multiplication entrepreneurs. By testing commercially based supply chain models for multiplying certified, quality-assured cassava seed, MEDA will advance the current acceptance and use of market-

based methods to enable small farmers in Lindi, Mtwara, Coast region and Lake zone area access a consistent supply of disease-resistant, disease-free seed. The focus of the initiative is to encourage small scale farmers to establish seed multiplication businesses and link them with agribusiness and profitable markets.

One Acre Fund

One Acre Fund is a not-for-profit organization that supplies smallholder farmers in East Africa with asset-based financing and agriculture training services to reduce hunger and poverty. The One Acre currently serves farmers in Kenya, Rwanda, Burundi and Tanzania. Using a market-based approach, One Acre Fund facilitates activities and transactions at various links in agricultural value chains, including seed sourcing and market support. The NGO entered Tanzania in 2013 and has served close to 20,000 farmers. One Acre Fund Tanzania's headquarters is based in Iringa, roughly 300 miles from the capital city, Dar es Salaam.

AGRA

AGRA is an African-led alliance focused on putting farmers at the center of the continent's growing economy. AGRA advances uniquely African solutions to sustainably raise farmers' productivity and connect them to a growing marketplace. Together with its partners—including African governments, researchers, donors, the private sector, and civil society—AGRA seeks to create an environment where Africa feeds itself. AGRA works across 18 countries in sub-Saharan Africa. Since 2007, Tanzania has received grants totalling approximately $48 million to cover research and development activities (TDN 2015). A more recent example in the area of seeds is the AGRA partnership with the US government to implement a major Feed the Future initiative through USAID in support of the New Alliance – the Scaling Seeds and Technologies Partnership (SSTP). This four-year program builds on AGRA's experience and seeks to accelerate farmer access to improved seeds and better farming technologies that have been prioritized by national governments in Ethiopia, Ghana, Malawi, Mozambique, Senegal, and Tanzania.

CGIAR

CGIAR is consortia of international agricultural research organizations that work to advance agricultural science and innovation to enable poor people, especially women, to better nourish their families, and improve productivity and resilience so they can share in economic growth and manage natural resources in the face of climate change and other challenges. CGIAR have invested heavily in variety development, seed research and development, policy and capacity building programs. Key CGIAR-active organizations operating in Tanzania include ICRISAT promoting mainly sorghum and millets, IITA for cassava and sweet potato, CIAT concentrating on common beans and CIMMYT's work with mainly maize and wheat.

Private sector overview

The overall policy in Tanzania is to support the development of a strong private sector, which also applies to the seed sector. Until the early 90s, the Tanzanian Government had a monopoly on the seed sector but following liberalisation and structural adjustment, the government set out to reduce state control in the seed sector, allowing private seed companies to operate in the country.

Private seed companies

Multinational seed companies entered the Tanzanian seed market from 1993, targeting profitable seed (mainly maize hybrid and some rice), mostly based on imported seed and germplasm. Information is scarce regarding industry market shares but, according to figures from 2011, Zimbabwe's Seed Co Limited accounted for 46% of the market, followed by Pannar and Monsanto (both 9%) and DuPont Pioneer at 6 percent (ACB, 2016).

Participation of local seed companies has been limited but the sector is expanding slowly thanks to the technical and financial support from the government and international organisations, in particular, AGRA. Between 2007 and 2012 AGRA gave grants to 11 Tanzanian seed companies and has remained a major player in the domestic seed industry in Tanzania. Currently, there are 65 registered seed companies operating countrywide out of which 40 are local seed companies while 25 are foreign based companies (URT, 2013c). Despite the large number of registered private seed companies, there are only 26 (18 local and 8 foreign) active seed companies in Tanzania (Table 7).

Table 7: List of active private seed companies in Tanzania

Company Name	Location	Country of origin
Krishna Seed Company Ltd	Arusha	Tanzania
Zanobia Seed Ltd	Arusha	Tanzania
Suba-Agro Trading and Engineering Co.	Arusha	Tanzania
Mbegu Technologies	Moshi	Tanzania
Tanseed International	Morogoro	Tanzania
FICA seed Ltd	Arusha	Tanzania
Mount Meru Seed Company	Arusha	Tanzania
IFFA Seed Company	Arusha	Tanzania
Highland Seed Growers Ltd	Mbeya	Tanzania
Northern Seed Co.	Moshi	Tanzania
Meru - Agro Tours	Arusha	Tanzania
Aminata Quality Seed	Tanga	Tanzania
Tropical Seed Ltd	Mbeya	Tanzania
Monsanto (T) Ltd	Arusha	USA
East African Seed	Arusha	Kenya
Kibo Seed Co.	Arusha	Kenya
Pannar Seed Ltd	Arusha	South Africa?
Brac Tanzania	DSM	USA?
Bytrade (T) Ltd	DSM	Kenya?
Seedco (T) Ltd	Arusha	Zimbabwe
Kisimbaguru Estates Ltd	Songea	Zambia?

Key: Local companies Foreign companies

Source: URT (2013c)

Despite production and policy challenges the private sector has increased its certified seed production in Tanzania. The combined amount of imports and domestic production of certified seed from private sources doubled in the period between 2006 and 2011 from 8,748 to 16,545 tons (Table 8).

Table 8: Supply of improved seed (MT)

Source of improved varieties	2005/06	2007/07	2007/08	2008/09	2009/10	2010/11
Private companies	8748	14870	16174	10511	14536	16545
Public organisations	1728	1656	217	545	1608	5679
Total	10476	16526	16391	11056	16144	22224

% from private sources	84%	90%	99%	95%	90%	74%

Source: USAID (2013); World Bank (2012)

Until 2011, the private sector was not permitted to produce breeder or basic seed. However in May 2011, the MALF published a Ministerial Circular on the licensing of protected varieties which enables increased access to breeder seed of public varieties by allowing the private sector to sign licensing contracts directly with MALF. To date, only 4 companies out of 27 active companies have been granted licenses. The poor participation of the private sector in seeking licensing has been blamed on strict conditions attached to the circular. The circular applies only to public-sector protected varieties. Administrative delays in processing and issuing permits was also cited by some stakeholders as one of the shortfalls.

Agro-dealers

Certified seed is primarily sold through agro-dealers, although some seed companies and the ASA also engage in direct sales to farmers. The MALF has registered over 4000 agro-dealers, but only 1500-2000 agro-dealers are estimated to be actively selling inputs today (URT, 2013c).

Tanzania Seed Trade Association (TASTA)

Tanzania Seed Trade Association (TASTA) is an organ of seed traders established in 2000 with the objective of promoting the seed trade and use of quality seed by farmers throughout Tanzania. Currently 41 seed companies out of the 65 are members of TASTA (URT, 2013c). TASTA is a member of the National Seeds Committee and works closely with the MALF on variety release and seed policy issues.

Community/local based seed production systems

Community/local based seed production systems produce and exchange or otherwise distribute to provide farmers with access to new varieties or seeds either for profit or not-for-profit. Different forms of this system exist: they can be farmers and associations that are contracted by seed companies or agro-dealers to produce certified seed; farmers and associations involved in QDS production; while others are involved in market-oriented seed production fully in the informal sector, e.g. in cassava and sweet potato production, the latter, often with support from various projects and NGO's. Community based seed multiplication exists for various food crops including sesame, groundnuts, sorghum, cowpeas, pigeon pea, maize, green gram, rice and cassava, sweet potato. This system is also well established in cash crops like tea, coffee, and cashew for production of improved planting materials in the form of grafted seedlings or cuttings.

CHAPTER 2: CURRENT SITUATION - PRIORITY CROPS FOR EGS STUDY

2.1 FRAMEWORK FOR PRIORITISATION

The crops selected for in-depth EGS system analysis were identified during a consultative process with key seed sector stakeholders from the public and private sectors during a roundtable meeting convened in Dar-es-Salaam, Tanzania on 23rd March, 2016. The event was attended by key stakeholders from relevant institutions and organisations, such as the Ministry of Agriculture, Livestock and Fisheries (MALF) headquarters, breeders from National Agricultural Research Systems (NARS), the government-run Agricultural Seed Agency (ASA), representatives from the Consultative Group on International Agricultural Research (CGIAR), private seed companies and the Southern Agricultural Growth Corridor of Tanzania (SAGCOT).

As Table 9 depicts, a matrix of key indicators crossed with ratings definitions was used as the basis for discussions.

Table 9: Crop selection framework

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

CAGR: Compound Annual Growth Rate

Source: Context expert analysis

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Selected crops

As a result of this process (details of which are highlighted in Table 10), four crops were selected for analysis: maize (Hybrid and OPV), beans, cassava and sorghum. Below is a summary of the key reasons why each crop was selected for this EGS study.

Maize

Maize is the leading cereal crop and an important staple for Tanzania. The government continues to invest in research and development especially for varieties with enhanced nutrition such as Vitamin A-rich orange maize. There is also a growing interest in developing varieties that addresses the effects of climate change. The Tanzania maize program in collaboration with the Water Efficient Maize for Africa (WEMA) project has just released drought tolerant varieties developed using conventional breeding methods. Varieties WE 2109, WE

2112 and WE 2113 were released in 2013; while varieties WE 3102, WE 3102 and WE 3102 were released in 2015. There are ongoing activities for developing transgenic Bt and drought tolerant maize.

As indicated in the earlier sections, the demand for maize in the Democratic Republic of Congo (DRC) and South Sudan is growing and there is high export market potential in these countries. Farmers will be looking for high yielding varieties to optimise their yield potential to achieve surplus to sell to external markets. Varieties resistant to drought and new diseases such as Maize Leaf Necrotic Disease (MLND) will be highly attractive to both farmers and seed producers.

The Tanzanian stakeholders chose both Hybrid maize and OPV maize. Hybrid maize is attractive to the seed companies because it is profitable and the demand is high. The demand for OPV maize, on the other hand, is slightly uncertain because farmers can easily save, produce and market seeds in informal markets. Despite this, OPV maize was prioritised because it is more suitable to resource poor farmers and more adaptable to marginal areas with poor soils and low rainfall. Substituting the currently used OPV and/or landrace cultivars with OPVs with better traits will increase maize yields. In addition, increased use of seed from improved OPVs by farmers should encourage investments by private and public seed enterprises, resulting in the eventual adoption and use of hybrids in the long run.

Therefore, the development of EGS to address the demand for high yielding nutritionally enhanced and stress tolerant maize varieties for both hybrids and OPV will be critical given the increased demand of maize in both local and foreign markets. EGS for varieties tolerant to Maize Leaf Necrotic Disease (MLND) will be in high demand to counter the devastating nature of the disease.

Common beans

Common bean is the most important grain legume in human diets in many areas of Tanzania. It is the second most essential source of calories after maize. Despite being an important food and nutrition crop in Tanzania, the availability of EGS for the farmer preferred varieties is a constraint for varieties with good color, taste and cooking properties. Common bean also scored highly because it is a women's crop with big impact on household incomes and health status of families.

Sorghum

Sorghum is a government priority crop that has the potential to significantly improve food and nutrition security and the incomes of smallholder subsistence farmers, especially those that live in dry areas where maize production has dropped due to low rainfall.

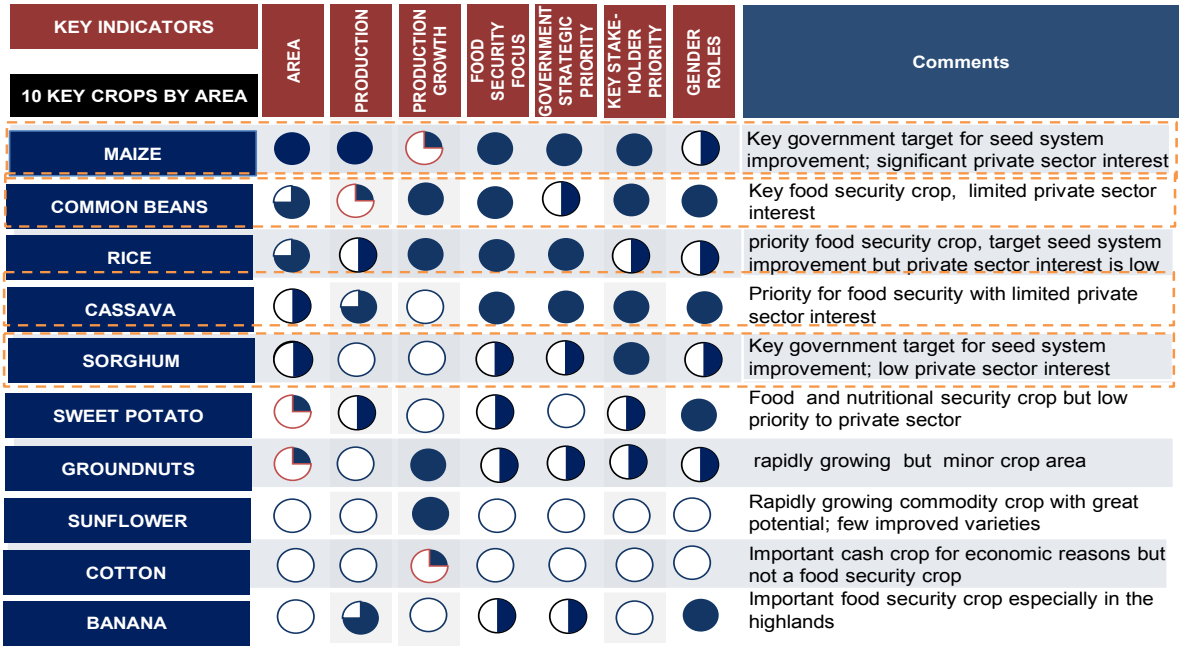
The demand for sorghum in East Africa has increased dramatically following a resolution by the East African Breweries Limited to use it to produce one of its beer brands. The brewing requirements will create an attractive niche market for both farmers and private seed producers. The market segment will require supply EGS of varieties required by the beer industry.

Cassava

Cassava, like sorghum, is a government priority crop that has the potential to significantly improve food security and the incomes of smallholder subsistence farmers, especially those that live in dry areas where maize production has dropped due to low rainfall.

Most of the current cultivars are susceptible to Cassava Mosaic Disease (CMD) and Cassava Brown Streak Disease (CBSD) necessitating the need for the development and deployment of varieties with dual resistance to the two diseases. Cassava was also selected by the stakeholders because it has great potential as a cash crop through processing. There is therefore a significant demand for EGS for virus-free cassava planting materials and the unearthed market opportunities in cassava for industrial use such as human foods, animal feeds, starch and ethanol.

Table 10: Priority crop selection results in Tanzania



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

CHAPTER 3: CURRENT SITUATION-EGS SYSTEMS

3.1 Maize

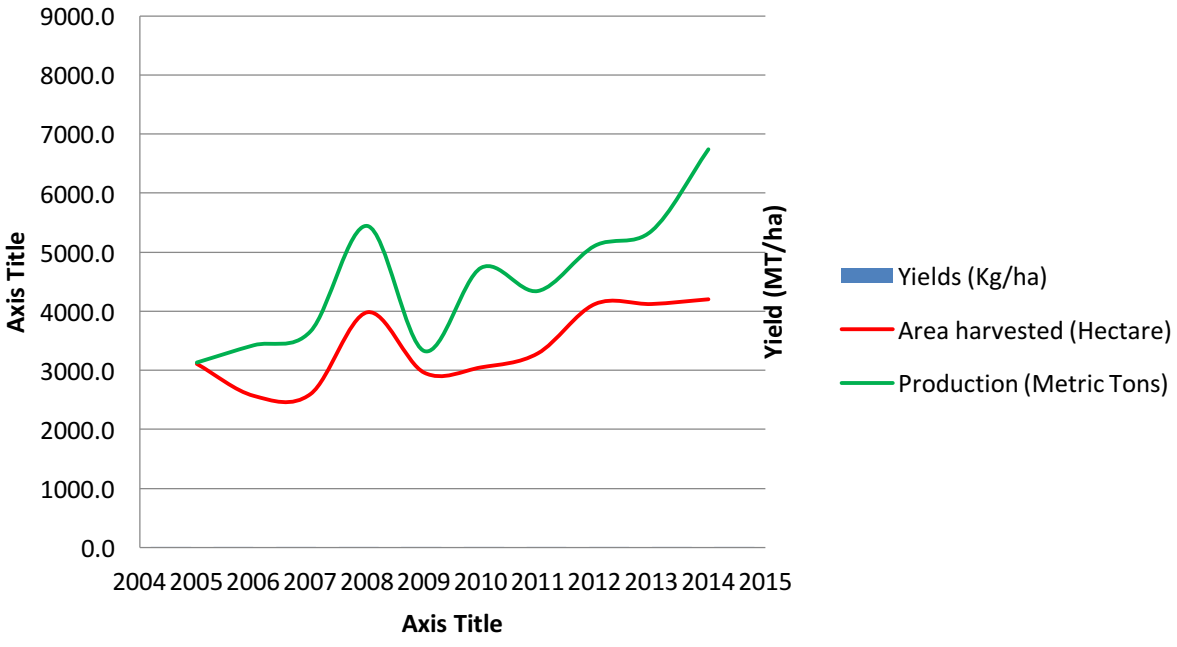
Supply

Tanzania has the second largest area planted with maize in Africa, after Nigeria (Figure 15). Of all staple and cash crops cultivated in Tanzania, maize is the major and most preferred staple crop (USAID, 2010). According to the Food and Agriculture Organization of the United Nations (FAO) data, approximately 4.12 million ha of land was planted with maize in Tanzania in 2012. It has been identified as a key crop to enhance food production, income, poverty alleviation and food and nutrition security (Homann-Kee *et al*., 2013).

Maize productivity in Tanzania is still low despite its importance to the country's food security and economic well-being. The national yield oscillates between 1.0 and 1.5t/h (Figure 13), which is low relative/compared to 12 t/ha, in the USA or 2 to 4 t/h in other countries in Africa (Figure 14). FAO data for the period 2003-2012 shows that the yield gain for maize in Tanzania was 33 kg/ha/yr, compared to 146 kg/ha/yr for Malawi, 124 kg/ha/yr for Uganda and 110 kg/ha/yr for Zambia (DT Maize, 2014).

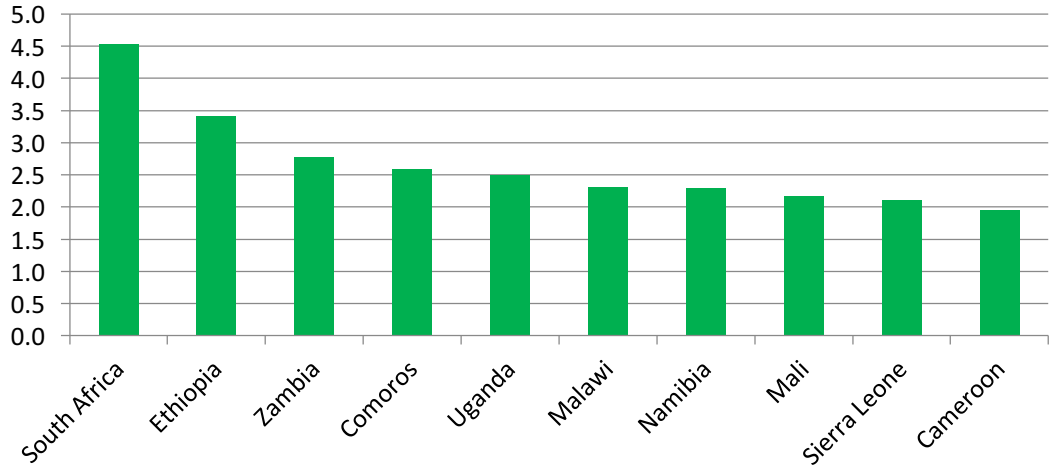
The main constraints of low yield and sporadic production are drought stress, infestation by insects, moulds, and other pests. Other factors include poor agricultural practices, farm size, low fertilizer use, lack of improved seeds and inadequate access to information and credit to purchase inputs (Cairns *et al*., 2013; Homann-Kee *et al*., 2013).

Figure 13: Maize Production, Yields and Area harvested in 2014



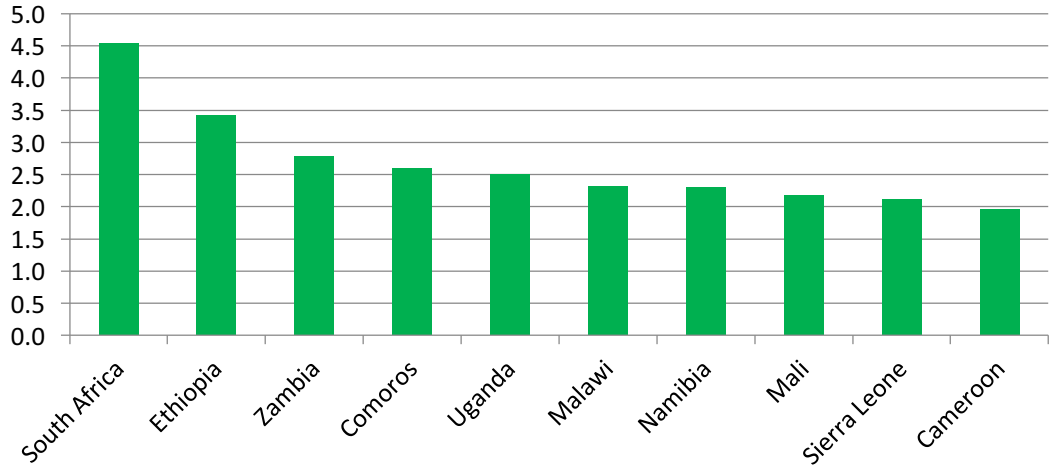
Source: FAOSTAT 2014 (Accessed in June, 2016)

Figure 14: Africa maize yields in 2014



Source: FAOSTAT 2014 (Accessed in June, 2016)

Figure 15: Africa Maize- Area harvested in 2014



Source: FAOSTAT 2014 (Viewed in June, 2016)

Maize production in Tanzania is widely distributed across all agro-ecological zones and regions (Table 11). The southern zone regions (Iringa, Rukwa, Ruvuma, Njombe, and Mbeya) which are also called the *breadbasket,* are the largest producers of maize and account for over 45% of the total annual maize production in the country (Suleiman and Rosentrater, 2015). The Lake zone regions of Mwanza, Simiyu, Mara, Geita, and Kagera collectively produce around 25-30% of the country's total maize output. The three regions of the Northern zone (Arusha, Kilimanjaro, and Manyara) account for about 10% of the total maize production. Table 11 shows maize production in Tanzania for the market year 2004-2014 (FAOSTAT, 2014).

Table 11: Maize Area, Production and Yields by region, 2010

Region	Area 000' Ha	Production 000' MT	Yield MT/ha
Arusha	88.9	144.0	1.6
Dar es Salaam	1.0	1.0	1.8
Dodoma	319.2	78.0	0.7
Iringa	319.2	393.2	1.5
Kagera	100.2	182.6	2.3
Kigoma	146.9	170.7	1.5
Kilimanjaro	93.4	216.5	2.9
Lindi	64.6	89.5	1.5
Manyara	180.3	241.0	1.6
Mara	65.6	169.5	2.7
Mbeya	300.0	621.5	2.6
Morogoro	172.6	274.9	2.9
Mtwara	41.6	65.6	1.4
Mwanza	143.0	202.1	1.6
Pwani	53.8	82.1	1.5
Rukwa	185.9	372.8	2.3
Ruvuma	131.7	289.6	2.4
Shinyanga	445.1	607.1	1.3
Singida	70.4	91.9	1.3
Tabora	165.2	245.2	1.6
Tanga	167.9	193.4	1.1
National	3050.7	4732.2	1.6

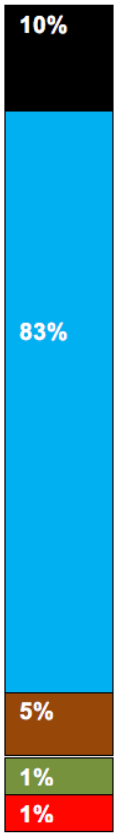
***Source*:** URT (2010), Agricultural statistics MALF

Demand

Maize accounts for 31% of the total food production and constitutes more than 75% of the cereal consumption in Tanzania. It is estimated that the annual per capita consumption of maize is 128kg. According to Suleiman and Rosentrater (2015) nearly 400 grams of maize is consumed per day per person in Tanzania. The average national consumption is estimated to be over three million metric tons per year (FAOSTAT, 2014). Maize contributes between 34% and 36 % of the average daily calorie intake (BEFS, 2013).

According to FAOSTAT, (2014) food balance sheet, 60.8% of the total maize produced in 2013 was used for human consumption. Feed represents 16.1% and 0.5% was used in food manufacturing (Figure 16). Maize is consumed in a variety of forms; ground maize flour is mixed with water to make thin porridge or stiff porridge ("Ugali"). Green (fresh) maize is boiled or roasted on its cob and served as a snack, as well as popcorn.

Figure 16: Maize Demand Segment



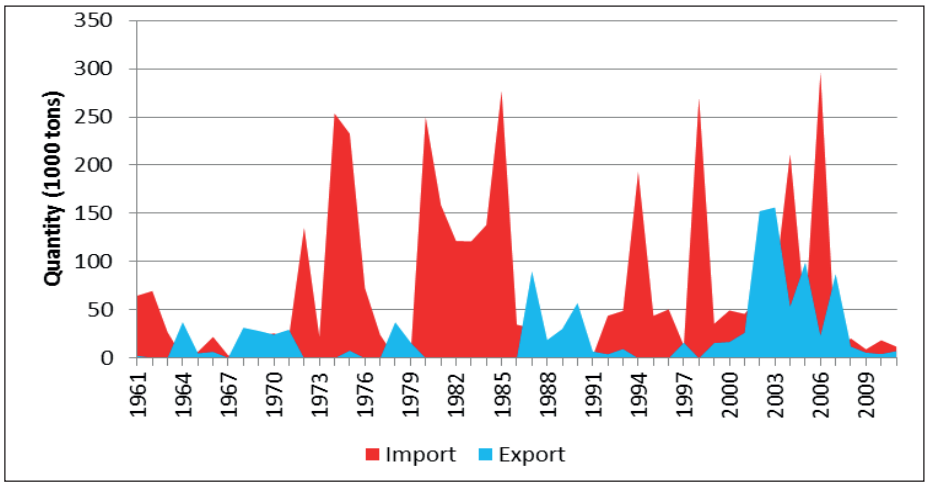
Type of market	Segment Description	Segment needs
On-farm consumption	Maize is mainly used for home consumption as soft (*uji*) and stiff (*Ugali*) porridge. A small proportion is consumed green (fresh) after boiling or roasting. This segment also includes farmer-saved seeds estimated to be 1.9%	Yield, disease and drought tolerance. Consumers prefer white flint maize; the amount of yellow maize is negligible.
Local and urban markets	Sold in local and urban markets to low and high income consumers. Milling capacity is growing rapidly. It is estimated that there is a minimum of 1 hammer mill per village and the number can rise to over 200 in big cities like Dar es Salaam Grain Reserve: National Food Reserve Agency (NFRA) and World Food Programme (WFP) (3%)	High yield and resistance to storage pests Sweet corn suitable for roasted corm business High yield and resistance to storage pests
Animal feeds	Small but an important segment due to rapid growth of livestock feed demand	Yield
Food processors	Very small formal grain milling into flour for various food products	Good pond ability, grain starch Nutritional qualities
Export Market (1%)	A growing market for export of grains and flour. Key importers are DRC Congo, Kenya, Comoro Burundi, Zambia and Kenya	Yield

Source: Lyimo *et al.,* (2014), Suleiman and Rosentrater (2015), Expert analysis (2016)

Trade

Maize is a food security priority crop and has been subjected to regular export bans. Despite its great production potential, Tanzania has remained a net importer of maize. Import volumes were high during shortfalls of production following bad years, mainly as a result of droughts. Figure 17 shows the trends in the maize trade in Tanzania from 1961 to 2009.

Figure 17: Maize Trade in Tanzania



Source: constructed by DT maize, 2014 from FAOSTAT, 2014

Production of improved varieties

Tanzania has improved seeds of both hybrid and OPV maize with the private sector playing a major role in the production and sales of improved seeds (Table 12).

Hybrid maize variety development

Until recent times Tanzania has relied on maize variety introductions from abroad. The first introductions were three hybrids: H622, H511 and H632 in 1968 (DT Maize, 2014). Eight years later, two more hybrids H 6302 and H614 were introduced in Tanzania by SeedCo (DT Maize, 2014). The production of hybrid varieties has been growing steadily - thanks to the National Maize Breeding Program (NMBP) initiated by the Government in the mid-90s. In total, 17 hybrid varieties were registered between the late 1950s and 2000 and by 2014 a total of 110 hybrid maize varieties had been registered (Table 12, Figure 18).

OPV maize variety development

Like hybrid maize, the first improved OPV maize to reach farmers was introduced from abroad. The first introduction was the short duration OPV variety Katumani from Kenya in the late 1950s, ARI-Ukiriguru and ARI-Ilonga were the first national research centers that developed and registered the OPV varieties namely: Ukiriguru Composite A (UCA) and Tuxpeno, respectively, in 1976 (Kaliba *et al.,* 1998). In 1977 another popular OPV variety ICW was released by ARI-Ilonga. In 1983 three OPVs were released: Kito, Kilima and Staha. Research on improved OPV progressed well and in 1987 two improved varieties TMV1 and TMV2 were released (Kaliba *et al.,* 1994). 1n 1998, the National Maize Research Program (NMRP) released versions of Kilima, UCA, Kito and Katumani that are resistant to Maize Streak Virus (MSV): Kilima-St, Kito-St and Katumani-St. In total, 11 OPV maize varieties were registered between the late 1950s and 2000 and by 2014 a total of 23 OPV maize varieties had been registered (Table 12, Figure 18).

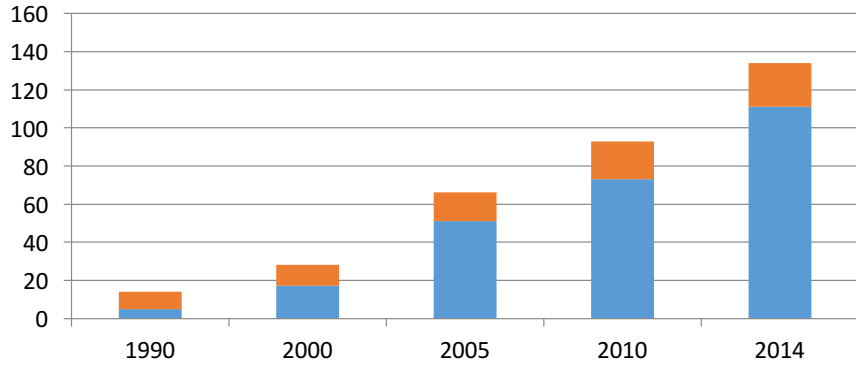
Table 12: Number of owner of maize released varieties from 1950 to 2014

Owner/ Maintainer	No of varieties Released			Type of Institution	Percentage
	OPVs	Hybrid	Total		
ARI Ukiriguru	1	0	1	Public	25%
ARI Dakawa	2	0	2	Public	
ARI Uyole	1	6	7	Public	
ARI Selian	4	5	9	Public	
ARI Ilonga	7	7	14	Public	
Aminata	1	2	3	Private National	23%
Western	0	3	3	Private National	
Tanseed International	3	3	6	Private National	
SATEC	2	6	8	Private National	
Meru Agro-Tours & Consultants Co. Ltd	0	10	10	Private National	
Finca	0	1	1	Private International	49%
Multi-Agro Trading	0	1	1	Private International	
IFFA Seed Company	0	1	1	Private International	
East Africa	0	2	2	Private International	
FICA	1	2	3	Private International	
Bajuta	0	2	2	Private International	
Chareon Pokphand	0	3	3	Private International	
Cargill – Zimbabwe	0	4	4	Private International	
Monsanto	0	7	7	Private International	
Seed Co Tanzania	0	5	5	Private International	
Pioneer	0	8	8	Private International	
Kenya Seed Company	0	10	10	Private International	
Pannar Seed Co. Ltd	0	16	16	Private International	
KARI	1	0	1	KARI	4%
EAC	0	4	4	EAC	
Total	**23**	**110**	**131**		

Source: TOSCI (2015b), Research Team analysis (2016)

In summary, by 2014 a total of 134 maize varieties (hybrids and OPVs) had been registered. The registered varieties were produced by public research institutions under DRD (22%), private local seed companies 30% and private foreign/international seed companies 48% (Table 12). The breeding program has focused on many important traits including enhanced yield, disease and pest resistance, early maturity, drought tolerance, milling quality, tolerance to lodging, poundability and nutritional qualities such as enhanced lysine and tryptophane.

Figure 18: Total number of OPV and hybrid maize released, 2014



Source: TOSCI (2015b), Research Team analysis (2016)

Production of EGS seed of Maize

Volumes of EGS of maize produced from 2007/08 to 2010/2012 are as shown in Table 13. The percentage growth was 47% and 87% for pre-basic and basic seed respectively.

Table 13: Quantity of EGS of maize over the past 5 years in MT (2008-2012)

Crop	Seed type	2007/2008	2008/2009	2009/10	2010/2011	2011/2012
Maize	Prebasic	3.6	2.9	4.2	8.3	6.9
	Basic	19	24.3	92.7	220.2	154

Source: URT (2013c)

Adoption of improved varieties/quality seed

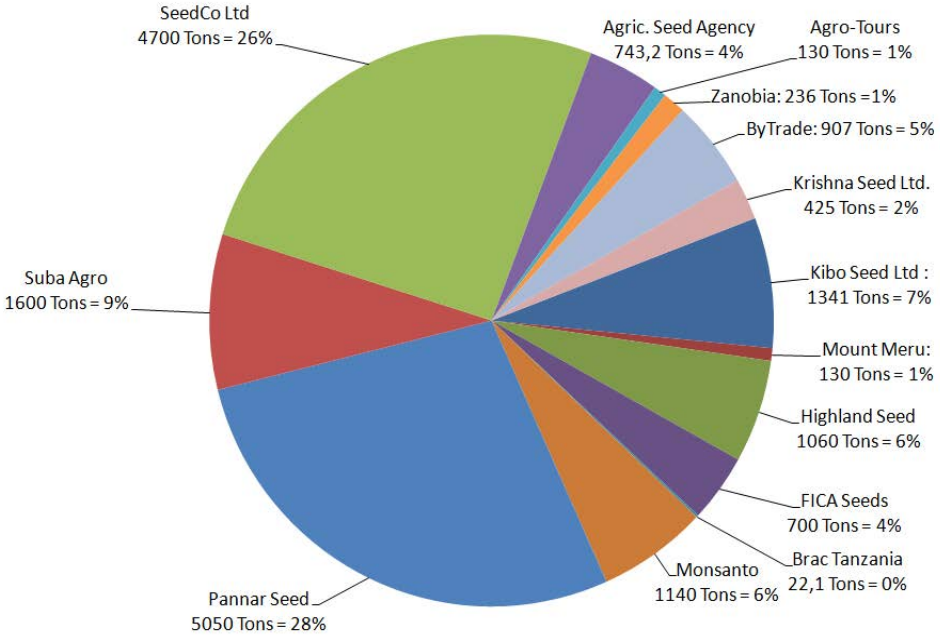
It is estimated that over 70,000 MT of maize seed is used each year in Tanzania (MAFC 2015). Of this, about 73% is seed that has been retained by the farmers from the previous harvest. Of the remainder (27%), approximately 18% are hybrid seeds and 9% are improved OPVs. The private sector markets whose share is far greater than the public (Figure 19) is the main supplier on improved seeds.

Figure 19: Seed sales in Tanzania by year and by sector (Private Public)

Source: World Bank (2012); Lyimo *et al.* (2014)

According to 2011/12 data on private firms operating in Tanzania, the Pannar Seed (South Africa) and Seed Co Ltd (Kenya) led the market with 28% and 26% of the market respectively. The rest, which were mainly local Tanzanian companies, had no more than 6-7% of market share (Figure 20).

Figure 20: Market share in the Maize seeds market (2010/2011)



Source: World Bank (2012); Lyimo *et al.* (2014)

While the availability of improved varieties and seed sales have increased dramatically over the last decade, the proportion of maize area under improved seed remains low, and the proportion of farmer adoption of improved maize varieties is even lower.

The results adoption studies based on seed sales conducted by Hassan *et al*., (2001), Langyintuo *et al*., 2008), Lyimo *et al*., (2014) have indicated that improved varieties covered 4%, 18% and 26.6% respectively, of the cultivated area. The Adoption study conducted by Lyimo *et al*. (2014), shows that a large majority of respondents (87%) indicated the high price of improved maize seed as the most important reason why farmers did not use them. Other important factors constraining higher adoption rates include lack of information or knowledge about the varieties, and their availability. These results are also in line with the baseline survey by the World Bank (Table 14). Among farmers who want to use improved seed, seed prices are often considered beyond their means, particularly given the uncertain market conditions in which they will eventually sell.

Table 14: Reason of not using improved seeds in the past

Reason	Percentage
Cost	69
Awareness	21
No need (land is fertile)	0
Low returns	1
Availability	3
Risk of loss	1
Others	6

Source: **World Bank (2012)**

Structure of EGS seed value chain – hybrid maize

It is difficult to get consistent and accurate figures about the area planted with maize hybrids in Tanzania. However, Lyimo *et al.* (2014) and URT (2013) estimated the area to be 18% and 12%, respectively. It was evident from the interviews conducted for this study that this market segment is expanding rapidly and even some OPV farmers from lowland areas would appreciate the switch to hybrids.

Formal system

All hybrids planted in Tanzania are produced and delivered through the formal system by either public or private sector institutions. There are three different systems for hybrid maize depending on the owner of the materials (Figure 21). The systems are: (i) Public and not protected hybrids, (ii) Public and protected hybrids and (iii) Private hybrids. The EGS for three systems is as follows:

(i) Public and not protected hybrids

Breeding is carried out by NARs (DRD and Universities) while basic and certified seed is produced by ASA. Market and distribution is through agro-dealers or NGOs

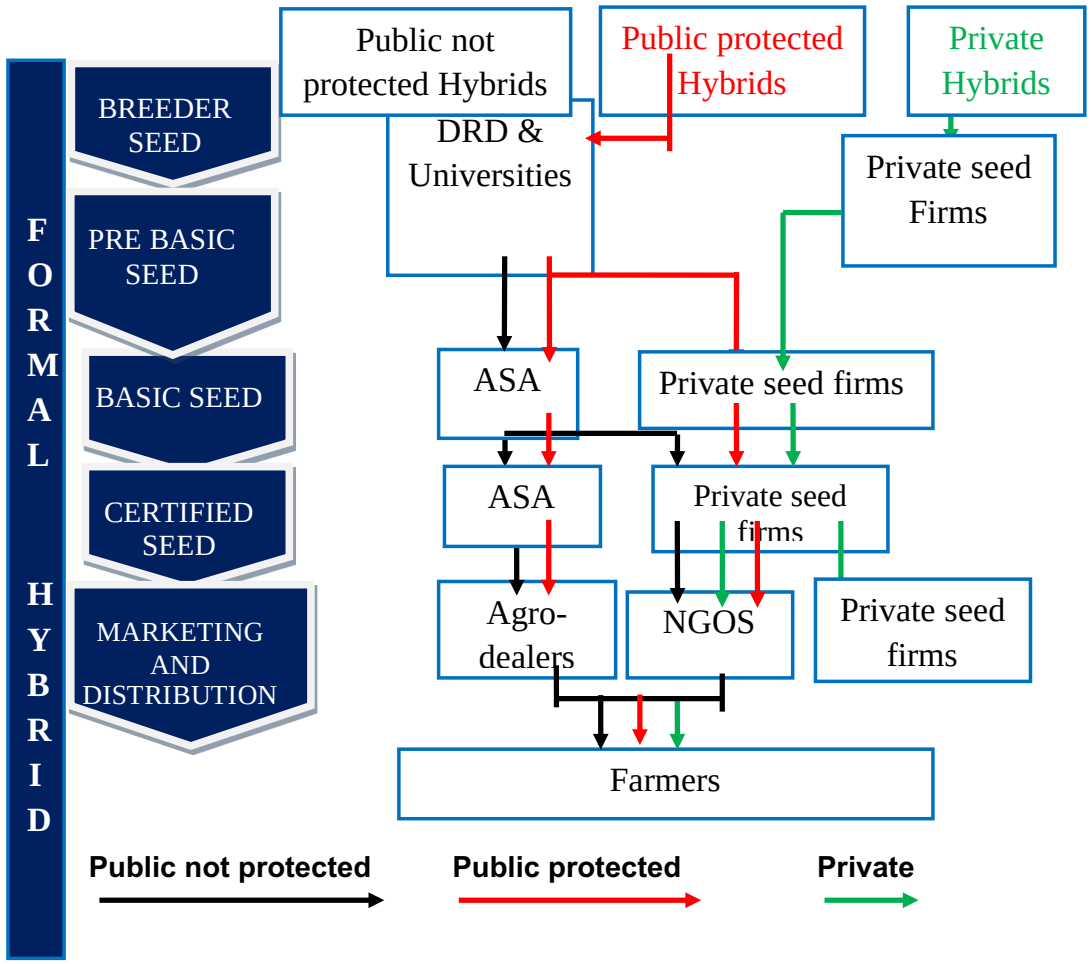
(ii) Public and protected hybrids

Breeding is done by NARs (DRD and Universities). Unlike (i) above, in this category, private sector can also produce basic seed and certified seed. Market and distribution is through agro-dealers or NGOs but also private companies can participate in selling their seeds.

(iii) Private

In this category all the main activities in the value chain are carried out by the private sector. Marketing and distribution are through agro-dealers and NGOs but in this case private companies can also participate in selling their seeds directly to farmers.

Figure 21: Structure of Hybrid maize seed system



Source: Research Team analysis (2016)

Key EGS bottlenecks and constraints- hybrid maize

The supply of EGS of hybrid maize is largely constrained by both the supply side as well as demand side factors. 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.

Lack of policy for maintenance breeding: Maintenance breeding is a procedure followed to maintain the genetic purity of the variety or parents of the hybrid. The responsibility for maintaining the purity of breeder's seed as long as the variety is in production rests with the breeder. Most breeding programmes do not possess adequate resources (financial and human) to guarantee genetic and physical purity of nuclear and breeder seeds.

Insufficient land for seed production: To maintain genetic purity and avoid varietal deterioration, seed multiplication fields of hybrid maize must follow the recommended isolation standards; 300-meters for breeder's seed and 200-meters for foundation seed. To meet the ever-increasing demand for EGS, breeders and seed producers need plenty of land. This is a big challenge given the fact that fertile land is expensive and not always readily available.

Outbreak of maize lethal necrosis disease: The government of Tanzania has imposed a quarantine on the movement of both maize grain and seed from the northern regions following the outbreak of maize lethal necrosis disease in 2012 in Northern Tanzania. This is a severe blow to the maize seed industry because close to 80% of all seed producing companies are based in the Northern zone. This disease will severely impact the production and dissemination of EGS because of the costs associated with the restrictions.

Limited institutional capacities: Unlike OPV maize, hybrid maize seed production is technically and financially more demanding. It requires competent breeders and seed technologists that are able to employ the current state of the art breeding methods and innovations.

Licensing

The recently introduced Ministerial Circular has the potential to alleviate the EGS supply bottlenecks but to date only 3 out of the 27 active companies (10%) have applied for licensing agreements. This low turnout by the private sector companies suggests that the arrangement has limited effectiveness due to unattractive terms and conditions placed on the licenses.

Demand bottlenecks

Prevalence of Counterfeit/fake Seeds: Seed counterfeiting is a serious challenge hindering the performance of the seed market. A study by USAID (2013) estimated that 25-30% of the certified seed used is "fake seed." Apart from distorting the functioning of the seed market, counterfeit seeds demoralize innovations and lowers demand because farmers lose faith in certified/improved seeds as well.

Limited access to credit: Hybrids are usually higher yielding than OPVs, but they generally require optimal nutrition and higher standard field management practices to attain maximum yield. Farmers growing hybrid maize would therefore require financial support in the form of credits to cover the costs of fertilizers, pesticides and other inputs. The ability to borrow money increases a farmer's ability to bear risk. Given the option to access credit, smallholder farmers are likely to be more prepared to shift away from traditional low-risk, low-return farming practices such as the use of local maize landraces to riskier and more profitable agricultural technologies such as hybrid maize.

Limited promotion and insufficient distribution of certified seeds: Most breeding programmes and seed companies do not have the necessary resources to promote their varieties, thus they remain invisible to the farming communities. Since the efforts by seed companies to promote and distribute certified seeds in Tanzania are limited, some farmers are not inspired to use them, thus the low demand.

Limited availability and access to maize hybrids adapted to marginal areas: The development and release of well adapted maize hybrids suitable for Tanzania's high potential areas tends to be concentrated in the northern and southern zones. The low-potential areas in the eastern and western zones however, received less attention, and farmers in these areas lack hybrid varieties that are adapted to their distinct agro-ecological conditions.
The national maize breeding program, the International Maize and Wheat Improvement Centre (CIMMYT) and Water Efficient Maize for Africa (WEMA) projects are shifting their research interest to the marginal areas and focusing on the development of hybrid cultivars that are better adapted to stressed environments. Although this is an important step, the number of hybrids released for these particular environments is limited.

Structure of EGS seed value chain – OPV maize

Although improved maize hybrids have diffused rapidly in high potential areas of the southern and northern highland zones of Tanzania (adoption is over 90%), a large proportion of resource poor farmers in marginal areas still use local varieties and prefer improved open-pollinated varieties (OPVs) over hybrids. Consistent and accurate figures about the size of the area planted with OPV maize is not available. However, Lyimo *et al*. 2014, estimated the area to be 9%. It was evident from the interviews conducted for this study that this market segment will in the long run decline as hybrid varieties adaptable to marginal areas become available. Unlike hybrids, improved OPV maize in Tanzania is supplied through both the informal and formal sectors. The formal sector has two categories (i) certified seed system and (ii) QDS system.

Formal system

Certified seed system

The certified seed system for OPV maize is similar to the hybrid maize system where public institutions, local seed companies, community based groups, farmers produce commercial seed and either sell directly to farmers or through agro-dealers or NGOs (Figure 22). The main difference with hybrids is that there are no protected or licensed OPVs. Most of the seed produced in Tanzania is through public sector but a recent development has seen the entry of a few private sector companies in the OPV breeding and seed production business.

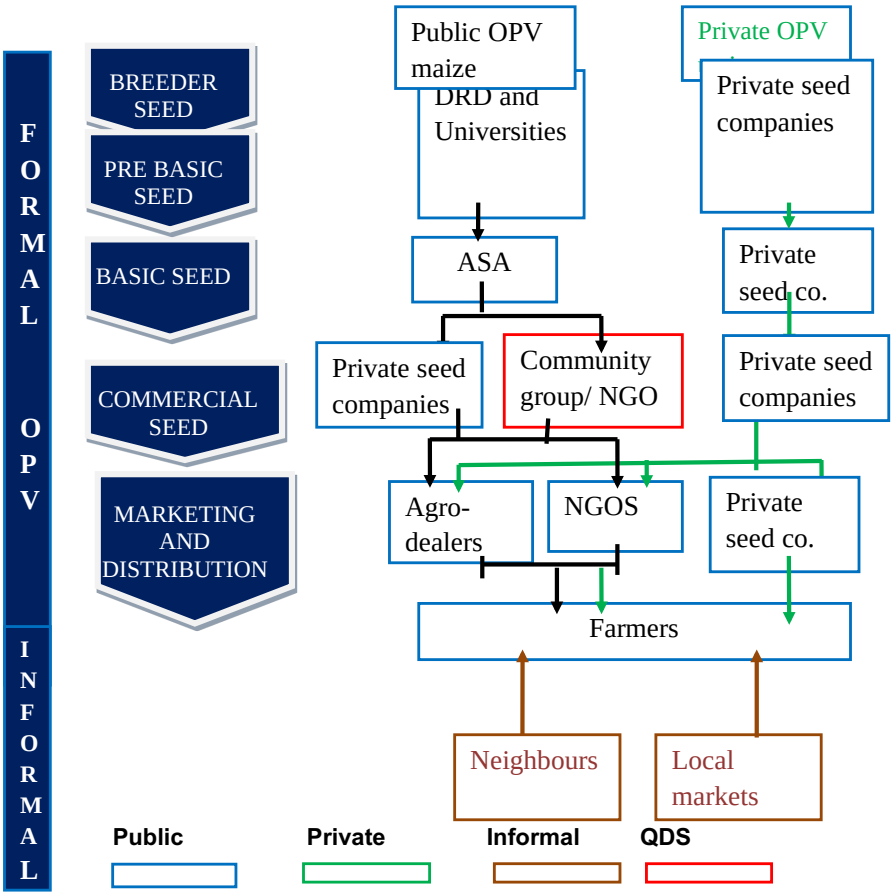
QDS system

The second most important system for supplying commercial OPV seeds is the Quality Declared Seed (QDS) production system (Figure 22). A number of non-governmental organizations (NGOs), religious organisation, individual farmers, farmer/women groups and other organizations have initiated community-based seed production in a number of regions in the country for OPV maize and other crops. Examples of such organizations are the Christian Council of Tanzania (CCT), the Diocese of Central Tanganyika (DCT) and Zoissem-LVIA in Kongwa in Dodoma, HIMA in Iringa, Mara Farmers' Initiative Project supported by IFAD, ICRISAT/SADC, FINACO in Dodoma, Mtumba Women Rural Training Centre in Dodoma, Sokoine University of Agriculture (SUA) in Morogoro (Lyimo *et al* 2014). The FAO QDS system was modified and adopted by Tanzania in the year 2000. The QDS was incorporated into the formal seed system in the national Seeds Act of 2003, along with its seed rules, regulations and procedures (2007). In Tanzania only OPVs that are on the official national variety list can be produced under QDS and not F1 Hybrids. Quality declared seed is inspected and approved by the Tanzania Official Seed Certification Institute at the district level where sales are restricted to the ward level.

Informal system

The informal maize seed system is estimated to be around 73% (World Bank, 2012) or 79% (MALF, 2013). The informal seed market consists primarily of farmer-saved, farmer to farmer sharing and seeds sold to neighbours or local markets (Figure 22). The informal system is not limited to farmer saved seeds or landraces but also includes recycled improved OPV.

Figure 22: Structure of OPV maize seed system



Source: Research Team analysis (2016)

Key EGS bottlenecks and constraints - OPV maize

The OPV maize EGS supply in Tanzania is largely constrained by both supply side as well as demand side factors. As noted in the earlier sections, these factors are primarily aggravated by insufficient policies to support research, good governance, regulations, limited private sector operations etc. This section will mainly focus on the most critical ones. These include the following:

Supply bottlenecks

Lack of policy and the limited capacity of breeders to maintain seed varieties: A stable EGS supply requires long term maintenance of a newly released seed variety. This is one of the major challenges which the EGS marketing system in Tanzania has been facing. ARI Ilonga for example, developed good OPVs like TMVI and Situka, but the seed available on the market today is highly contaminated because the parent lines are not properly maintained. Most national research institutions do not possess adequate resources (financial and human) to guarantee genetic and physical purity of nuclear and breeder seeds. Most research institutions as well as companies complained about the deterioration and contamination of OPV maize varieties and the absence of qualified and well trained breeders and seed technologists.

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. Big players in the seed industry like ASA and other commercial seed producers do not have the requisite capacity to forecast demand for EGS in the country. 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.

Limited infrastructural capacities: Important infrastructural facilities to support an efficient system for production of EGS like irrigation, cold storage and seed processors are missing in most of the institutions visited. Of the 27 active seed companies not more than 5 (USAD, 2013) have their own processing and storage facility.

Limited private sector participation: Private seed companies are not attracted to OPV maize because it has low variety turnover rate, as many improved varieties can meet farmer's needs for many years. In Tanzania for example, out of 133 registered maize seed, only 23 (17%) are OPV varieties (Table 12) and as a result OPV varieties developed in the early 60s are still popular and in high demand. Furthermore, the private sector interest in OPV is low since seed of OPV maize can be saved and shared/re-used from season to season with limited decline in seed quality and variety performance.

Demand constraints

Limited technological knowledge and lack of business skills among members of the farming community: Farmers growing OPM maize in Tanzania are generally unaware of the potential return on investment associated with EGS as well as the benefits that could accrue from improved agronomic practices. Limited knowledge and information over the potential of certified seeds among smallholder farmers has tended to decrease market demand for EGS because farmers will revert to long periods of recycling. Farmers need to be made aware of the yield, nutritional and environmental benefits of using new improved OPV varieties such as TMV Lishe.

Perceived high cost of seeds: As demonstrated in the previous sections, farmers perceive seed cost as a high-cost input relative to their low levels of income. This is a serious concern as OPV maize is cultivated in marginal areas where the farming community/households have limited capacity for income generation. Farmers with no/lower regular cash income have limited purchasing power. This affects market demand negatively as most farmers will opt for farmer-saved seeds over improved seeds.

Limited farmers' access to credit: Smallholder farmers in Tanzania lack access to the affordable credit options that would allow them to purchase and make use of certified seeds and invest in other high quality agricultural inputs. This has often necessitated them to purchase lower quality and sometimes counterfeit seeds and inputs. The demand for genuine EGS has subsequently declined. Financial institutions are reluctant to finance smallholder farmers because they are a credit risk. The majority are to be found in remote areas thus making it un-attractive for financial institutions to link with them.

Lack of policy or guidelines for replacing obsolete varieties: A significant number of farmers still prefer old and obsolete OPV maize varieties and do not demand quality seed of improved varieties. This is mainly because they consider improved varieties to be too expensive but also because there has been no sufficient promotion of the new varieties.

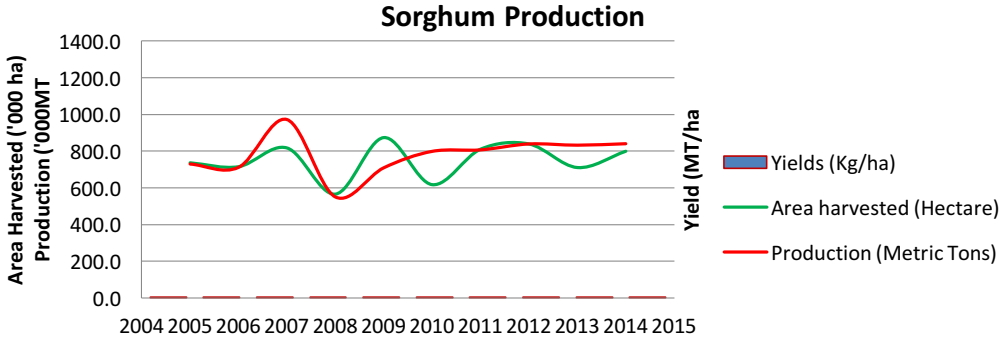
3.2 Sorghum

Supply

Sorghum (Sorghum bicolor L. Moench) is primarily an African cereal crop (Orr *et al*., 2016) and one of the most important drought tolerant cereals grown in arid and semi-arid parts of Africa (Abdulai *et al*., 2012). Of the 44 million ha planted with sorghum worldwide, 27 million ha (62%) is in Africa (Orr *et al*., 2016).

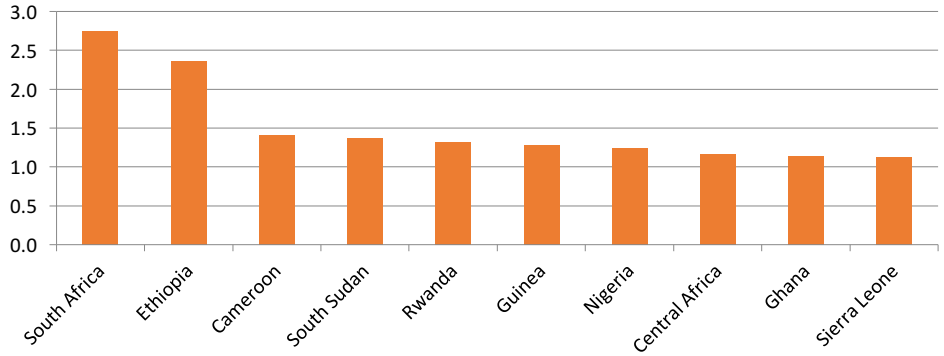
Tanzania ranks third in sorghum production in the Eastern Africa region after Sudan and Ethiopia Over the last 10 years (2004-2014), sorghum production has averaged around 778,906 metric tons per year and productivity is very low ranging from 0.8 to 1.3 MT/ha (Figure 23) mainly as a result of traditional farming practices with low inputs (non use of inorganic fertilisers or pesticides) and local cultivars with poor yield potential. Productivity is relatively low as other countries in the region such as South Africa and Ethiopia have higher yields (Figure 24).

Figure 23: Sorghum production yield and area harvested in 2014



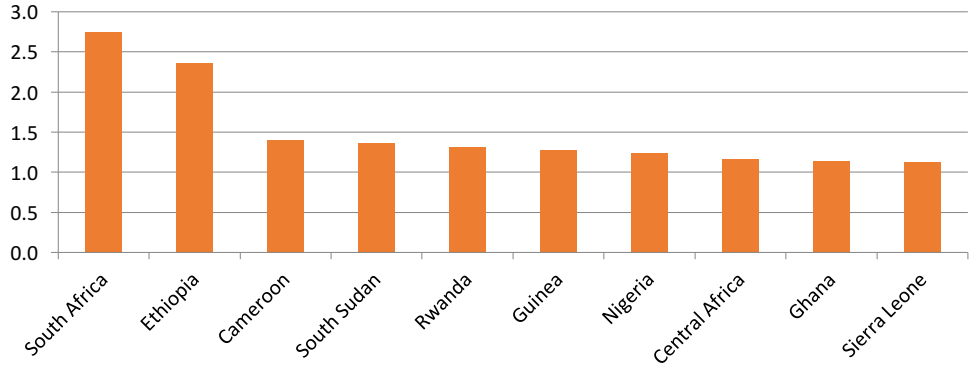
Source: FAOSTAT 2014 (Accessed in June, 2016)

Figure 24: Africa Sorghum Yields



Source: FAOSTAT 2014 (Accessed in June, 2016)

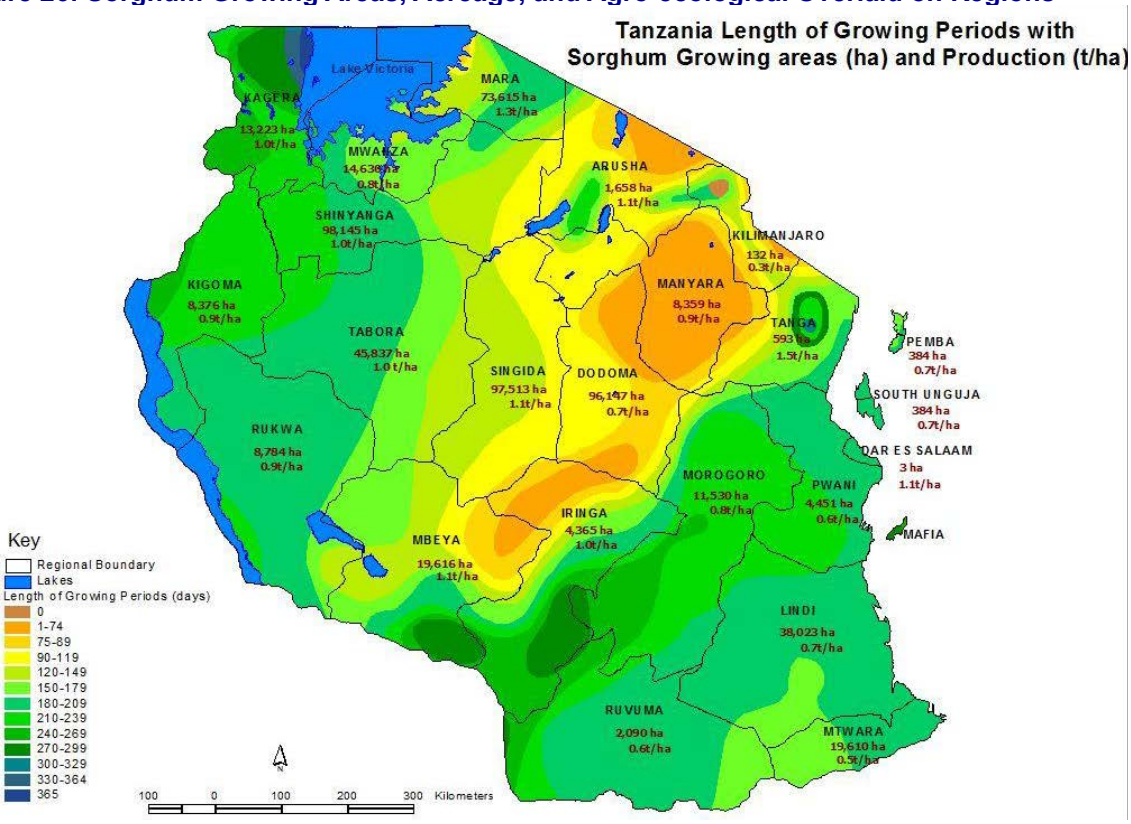
Figure 25: Africa sorghum - Area harvested, 2014



Source: FAOSTAT 2014 (Accessed in June, 2016)

Sorghum is the third most important cereal in Tanzania (Pass Trust, 2013). It is produced mostly by smallholders on marginal lands or sub marginal lands. The major production areas are Dodoma and Singida regions in the Central Zone; Tabora region in the Western Zone; Shinyanga, Mwanza and Mara regions in the Lake Zone; and Lindi and Mtwara regions in the Southern Zone. Dodoma, Singida, Shinyanga, Mwanza and Mara regions account for most of the national sorghum area. These are semi-arid areas that receive low (< 600mm) and erratic rainfall and have a short crop growing period ranging from 74 to 120 days. However, the ongoing climate change and the outbreak of diseases like Maize Leaf Necrotic Disease (MLND) are already a threat to maize production in regions like Morogoro, Kilimanjaro, Arusha and Manyara thus forcing farmers to shift production from maize to Sorghum. Figure 26 shows the sorghum growing areas, acreage, yield and agro-ecological zones overlaid on regions.

Figure 26: Sorghum Growing Areas, Acreage, and Agro-ecological Overlaid on Regions



Source: MALF, (2014)

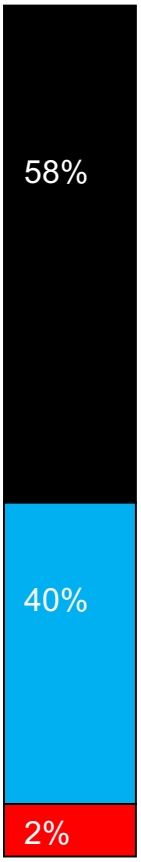
Demand

Tanzania produces over 778,906 tonnes of sorghum per year; virtually all of it produced on a subsistence basis. Sorghum has a wide variety of uses (Figure 27). At household level, sorghum is consumed as thin and stiff porridge (*Uji* and *Ugali*, respectively). Sorghum is also used in making local and industrial malt and clear sorghum beer; it is the best alternative to barley for lager beer brewing Opaque beer manufactured by modern breweries (e.g. Chibuku shake-shake) is a popular alcoholic drink. Sorghum varieties suitable for brewing have low tannin content since consumers prefer beer with this taste. In Tanzania the use of sorghum for food processing (mainly opaque beer equals or exceeds the use of sorghum for food (Orr *et al*., 2016).

Although the export segment is low, there is a growing demand for sorghum grains in the domestic market, as well as in the export market. In Tanzania, sorghum grain is not usually fed to livestock, but sorghum stover is used for fodder as well as fuel and material for building and roofing houses. The grain from Tanzania has a potential market in Europe for organic grains in animal and poultry feed mills. Worldwide, more sorghum was used for feed in 2009-11 (26 million tons or 43%) than for food (25 million tons or 41%). This reflects sorghum's primary use as livestock feed in the United States and other developed countries (Orr *et al.* 2016). The crop shows future potential for use in the manufacture of non-allergenic and gluten-free products.

Figure 27: Comparison of sorghum demand segments

Sorghum market share



Type of market	Segment Description	Segment needs
On-farm , local and urban market consumption	Mainly used for home consumption as soft (*uji*) and stiff (*Ugali*) porridge Local brew On farm saved seeds	Yield, disease and drought tolerance, Color: Color can determine preference depending on location of the market Red is preferred in the lake zone while the rest is white
Food processors mainly brewers	A growing segment for brewers TBL, Serengeti, (TOB DAR Brew) producing products such as Eagle, Senator, Tingisha, respectively.	Varieties preferred for brewing e.g. Cv with low tannins
	This segment also includes small formal grain milling for processing flour for food consumption	Color preferences depending on the targeted market
Animal feeds	Very small but there is one company (Azam Ltd) producing animal feed	Yield

Production of improved varieties

The Tanzania National Sorghum and Millet Improvement Program (NSMIP) of the Division of Research and Development (DRD), in collaboration with the SADC/ICRISAT Sorghum and Millet Improvement Program (SMIP), have developed several new varieties that have better quality traits than the farmers' landraces. The sorghum breeding program has led to the release of 13 new varieties as indicated in the Table 16 and focusing on early maturity, higher yields and resistance to stresses particularly diseases, insect pests and Striga.

Table 15: Key sorghum varieties released from 1970 to 2015

Variety Name	Year of release	Yield MT/ha	Characteristics	Developer	Type of Organisation
Dobs Bora	1966				EAC
Lulu Tall	1970s				
Lulu Dwarf	1970s				
Serana	1970s		Tolerant to *Striga*	EAC	
Tegemeo	1986	3.0-3.5	Susceptible to *Striga*	ARI Ilonga	Public
Pato	1995	2.5-3.0	Susceptible to *Striga*	ARI Ilonga	
Macia	1999	1.6-3.3	Moderately resistant to *Striga*	ARI Ilonga	
Wahi	2002	2.5-3.0	Highly resistant to *Striga*	ARI Ilonga	
Hakika	2002	3.5	Resitant to *Striga*	ARI Ilonga	
Sila	2005	3.5	Drought tolerant	SEEDCO	Private International
NACO Mtama 1	2012	2.2-2.6	Big seed size	Namburi Agricultural Company	Private Local
NACOSH 1	2013	4.5-5.5	Big seed size	Namburi Agricultural Company	
NACOSH 2	2013	3.0-3.5	Big seed size	Namburi Agricultural Company	
PAC 537	2014	3.8	Suitable for food and feed	Advanta Seed Company	Private International
PAC 501	2014	3.7	Suitable for food and feed	Advanta Seed Company	

***Source*:** TOSCI, 2015b, Research Team analysis (2016)

Production of EGS sorghum

Table 17 provides data on the volumes of EGS of sorghum produced from 2007/2008 to 2010/12 It is evident that the production of EGS is extremely low as it rarely exceeded 10 tons per year.

Table 16: Quantity of EGS of sorghum producers from 2007/2008-2012/2012)

Crop	Seed type	2007/2008	2008/2009	2009/10	2010/2011	2011/2012
Sorghum	Prebasic	3.3	1.9	2.6	2.3	0.7
	Basic	5.3	6.8	8.6	7.6	2.6

Source: URT (2013c)

Adoption of improved varieties/quality seed

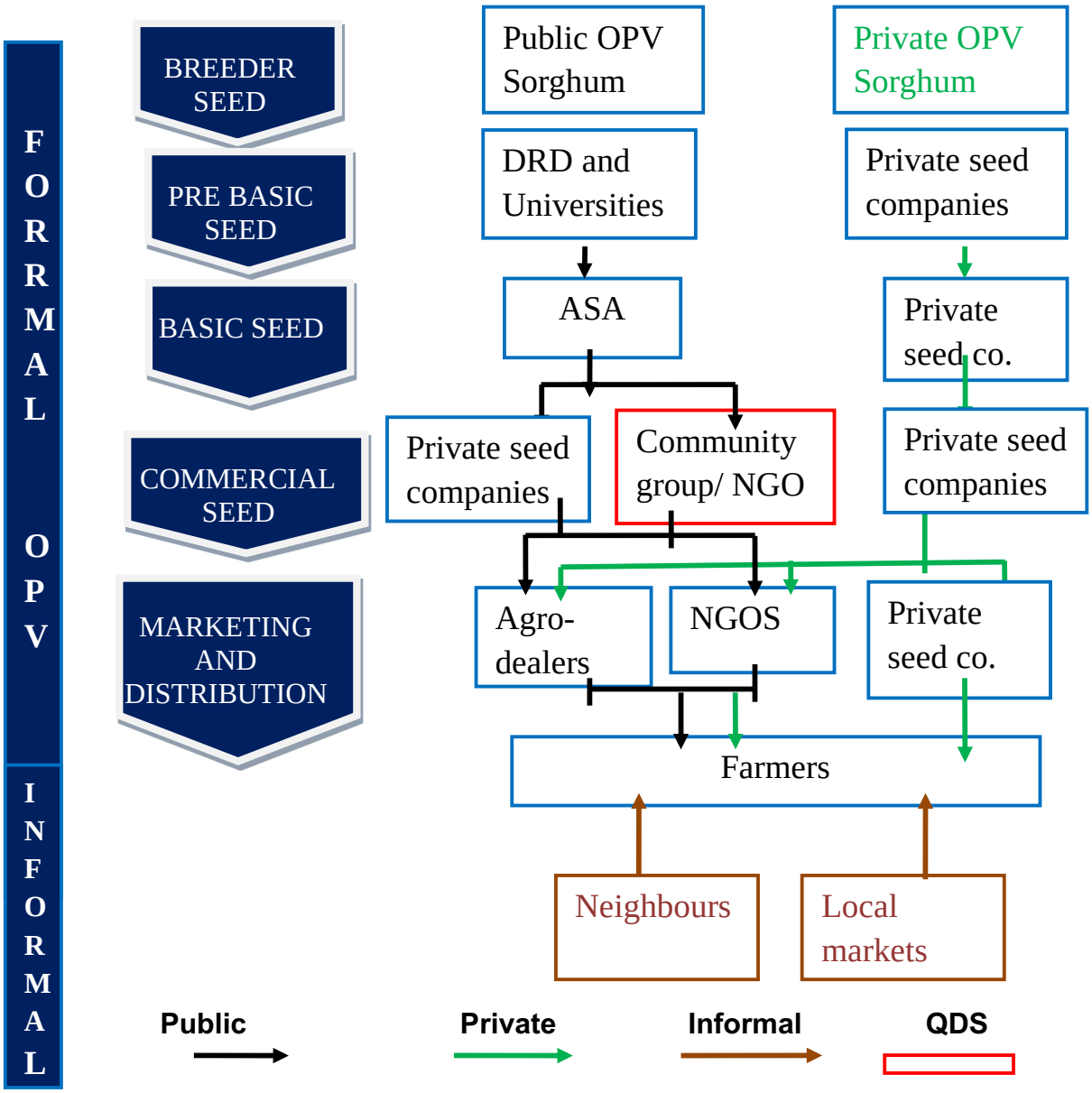
Improved varieties occupy approximately 36% of Tanzania's sorghum area. They are widely popular mainly for their early maturity (and thus drought tolerance) traits and high yield, 10% to 38% higher than local landraces (URT, 2014). Adoption is stimulated by interventions by ICRISAT, NGOs, and other partners, to strengthen local seed systems and community-based seed production; and by the efforts of the national extension service to make farmers aware of the benefits of the new varieties. However, despite these efforts improved varieties have not been widely adopted by farmers. Adoption studies conducted by several scientists indicate an adoption rate ranging from 23%-36% (URT, 2014). The factors constraining higher adoption rates included lack of seeds and affordability. From our discussions with farmers it was evident that farmer-perceived cost of certified seeds are more than 2.5 times the cost of farmers saved seed. As noted in the maize section, to improve adoption rates farmers need evidence-based information to show that additional costs of improved seeds (certified and QDS) will be compensated by higher yields and superior returns.

Structure of EGS seed value chain – sorghum

The structure and actors in the sorghum EGS seed value chain (Figure 28) are similar to those described for OPV maize in section 3.1. It is estimated that only 4% of the sorghum seed originates from the formal seed system, with the balance of 96% being seeds sourced by farmers from informal systems (URT 2014). While there are several reasons for the dominance of the informal system, the primary factor is the low demand for quality seed due to limited promotion and marketing of the new varieties. The production of EGS is public driven but there are private companies such as Namburi Agricultural Company that produce their own EGS.

Figure 28: Structure of OPV Sorghum seed system

Figure 1: Structure of OPV Sorghum seed system



Source: Research Team analysis (2016)

Key EGS bottlenecks and constraints

The EGS supply of OPV sorghum in Tanzania is constrained by several supply side as well as demand side factors. This section will focus on the most critical factors. These are:

Supply bottlenecks

Low-level private sector involvement: There is weak private sector involvement due to seed being reused as most sorghum seed is produced by the informal sector with limited decline in seed quality of variety performance sorghum. Furthermore, private seed companies are not attracted to OPV sorghum because it has low variety turnover rate, as many improved varieties can be reused and still meet farmer's needs for many years.

Limited capacity to forecast demand: Sorghum is a food security crop in Tanzania that is often grown for on farm-consumption and rarely marketed through formal systems. In such circumstances it is extremely difficult to estimate the seed requirements. 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 that would in turn lower production costs.

Infrastructure challenges: ASA and other seed producing companies do not have adequate infrastructural facilities to support production and distribution of EGS. Increased demand for EGS would require irrigation systems for off season production, cold storage for seed stocks and seed machines for processing grading and packing of improved seeds.

Demand bottlenecks

Low income and Limited Purchasing power: Sorghum is a smallholder crop grown in marginal areas by farmers with low income and access to certified seeds is limited due to low purchasing power.

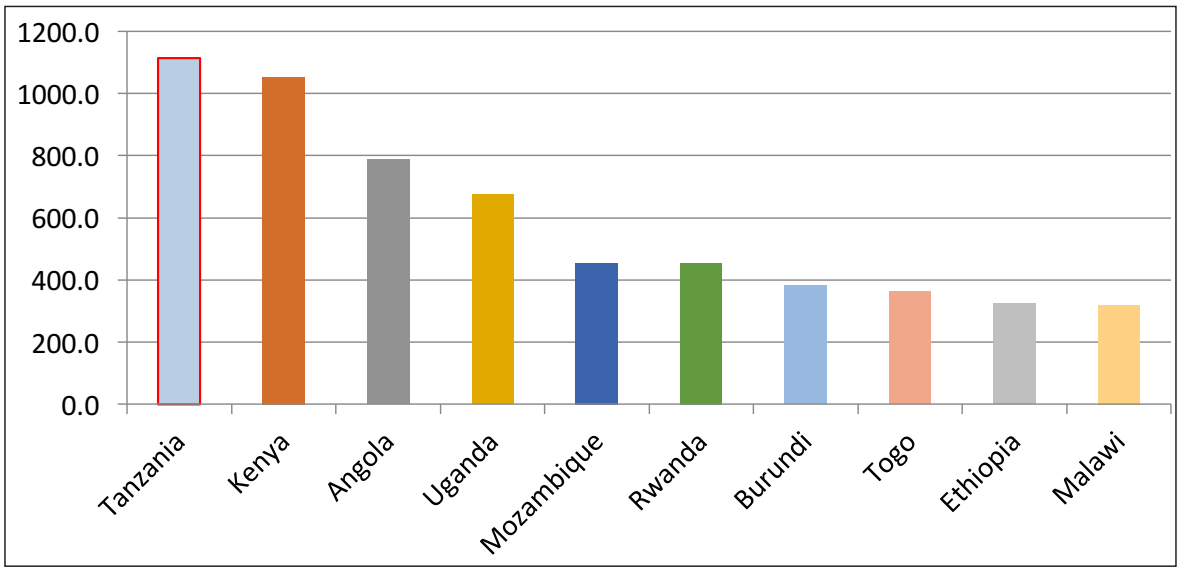
Limited access to credit and financial exclusion: The majority of sorghum farmers in Tanzania do not access credit due to lack of collateral and the fact that they are scattered in remote rural areas. Financial inclusion is low partly.

3.3 Common beans

Supply

Bean (*Phaseolus vulgaris L*) is an increasingly important crop in Tanzania, contributing to the national economy (commodity and employment) and as a source of food and cash income for resource poor farmers. Tanzania is the largest common bean producer (Figure 29) among the 29 countries that produce common bean in sub-Saharan Africa and the world's seventh largest common bean producer (Ronner and Giller, 2013). The area occupied by common bean is second to maize, accounting for nearly 11% of the total cultivated land. It is the leading leguminous crop, accounting for 78% of land under legumes.

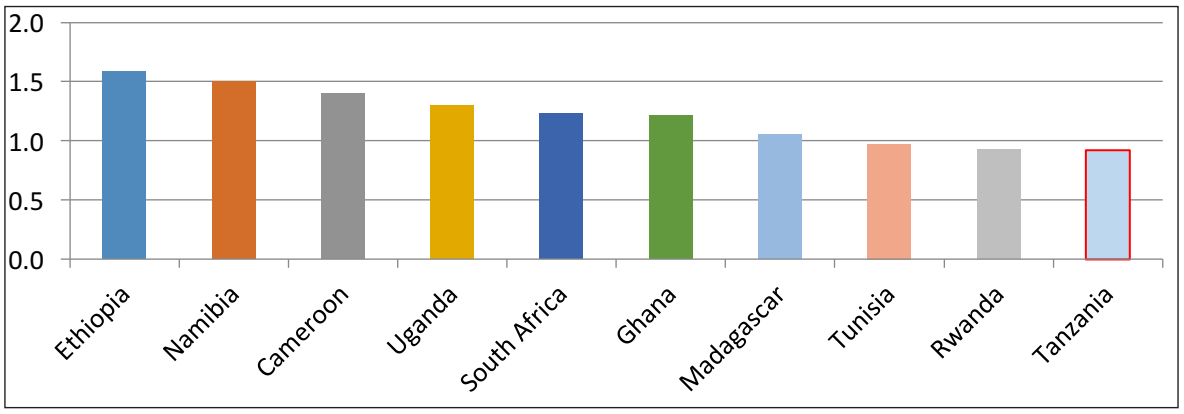
Figure 29: African Common bean - Area harvested - 2014



Source: FAOSTAT 2014 (Accessed in June, 2016)

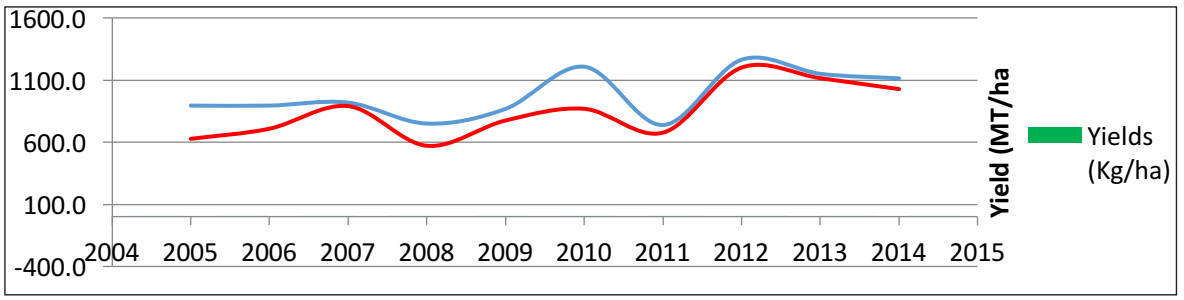
The crop is grown by smallholder farmers, particularly women, under diverse farming systems and agro-climatic conditions for both household food requirements and income generation. Between 2004 and 2014, the bean area harvested increased by 25%, from 894,771 ha in 2005 to 1,114,640 ha in 2015, while production almost doubled, increasing by 64%, from 626,340 tons in 2005 to 1,025,930 tons in 2010. On the other hand, yield growth rates have been modest (Figure 30) increasing by 32%, from 0.7 tons/ha in 2005 to 0.9 tons/ha in 2014 (Figure 31).

Figure 30: African Common bean yields



Source: FAOSTAT 2014 (Accessed in June, 2016)

Figure 31: Common bean production, area harvested and yield



Source: FAOSTAT 2014 (Accessed in June, 2016)

Common bean is widely grown across the country. The highest concentrations are located in the Northern zone (Kilimanjaro, Arusha, Manyara, Tanga regions), Southern Highlands zone (Mbeya, Ruvuma, Iringa, Rukwa regions), Lake zone (Kagera region), Western zone (Kigoma region) (Table 19).

Table 17: Common bean area, production and yield by region and dominant variety

Zone	Region	Area 000' Ha	Production 000' MT	Yield MT/ ha	Dominant variety
Northern	Kilimanjaro	78.5	61.7	0.8	Lyamungu85, Lyamungu90, Selian94 JESCA, Selian 97, Selian05, Selian 06, cheupe
	Arusha	33.6	25.1	0.7	
	Manyara	120.0	80.6	0.6	
	Tanga	56.6	50.6	0.7	
Southern Highlands	Iringa	79.6	79.1	1.1	Wanja, Urafiki, Calima Uyole, Roba1, NRIE27 and PASS
	Mbeya	200.7	96.7	1.0	
	Rukwa	68.8	58.8	1.0	
	Ruvuma	28.7	22.4	0.7	
Lake	Mwanza	36.1	30.1	0.8	Lyamungu09, Selian06, Uyole Nyano
	Kagera	154.0	112.1	0.8	
	Mara	17.9	19.7	1.3	
Central	Dodoma	20.0	9.7	0.4	JESCA
	Singida	10.0	6.9	0.6	
Western	Kigoma	134.6	83.7	0.6	Lyamungu09, Selian06, Uyole Nyano
	Tabora	20.6	12.8	0.6	
	Shinyanga	94.8	79.6	0.8	
Eastern	Dar es salaam	0.0	0.0	0.0	Rojo, Ushindi, Pesa, and SUA 90,
	Morogoro	31.3	23.5	0.8	
	Pwani	0.0	0.0	0.0	
Southern	Mtwara	0.5	0.4	0.9	JESCA
	Lindi	0.9	0.4	0.4	
	National	1208.7	867.5	0.7	

***Source*: URT (2010), Agricultural statistics MALF**

Demand

Legumes represent the most affordable source of protein and micronutrients available to the rural and urban poor, and especially women and children. Legumes are nutrient-dense and provide an essential complement to the starches derived from cereals and root crops. The nutritional value of grain legumes is attributable to their high nutrient composition (e.g., protein, complex carbohydrates, essential minerals and fatty acids), as well as properties that promote nutrient absorption and reduce gut inflammation.

Additionally, the ability of grain legumes to fix atmospheric nitrogen and deposit it in the soil is a major benefit to farmers and the landscapes in which they work. Beans add nitrogen to the soil for use by non-fixing crops such as cereals and starch root crops. Consequently, legume crops boost starch staple crop yields where fertilizers are not used, and offset the need for purchase of expensive nitrogen fertilizers.

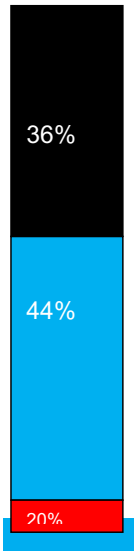
Much of the bean production is consumed on-farm. Per capita bean consumption is 19.3kg, contributing 16.9% protein and 7.3% calories in human nutrition (Rugambisa, 1990) and 71% of leguminous protein in diets (Grisley, 1990). It is estimated that over 75% of rural households in Tanzania depend on beans for daily subsistence (Xavery et al., 2006; Kalyebara and Buruchara, 2008). The crop residues are used as livestock feed and as a source of organic matter to enhance soil fertility. Based on data collected from various sources (Figure 32), on-farm consumption accounts for 36.2% of the demand, while local and urban market share is estimated at 44%. Bean leaves are consumed as well, and this also forms an important consideration for the selection of the varieties cultivated.

Regarding export market share, Tanzania has registered significant increases in its export volumes although the trade is informal and often goes unrecorded. A substantial export volume (estimated at about 10-20%) of beans produced in Tanzania is exported through the Kenya-Sudan-Somali transport corridor and Zambia,

Malawi and DRC corridor, as well as the Eastern corridor through the Dar es Salaam sea port. The main export destinations are in the neighbouring countries (Kenya, Rwanda, Burundi, Malawi and DRC) with a significant proportion going through informal trade. Varieties that are highly demanded by the external market include Uyole 94 (Malawi), Uyole 98 (DRC), Uyole 03 (South Africa), Calima Uyole (Kenya, Malawi, Zambia), Lyamungo 90 (Kenya).

Figure 32: Comparison of common bean demand segments

Bean Market share by segment



Type of market	Segment Description	Segment needs
On-farm consumption	Mainly consumed on-farm consumption as source of protein. The segment also includes on-farm saved seeds	Yield, disease and pest tolerance, Yield, colour, cooking time, storability
Local and urban market consumption	A growing segment as consumer is looking for most affordable source of protein and micronutrient. There is also a significant demand by the WFP	Yield, seed size colour, cooking time, storability
Export market	Growing bean export market in the Eastern Africa region, South Africa and overseas	Export market targets varieties with high yields, good colour, cooking time, large seed size

Source: Research Team analysis

Production of improved varieties/quality seed

Bean research in Tanzania has been conducted in close collaboration with the International Center for Tropical agriculture (CIAT) as early as 1973 (Hillock *et al*., 2006). Table 20 shows the number of bean varieties released since 1970s. So far, a total of 27 bean varieties have been released in Tanzania, with 24 of them released by the Department of Research and Development and 3 by the Sokoine University of Agriculture (Table 20).

Table 18: Bean varieties released in Tanzania from 1977-2014

Variety Name	Year of release	Developer	Yield MT/ha	Characteristics
Canadian wonder	1977	ARI Selian	1.1-2.4	Moderately resistant to halo blight and Bean Common Mosaic Virus (BCMV)
Kabanima	1980	ARI Uyole	1.5-1.8	Resistant to anthracnose and rust
Uyole 84	1984	ARI Uyole	1.5-4.0	Resistant to anthracnose and halo blight
Uyole 90	1990	ARI Uyole	1.5-2.0	Tolerant to halo blight and angular leaf spot (ALS)
Uyole 94	1994	ARI Uyole	1.0-1.8	Resistant to *ascochyta* and rust, tolerant to BCMV and ALS
Uyole 96	1996	ARI Uyole	1.0-1.8	Tolerant to rust, ascochyta and BCMV
Uyole 98	1998	ARI Uyole	1.2-2.0	Resistant to anthracnose, ALS and rust. Tolerant to halo blight and *ascochyta*
Ilomba	1990	ARI Uyole	1.5-2.5	Resistant to anthracnose, halo blight and rust, Tolerant to *ascochyta*
Lyamungu 85	1985	ARI Lyamungu	1.2-1.5	Resistant to anthracnose, ALS, BCMV and intermediate to common bacteria blight.
Lyamungu 90	1990	ARI Lyamungu	1.2-1.6	Low tannin content Resistant to leaf rust and anthracnose
Selian 94	1994	ARI Selian	2.5-3.5	Moderately susceptible to anthracnose and ALS
JESCA	1997	ARI Selian	2.0-3.4	Resistant to anthracnose, BCMV and halo blight, moderately resistant to bean rust, ALS, common bacterial blight
Selian 97	1997	ARI Selian	2.0-2.8	Resistant to anthracnose, BCMV and halo blight, moderately resistant to bean rust, ALS, common bacterial blight
Rojo	1997	SUA	2.2	Resistant to BCMV, moderately resistant to common bacterial blight and nematodes, Fast cooking
Wanja	2002	ARI Uyole	1.5	Early maturity and drought tolerant. Large khaki seeds with black halo around the hilum
BILFA 16	2004	ARI Uyole	1.5-2.5	Tolerant to Halo blight, Drought resistant Resistant to Anthracnose and bean rust
Uyole 04	2004	ARI Uyole	2.0 – 2.5	Resistant to bean rust, Anthracnose and Tolerant to Halo blight and drought
Pesa	2006	SUA	0.9-1.5	Moderate resistant and ALS, Resistant to BCMV and short to modern cooking time
Mshindi	2006	SUA	0.9-1.5	Moderate resistant to Angular Leaf Spot and Resistant to BCMV Has short to modern cooking time
Selian 05	2005	ARI Selian	1.0-1.6	Resistant to bean rust, Anthracnose, BCMV and Halo blight
SELIAN 06	2007	ARI Selian	2.5-3.0	Resistant to bean rust, Anthracnose, BCMV, and blight
CHEUPE	2007	ARI Selian	2.5-3.0	Resistant to Bean rust, Anthracnose, BCMV, and blight
Njano Uyole	2008	ARI Uyole	2.5 – 3.0	Resistant to Anthracnose
Calima-Uyole	2012	ARI Uyole	2.0	Resistant to Bean rust, Anthracnose, BCMV
Rosenda	2012	ARI Uyole	2.1	Resistant to Anthracnose
Pasi	2012	ARI Uyole	2.0	Resistant to Anthracnose
Fibea	2012	ARI Uyole	2.1	Resistant to Anthracnose

Source: TOSCI (2015b), Research Team analysis (2016)

Production of EGS of beans

Table 21 shows the amount of EGS of beans produced from 2008 to 2012. It is evident that the production of EGS is extremely low.

Table 19: Quantity of EGS beans supplied from 2008 to 2012 in MT

Crop	Seed type	2007/2008	2008/2009	2009/10	2010/2011	2011/2012
Beans	Pre-basic	9.8	10.3	7.4	10.7	5.5
	Basic	2.5	2.8	12.4	43.1	0

Source: URT (2013c)

Adoption of improved varieties/quality seed

Despite the release of several new bean varieties the majority of farmers are still growing old varieties and practice recycling. This practice has led to severe yield loss due to impurities and contamination by diseases; especially bacterial and fungal diseases that are common in most of the bean growing ecologies.

As noted in earlier sections and as evidenced from our discussions with sample of farmers, the perceived seed prices to be beyond what they can afford. Farmers interviewed in Mbeya and Arusha said good quality seeds were beyond their reach due to high prices.

Programs and NGOS

CIAT/ Pan African Bean Research Alliance (PABRA)

PABRA-ECABREN in cooperation with CIAT's bean programme has has carried out extensive work with the common bean. Pest and disease resistant germplasm has been developed, as well as varieties with improved nutritional values and tolerant to abiotic stresses.

McKnight Foundations

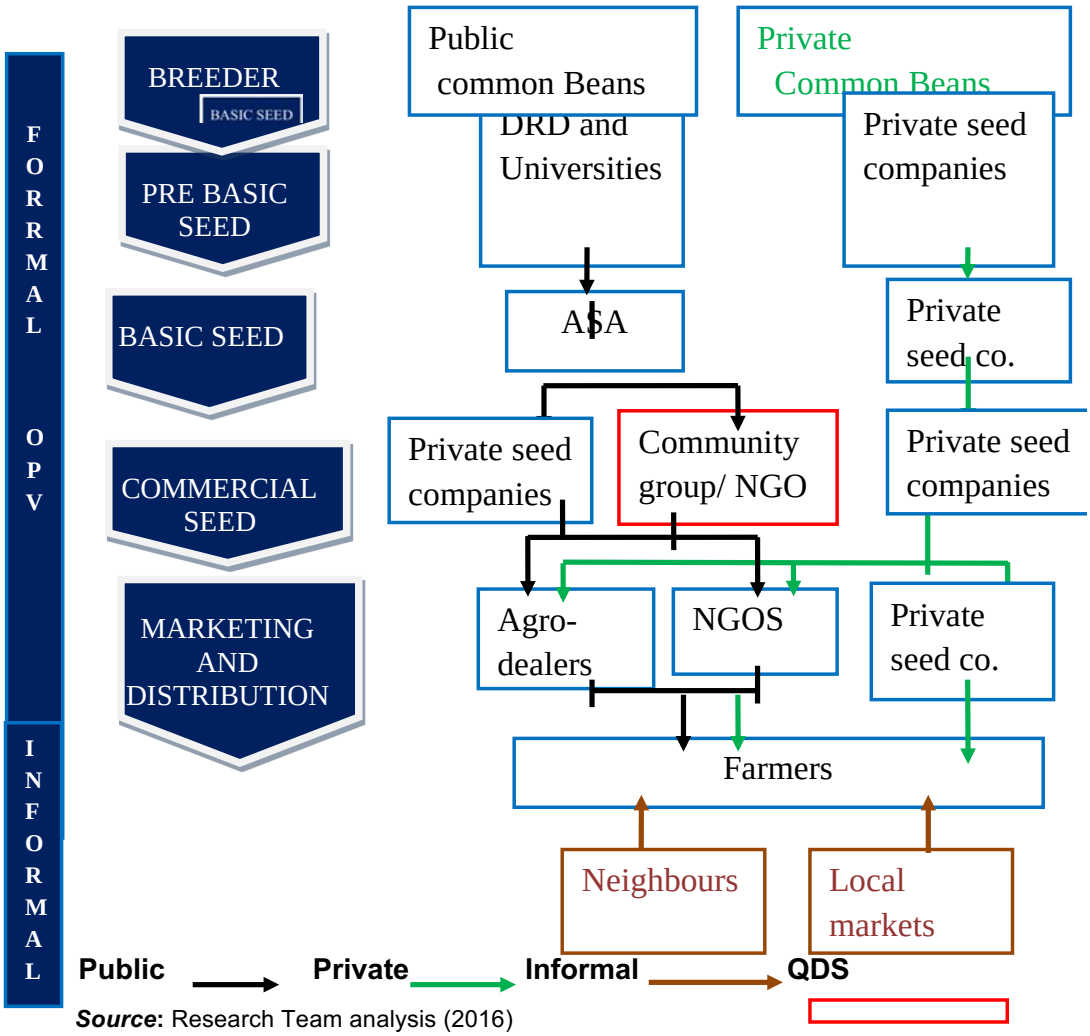
The McKnight Foundation Collaborative Crop Research Program (CCRP) is a competitive grants program that seeks to increase food security for resource-poor people in developing countries. The CCRP supports a variety of approaches such as crop physiology and breeding, seed systems, analysis and utilization of crop biodiversity, integrated pest management and commercialization. Under the CCRP in Southern Africa, a number of projects on grain legumes are carried out in Tanzania.

Tropical Legumes II (TLII) Supports crop programs to enhance legume productivity of six legumes (groundnut, common beans, cowpea, pigeonpea, chickpea and soybean) in sub-Saharan Africa and South Asia.

Structure of EGS seed value chain – beans

The structure and actors of common EGS seed value chain (Figure 33) is almost similar to OPV sorghum described in section 3.2. It is estimated that only 1%-5% of the planted area under common bean is supported by the formal seed system, while 95%-99% of the planted area is under recycled or seeds sourced by farmers from other informal sources. While there are several reasons for dominance of the informal system, the primary factor is the limited demand for quality seed.

Figure 33: Structure of Common beans seed system



***Source*: Research Team analysis (2016)**

Source: Research Team analysis (2016)

Key EGS bottlenecks and constraints

The supply of EGS for beans in Tanzania is constrained by several supply side as well as demand side factors including:

Supply bottlenecks

Inadequate private sector involvement: Private sector involvement on the production of common bean EGS is challenged by the fact that multiplication rates of this crop are low thus increasing the cost and multiplication time. Despite the high demand for seed, farmers tend to re-use seed for many years (3-7 yrs) before purchasing quality seed of improved varieties. Private seed companies are also not interested in venturing into the bean seed business because of the high cost of handling and transportation. Unlike, sorghum and rice, improved bean varieties are bigger and heavier, making it costly to transport.

Frequent changes in consumer taste and preferences: It was reported during interviews that the bean market is volatile and unpredictable due to frequent changes on consumer tastes and preferences. Demand can quickly shift by changes in the final product such as colour and cooking time. The economic viability of bean seed industry will depend on the ability to anticipate and respond to changes in consumer preference. This would need good market intelligence and accurate information on consumer trends. SUA and ARI Uyole had stock balances of breeder seeds that could not be sold due to changes in farmers' taste.

Limited infrastructure: Institutions and organisations producing EGS do not have the necessary resources to invest in production infrastructure such as irrigation, storage, transport and processing facilities and human capital.

Demand constraints

Lack of information and awareness: Farmers' awareness about newly released bean varieties depends heavily on their access to information. An important source of information in Tanzania is the extension service. Access by farmers to extension providers increases the likelihood of adopting new varieties and contributes to increased demand of improved bean seed.

Lack of access to credit: Access to credit plays an important role in farmers' decision to adopt new innovations. Credit has the potential to increase a farm household's ability to bear risk and shift from traditional low-return farming practices such as the use of local bean varieties to more rewarding technologies by planting improved bean varieties. Increased farmer's liquidity and purchasing power can therefore have a significant positive influence on the demand for improved seeds.

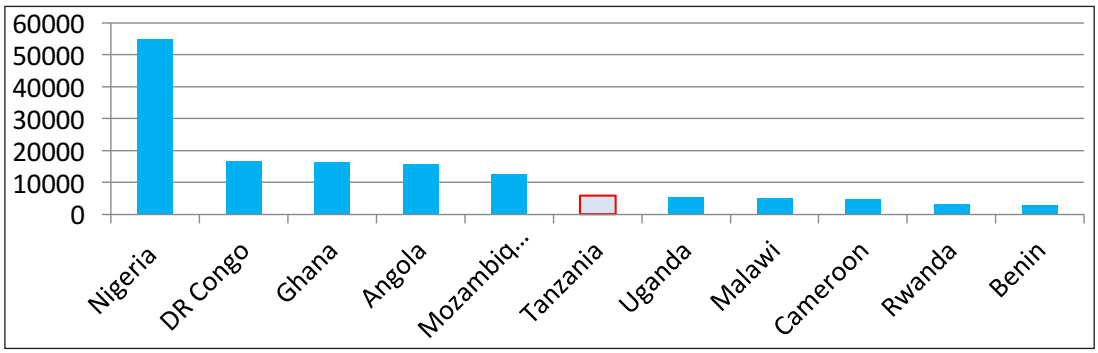
Promotion of Improved Seed varieties: This is another serious problem hindering EGS supply in Tanzania. It is not clear who is mandated to promote improved seed varieties in Tanzania, and as a result there is limited promotion of certified seeds. The majority of private seed companies in Tanzania are weak, resource constrained and do not invest in promotion/marketing of their products, thus affecting the demand.

3.4 Cassava

Supply

Cassava is the third most important source of calories in the tropics, after rice and maize. Millions of people depend on cassava in Africa, Asia and Latin America. Almost 60% of world production is concentrated in five countries Nigeria, Brazil, Thailand, Indonesia and the Democratic Republic of Congo. Tanzania is the sixth producer of cassava in Africa with annual production of about 5,000,000 tonnes (Figure 34). The leading African producers are Nigeria and the Democratic Republic of Congo (Figure 34).

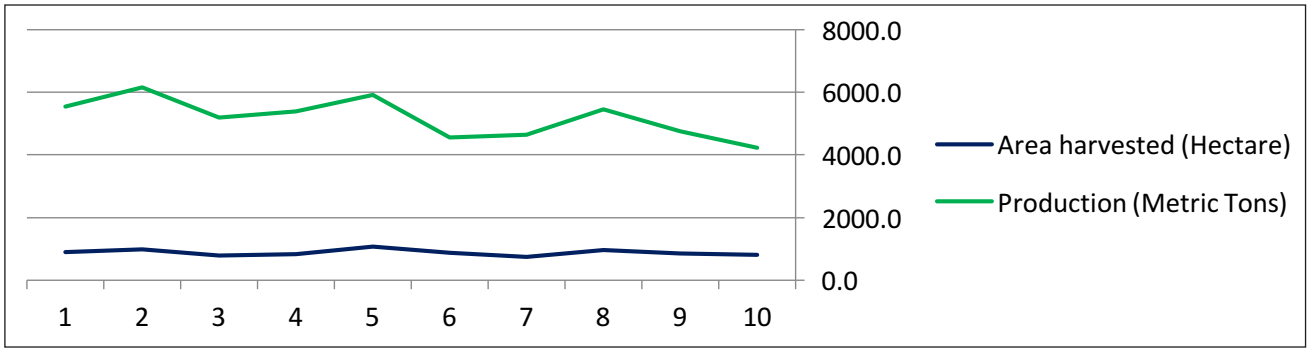
Figure 34: Africa's Cassava Production in 2014



Source: Modified from FAO (2015) by the Research Team

The broad agro-ecological adaptability of cassava and its ability to produce reasonable yields where most crops fail makes it the basis for food security at the household level and an important source of dietary energy. Despite its importance, the cassava production trends over the past 5 years (2011-2014) show a gradual downward trend. Between 2005 and 2014, the cassava area harvested decreased by 12%, from 906,387 ha in 2005 to 800,000 ha in 2014, while both production and yields, decreased by 14%, from 5,539,160 tons to 4,227,590 tons and 61,113 tons to 52,845 tons, respectively (Figure 35). The downward trend can be attributed to the rapid increase in severity of Cassava Brown Streak Disease (CBVD) and Cassava Mosaic Disease (CMD). The two viral diseases threaten cassava production not only in Tanzania but also in other cassava producing countries in sub-Saharan Africa.

Figure 35: Cassava production in 2014



Source: Modified from FAO (2015)

Cassava is grown in almost all regions of Tanzania (Table 23). The main growing areas include: the coastal strip along the Indian Ocean, around Lake Victoria, Lake Tanganyika and along the shores of Lake Nyasa. About 48.8% of total production is produced in the coastal strip along the Indian Ocean, 23.7% from around Lake Victoria, 13.7% from Lake Nyasa area and 7.9% from Lake Tanganyika area (Mkamilo and Jeremiah, 2005).

Table 20: Cassava area, production and yield by region, 2010

Region	Area 000' Ha	Production 000' MT	Yield MT/ha
Arusha	0.0	0.0	0.0
Dar es Salaam	3.9	21.8	5.7
Dodoma	14.9	51.1	3.4
Iringa	9.3	30.6	3.3
Kagera	62.3	332.3	5.3
Kigoma	50.9	368.5	7.2
Kilimanjaro	4.9	53.6	11.0
Lindi	56.6	154.6	2.7
Manyara	0.5	1.9	3.7
Mara	76.7	432.2	5.6
Mbeya	13.1	87.3	6.7
Morogoro	33.4	201.7	6.0
Mtwara	137.3	502.7	3.7
Mwanza	72.7	254.9	3.5
Pwani	49.1	505.9	10.3
Rukwa	42.0	241.0	5.7
Ruvuma	55.2	259.6	4.7
Shinyanga	84.5	551.8	6.5
Singida	10.7	40.7	3.8
Tabora	25.8	88.9	3.4
Tanga	69.4	366.5	5.3

Source: URT (2010), Agricultural statistics MALF

Demand

Cassava is utilized in a multitude of ways. The bulk of national cassava utilisation is in the form of food – fresh roots and processed products such as flour. Both cassava roots and leaves are suitable for human consumption and thus important for food security. Roots are an important source of carbohydrates while leaves provide important nutrients such as proteins and minerals. Cultivars are accordingly classified as sweet or bitter depending on their cyanide content. Bitter varieties are especially suited for industrial and feed purposes, because of their higher starch content, while sweet varieties are generally preferred if the root is to be consumed as food.

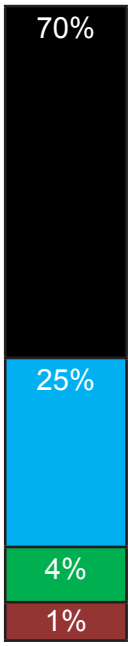
Cassava consumption and market share

Assessing the levels of utilisation and uptake by different markets in Tanzania is rather difficult because cassava roots are highly perishable and once harvested, they are utilized entirely within the crop year. However a study report by Issue pack (2013) shows that 70% of cassava is consumed at the household (HH) level as fresh roots or processed products such as chips and traditional flour. Thirty per cent (30%) of cassava is sold off the farm, with 25% destined for human consumption. Three percent (3%) is processed into cassava flour (used to make food), 1% is made into livestock feed, and 1% made into starch for industrial use in textile and other industries that use cassava starch as a raw material.

It is interesting to note that the current government has committed itself to establishing or reviving agro-industries to process local crops for value addition and increase farmer incomes. There is a lot of potential for Tanzanian cassava farmers to benefit from this initiative currently as most starch used by industries in Tanzania is imported from Asian countries such as Thailand and China.

Figure 36: Comparison of cassava demand segments

Cassava Market share by segment



Source: Issue pack (2013)

Type of market	Segment Description	Segment needs
On-farm consumption	Mainly consumed on-farm as fresh roots or processed products such as chips and traditional flour	Yield, disease and pest tolerance, taste
Local and urban market consumption	Sold off-farm to local and urban market consumers as fresh roots or processed products such as chips and traditional flour. Urban market is growing fast	Yield, starch content, taste
Processing	Processing for food products and industrial starch	Yield and starch content
Animal feed	Small but has future prospects to increased use of cassava in animal feeds	Starch content, yield

Source: Issue pack (2013)

PRODUCTION OF IMPROVED VARIETIES

Cassava research in Tanzania is headed by the DRD and takes place in various research institutions that are based in the research zones. The cassava research program is coordinated by the National Root and Tuber Crops Research Program (NRTRP). The program commenced in the early seventies and has generated a number of varieties. Currently, the program has released a total of 20 cassava varieties (Table 24).

Table 21: Cassava varieties released from 2003 to 2014

Variety	Year of release	Owner(s)/ Maintainer	Grain yield (MT/Ha)	Special attributes/ Disease reaction
Kibaha	2003	SRI Kibaha	30.0	Resistant to drought, moderate resistant to cassava mottle virus and cassava brown spot diseases
Naliendele	2003	SRI Kibaha	12.0	Ecological adaptability: Humid sub-humid (coastal areas)
Mumba	2003	SRI Kibaha	29.0	Moderate resistance to drought, cassava mottle & cassava brown spot disease, resistant to Cassava Green Mite (CGM).
Kiroba	2004	SRI Kibaha	26.0	Ecological adaptability: Humid sub-humid (coastal areas)
Hombolo 95	2004	SRI Kibaha	39.0	Resistant to Cassava Mosaic disease (CMD), Cassava Brown Streak Disease (CBSD), CGM and drought.
Rangi Mbili	2009	ARI-Ukiriguru	16-23	Resistant to CMD and CBSD
Meremeta	2009	ARI-Ukiriguru	16-23	Resistant to CMD and CBSD
Mkombozi	2009	ARI-Ukiriguru	16-23	Resistant to CMD and CBSD
Belinde	2009	ARI-Ukiriguru	16-23	Resistant to CMD and CBSD
Kasala	2009	ARI-Ukiriguru	16-23	Resistant to CMD and CBSD
Suma	2009	ARI-Ukiriguru	16-23	Resistant to CMD and CBSD
Kyaka	2009	ARI-Ukiriguru	16-23	Resistant to CMD and CBSD
Pwani	2012	ARI Naliendele	50.8	Resistant to CMD and CBSD
Mkumba	2012	ARI Naliendele	23.3	Resistant to CMD and CBSD
Makutupora	2012	ARI Naliendele	30.3	Resistant to CMD and CBSD
Dodoma	2012	ARI Naliendele	36	Resistant to CMD and CBSD
Chereko	2014	ARI-Kibaha	20.6	Resistant to CMD and CBSD
Kizimbani	2014	ARI-Kibaha	22.6	Resistant to CMD and CBSD
Mkuranga-1	2014	ARI-Kibaha	19.8	Resistant to CMD and CBSD
Kipusa	2014	ARI-Kibaha	18.6	Resistant to CMD and CBSD

Source: TOSCI, 2015b, Research Team analysis (2016)

Adoption of improved varieties/quality seed

Despite the release of several new cassava varieties, cassava landraces remain predominant in Tanzania. The majority of farmers still grow old varieties and practice recycling. It is estimated that only 2% of cassava is planted from quality planting materials (QPM) while 98% is planted with recycled or shared stem cuttings. This practice has led to severe yield decline due to spread of diseases especially CBSD and CMD that are common in most of the cassava growing ecologies. The disease pressure acts as a disincentive to investments in seed in areas of high disease pressure although on the other hand, the demand for improved seed in these areas is rapidly increasing.

Structure of EGS value chain – cassava

Cassava EGS can be produced using conventional cuttings or through tissue culture. The normal cutting system is well established in Tanzania but the possibility of employing tissue culture for production quality planting material is presently being evaluated. Certification of cassava is a challenge but Tanzania is currently developing standards and protocols for inspection and certification. Since the seed certification protocol for cassava is not ready yet, the only commercial seed material available in Tanzania is quality declared planting material (QDPM).

Variety development

Improved cassava varieties in Tanzania are produced through the NARS breeding programs in collaboration with IITA. It normally takes 8-10 years to bring a new cassava variety from research to release (Monitor Delloite Team, 2015), making it difficult to predict demand over such a long time horizon.

Breeder seed production

The NARS produces breeder seeds from approved varieties and maintains the population of the parental lines. Breeder seed can be produced using conventional cuttings or by tissue culture. Using the normal cuttings system, planting materials of new varieties are "cleaned up of diseases" through monitoring and regular roguing at reception fields within clean seed sites.

To get virus free breeder seed, the breeders send small quantities of planting material of new varieties for virus indexing to tissue culture laboratory for virus elimination and indexing before they are mass multiplied by a commercial tissue culture (TC) lab. TC materials multiplied in this way should subsequently be sent to clean seed sites where they would initially be grown under screen conditions (reception stage) before being multiplied out in the field at the holding stage.

Foundation seed production

The foundation seed can be generated through normal cuttings or through tissue culture system. Given the seriousness of CBSD and CMD both for the research system as well as for cassava growers who are interested in high quality disease-free planting material. As there are no private seed companies attracted to cassava, the breeder seed is multiplied into foundation seed by NARS with the assistance of the 5CP project. Prior to 5CP, there were no sources of "clean" cassava seed of improved cassava varieties in Tanzania. The 5CP therefore initiated the establishment of four clean seed sites (Foundation seed block) in isolated areas in Tanzania, at Maruku in Kagera Region, Hombolo in Dodoma Region, Mtopwa in Mtwara Region and Mwele in Tanga Region.

Certified seed production

Materials from all four sites are harvested and supplied to private seed companies and community/farmer groups for production of certified cassava seeds and /or of quality declared planting materials (QDPM). Since the seed certification protocol for cassava is not ready yet, the only commercial seed material available in Tanzania is QDPM. Figure 37 shows the structure of the cassava seed system in Tanzania.

Key EGS bottlenecks and constraints

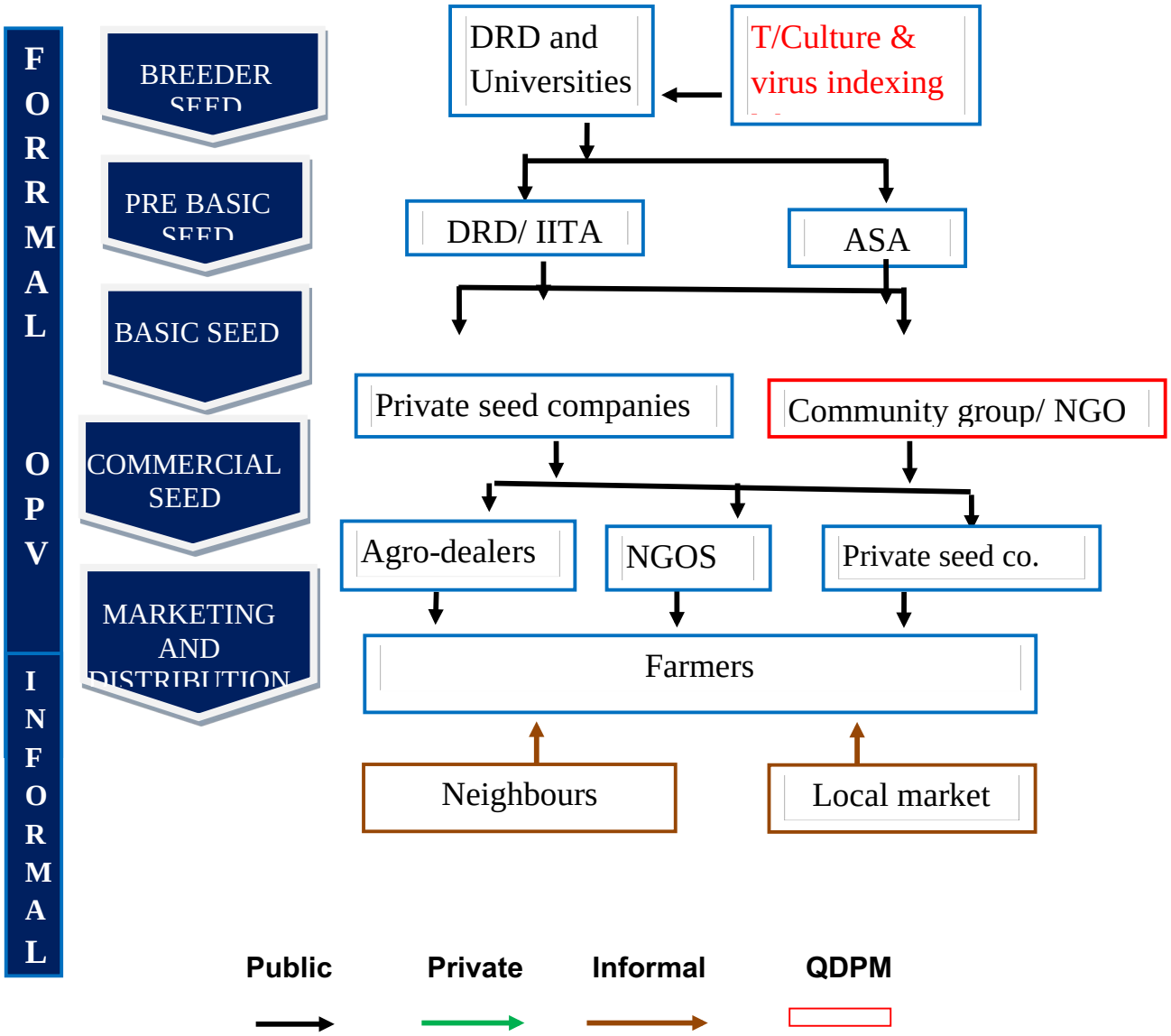
The production and distribution of EGS of cassava in Tanzania is constrained by several supply as well as demand side factors including:

Supply bottlenecks

Limited private sector involvement: Most private seed companies are not attracted to the business of multiplication, distribution and marketing of improved cassava varieties. Cassava, propagated vegetatively, has a relatively low multiplication ratio (5-7 cuttings/stem) and thus cannot compete vigorously with grain crops, which have very high multiplication ratios. Also, the one-year-long period of producing cassava planting materials has a comparative cost disadvantage over that of grain seeds, which are produced in 3-5 months. The various actors involved in the production of cassava planting materials, including the community based farmer groups, will require credit facilities to support the various activities associated with the business.

Lack of protocol for certification system: Vegetative propagated materials by their very nature are technically more difficult to certify. Inspection and certification protocols are not yet in place; they are also time-consuming and expensive to develop. However the government of Tanzania is in the final stages of developing a national certification process for cassava planting materials to improve farmer trust in quality seed of improved varieties and increase demand in the formal seed sector. The draft certification scheme was developed in partnership with several institutes including the national cassava research programme, IITA through the 5CP project, MEDA and TOSCI.

Figure 37: Structure of Cassava seed system



Source: Research Team analysis (2016)

Inadequate land for seed production: To maintain disease-free status of the planting materials, foundation seed is multiplied in isolated sites that are free from CBSV and CMV. Such areas are difficult to obtain and in most cases they very far from cassava growing areas. To meet the ever-increasing demand for EGS, breeders and seed producers need plenty of land. Furthermore, the large hectarage required to produce substantial quantities of cassava stems as well as the bulkiness of the planting materials usually requires significant funds for transportation, which often discourages private companies from investing in production, distribution and marketing of cassava stem cuttings to rural farmers.

Lack of virus indexing facility and limited tissue culture capacity: As noted in the previous sections, cassava is susceptible to many diseases and pests including the most devastating ones like CBSD and CMD. A number of institutions in Tanzania have tissue culture facilities but none have a virus indexing facility. This facility would be essential if Tanzania is to develop a formal system for production of certified disease free planting materials. Currently, the cassava plants are sent abroad for indexing which is not only expensive, but unsustainable as well. Institutions involved in the production of breeder and foundation seeds will need sufficient resources to install virus indexing facilities as well as weaning and screening nurseries for use in a commercial setup.

Demand constraints

Limited demand building and awareness activates: The current demand for improved cassava planting materials is low but there are many opportunities for building and harnessing demand that could be exploited, including demonstrations and farmer field days. MEDA's "Mihogo Mbegu Bora" program has developed and tested various demand building strategies that can be shared with other stakeholders interested in educating farmers and generating demand for certified seeds.

Distortion of markets by give-away programs: Through knowledge and information sharing over the potential of certified cassava planting materials, farmers in pilot project areas of NGO groups such as MEDA have appreciated the benefits of improved planting materials. Interested farmers are buying improved planting materials and sales have gone up significantly. However these achievements may not be sustainable because the "give–away free" programs by some NGO and local governments distort demand and introduce uncertainty in the market.

Inadequate inspection and certification facilities: As highlighted in previous sections, certification of vegetative planting materials is a challenge mainly because of the disease challenges and limited institutional capacity of TOSCI in terms of physical infrastructure and human capital. Increased demand for EGS would require more inspectors and state of the art laboratories and diagnostic capacity.

Promising model projects

5CP Cassava Project

The "New Cassava varieties and Clean seed to Combat CBSD and CMD project (5CP)" is a regional initiative being implemented in 5 African countries that have been severely affected by the two diseases. The project is funded by the Bill and Melinda Gate Foundation and led by IITA. Objective 2 of the 5CP project aims to provide a model for running a cassava seed system which assures high quality standards for planting material. The overall goal of such a system is to greatly reduce levels of cassava virus diseases and thereby increase yields and incomes of farmers. If this effort is successful, there is excellent potential for scaling out to other cassava-growing countries in sub-Saharan Africa. The project has conducted a pilot system for producing disease-free virus indexed Breeder seed materials and developed a protocol for certification of cassava planting material.

MEDA - Muhogo Mbegu Bingwa Project

With Pilot Innovation Project funding from the Bill & Melinda Gates Foundation and led by Mennonite Economic Development Associates of Canada (MEDA), the project works with the national seed certification authorities to build the capacity of seed-multiplication entrepreneurs to produce quality-assured cassava planting material.

CHAPTER 4: ECONOMIC ANALYSIS

4.1 Potential Early Generation Seed demand

The EGS marketing constraints spelt out earlier (Chapter three) are a clear testimony that the EGS marketing system in Tanzania is sub-optimal. The EGS marketing in Tanzania is constrained by both supply as well as demand side factors that are primarily aggravated by deficiencies in policies and regulations to support operations along the EGS market value chain. The EGS requirements or demands are a key variable in determining the optimal crop market archetype in Tanzania. The EGS demand projections for the five crops included in this analysis attempt to form one of the major inputs in proposing optimal crop marketing archetypes.

Consultations wizth key stakeholders in the seed industry enabled the research team to obtain some information and EGS data on the current EGS supply as well as demand constraints. The key stakeholders that participated in the interviews include ASA, TOSCI, TASTA, NARIs (breeders), individual seed companies and projects. The data collection process was challenging owing to the fact that data gaps and inconsistencies were observed throughout the interview chain especially for previous seasons' data on seed utilization, demand projections, costs, quality etc., that are recorded by government institutions as well as individual seed companies and projects for OPV maize, hybrid maize, sorghum, common beans and cassava. Data on breeder and foundation seeds produced was not readily available although some respondents provided a few. Tanzania does not have a formal system to determine more accurately the future EGS demand requirements. Currently, demand projections are based on estimations of previous sales performance, assumed growth prospects and experience and the views of a few individual private companies that have submitted some purchasing orders to ASA and NARIs. The data obtained through interviews was mainly based on the interviewees' experience and views of the system rather than on formal records. Thus, the research team also attempted to triangulate and confirm data through interviews with several individuals about a given crop and in multiple links of the value chain.

Thus in this study, potential demand for the five crops EGS was mainly based on information obtained from field interviews, and secondary data extracted from official records, i.e. official publications, and previous studies. In view of lack of accurate data from the field, the research team modelled the current supply, base case, base demand and their respective sensitivities to determine not only the magnitude of potential demand, but also the impact of key variables within the model on EGS demand. As noted, the three cases developed include:

(a) Current EGS supply: Current level of supply in market, based on current market conditions.

(b) Potential EGS demand – base case: All EGS specific recommendations are implemented, with other market impediments assumed to remain in place.

(c) 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).

The highest base and best case demand projections have been attained for maize, given the commercialized nature of certified maize seeds, level of private sector actors' engagement, local grain production and maize market growth prospects in Tanzania. The base and best case demand projections for common beans and sorghum have also been estimated over the present 5 to 6 years average informed by market growth outlook but also low existing EGS output levels and limited private sector participation. There is interest in sorghum by the breweries and this may boost demand, but overall EGS requirement is low and not very profitable for increased private sector participation. Projections for hybrid maize were the lowest over existing 3 year averages given the fact that a small proportion of maize farmers form part of the adopters.

As noted, the potential EGS demand cases are based on a 5 to 6 year timelines for implementation of the recommendations. Note that models and the analyses used in this study are meant to inform optimal crop archetypes rather than seed production plans. For maize, it was important to reflect the trade-off between acreage planted with OPVs and hybrids, the former decreasing as the latter increases. The sensitivity analysis used in the demand projection model allows for only variation of two variables namely the non-adoption rates and years of replacement. Hence, for Maize OPVs and hybrids, the case details are presented in place of the sensitivity graphs. For all the other crops, it would have been helpful to

show the effect of efficiency improvements in the EGS which should result in higher yield per unit area in the base and best case scenarios. Again the sensitivity model did not allow this and thus it must be noted that as efficiency and output improves especially at the breeder and foundation seed levels, the EGS requirements and hence area to be planted will be lower than presented.

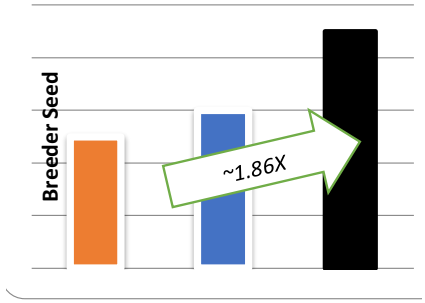
OPV MAIZE

Maize is the most commercialized improved seed in Tanzania. With the widest demand, distribution and private sector involvement, maize has the best prospects for increased adoption and growth. A distinction is made between OPV and hybrid maize to determine and understand their different current market and growth outlook.

Estimated adoption and seed replacement rates used in this model are based on the information provided to the research team by seed suppliers and research institutions during the field interviews. The current certified OPV maize output level of 16,89million MT supplies about 9% of farmers who buy new seeds every 5 years. Making provision for a reduction in % acreage cropped to OPV from 65% to 60%, assuming non-adoption rates is constant (at 0%) and replacement rates improving from 3 to 2 years led to base case demand increasing by approximately 132% (0.0062 MT). Although the best case demand (0.0086 MT) represents a 183% increase over the current supply, it is lower than the base case demand as acreage under OPV is projected to reduce by an appreciable margin under a best case scenario and will continue to do so as more OPVs are replaced by hybrids. Maize OPVs have established a foot hold on the Tanzania seed market and will be in the market for the foreseeable future. Significant revamping of the EGS system, particularly improvements in production efficiency, seed quality, promotion of the certified seeds along with expanded investments in irrigation, increased fertilizer availability and use would be required to make this a reality.

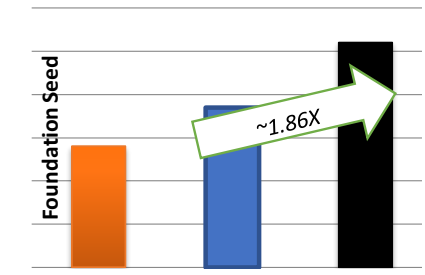
Figure 38: OPV Maize- Potential EGS demand for breeders, basic and certified seeds

Demand Estimates: 000 MT

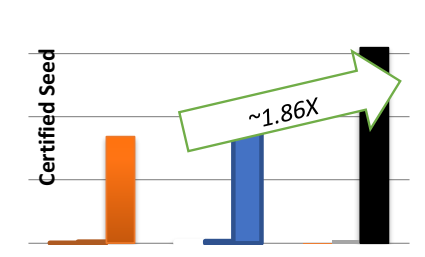


CASE DETAILS

	Current Supply	Base Case	Base Demand
(% of Area for crop sub segments)	82%	65%	60%
Estimated Seed Replacement (Years)	5	3	2
Non Adopters (%)	0	0	0
Demand (MT)	0.0047	0.0062	0.0086



	Current Supply	Base Case	Base Demand
(% of Area for crop sub segments)	82%	65%	60%
Seed Rate (Kg/Ha)	25	25	25
Estimated Seed Replacement (Years)	5	3	2
Non Adopters (%)	0	0	0
Demand (MT)	0.282	0.372	0.515

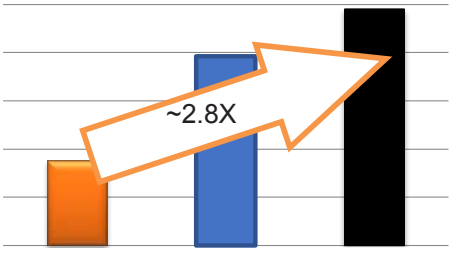


	Current Supply	Base Case	Base Demand
(% of Area for crop sub segments)	82%	65%	60%
Seed Rate (Kg/Ha	25	25	25
Estimated Seed Replacement (Years)	5	3	2
Non Adopters (%)	0	0	0
Demand (MT)	16.89	22.32	30.9

HYBRID MAIZE

Hybrid maize seeds account for just about 18% of maize area cropped. Responses from interviews indicated that most farmers using hybrid maize seeds replaced seeds every year. This is especially the case where seeds are supplied to farmers as input credit. Estimating increases in % acreage cropped from 18% to 40% to 50% results in base case and best case demands projections of 41.2 million MT (2.2 x current supply) and 51.5 million MT (2.8x current supply) respectively. Projections were informed by the growing interest in hybrids due to the superior performance of imported seeds and the moderate promotion and marketing by both the government and private companies. The maize hybrid seed market will be dominated by imports over the next several years. Local Seed companies will not only need to enhance their operational efficiency, improve quality of local hybrids and form strategic alliances to position themselves to be able to take advantage of this opportunity, but would also require policy support and regulatory reforms.

Figure 39: Hybrid maize-Potential EGS demand for breeder, basic and certified seeds

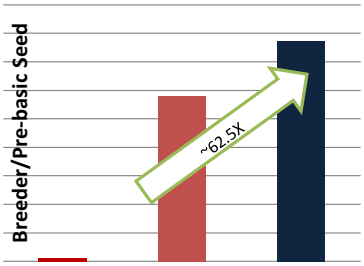
Demand Estimates: 000 MT	**CASE DETAILS**		
			
	Current Supply	Base Case	Base Demand
(% of Area for crop sub segments)	18%	40%	50%
Seed Rate (Kg/Ha)	25	25	25
Estimated Seed Replacement (Years)	1	1	1
Non Adopters (%)	0	0	0
Demand (MT)	18.54	41.2	51.5

Common beans

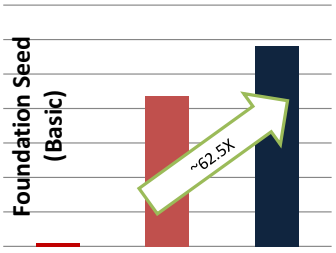
The certified seed currently produced is supplied to farmers who replace seeds every year. It is assumed that non-adoption rates will decline from 99% to 70% to 60% while replacement years will decline from 6 to 4 to 4. This produces base case and best case demands of 58.1 MT (47x current supply) and 77.4 MT (63x current supply) respectively. Estimates were informed by increasing local production which is projected to grow as the quality of local grain improves and will translate into demand for improved seeds. Currently, the demand for seeds is driven by projects and/or private seed companies. There is an urgent need to develop more direct and efficient marketing to farmers by increasing promotion and therefore awareness and availability in order to drive adoption increase. Capacity improvements in production, especially land preparation and efficient seed processing and handling are also critical.

Figure 40: Common bean - potential EGS demand

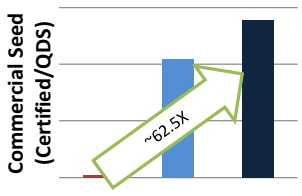
Demand Estimates ('000 MT)



Seed/Variety Replacement (Years)	Non-adoption % 60%	70%	80%	99%
1	309.62	232.22	154.81	7.74
2	154.81	116.11	77.41	3.87
3	103.21	77.41	51.60	2.58
4	77.41	58.05	38.70	1.94
5	61.92	46.44	30.96	1.55
6	51.60	38.70	25.80	1.29



Seed/Variety Replacement (Years)	Non-Adopter % 60%	70%	80%	99%
1	55,732	41,799	27,866	1,393
2	27,866	20,900	13933	697
3	18,577	13,933	9,289	464
4	13,933	10,450	6,967	348
5	11,146	8,360	5,573	279
6	9,289	6,967	4,644	232



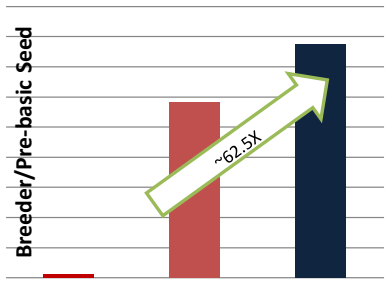
Seed/Variety Replacement (Years)	Non-Adopter % 60%	70%	80%	99%
1	4,644	3,483	2,322	116
2	2,322	1,742	1,161	58
3	1,548	1,161	774	39
4	1,161	871	581	29
5	929	697	464	23
6	774	581	387	19

Sorghum

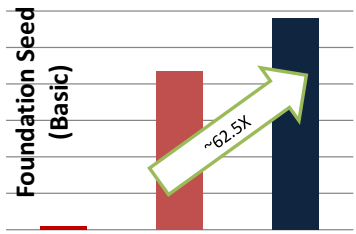
Currently, the certified seed output of 0.003 million MT supplies farmers who replace seeds every 3 to 5 years. Declining the non-adopters from 70% to 50% to 45%, and replacement years improving from 3 to 4 to 5 years result in base case and best case demand growing to 0.007MT and 0.01MT respectively, while the current supply stands at 0.003MT. Althogh critical for food security, total seed requirements for sorghum are limited due to low seeding rates and limited knowledge on the yield potential of improved varieties (lack of demonstration to farmers on the potential sorghum yield), and therefore considered unprofitable for private sector investment. Public sector support and key investment will be essential to attract private sector participation.

Figure 41 : Sorghum - potential EGS demand for breeder basic and certified seed

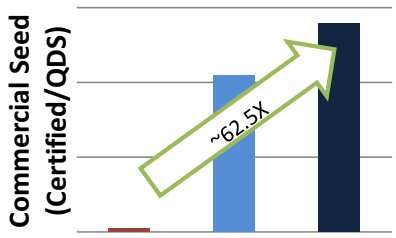
Demand Estimates ('000 MT) | **Sensitivity Analysis**



Seed/Variety Replacement (Years)	Non-Adopter %			
	45%	50%	60%	70%
1	0.0300	0.0273	0.0218	0.0164
2	0.0150	0.0137	0.0109	0.0082
3	0.0100	0.0091	0.0073	0.0055
4	0.0075	0.0068	0.0055	0.0041
5	0.0060	0.0055	0.0044	0.0033
6	0.0050	0.0046	0.0036	0.0027



Seed/Variety Replacement (Years)	Non-Adopter %			
	45%	50%	60%	70%
1	9.387	8.533	6.827	5.120
2	4.693	4.267	3.413	2.560
3	3.129	2.844	2.276	1.707
4	2.347	2.133	1.707	1.280
5	1.877	1.707	1.365	1.024
6	1.564	1.422	1.138	0.853



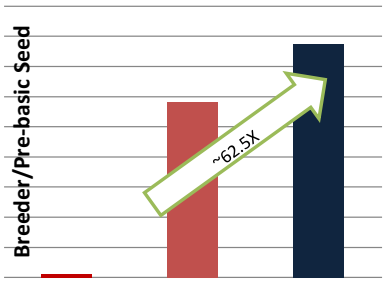
Seed/Variety Replacement (Years)	Non-Adopter %			
	45%	50%	60%	70%
1	3,520	3,200	2,560	1,920
2	1,760	1,600	1,280	960
3	1,173	1,067	853	640
4	880	800	640	480
5	704	640	512	384
6	587	533	427	320

Cassava

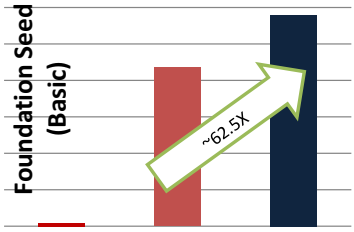
As noted earlier cassava, a vegetatively propagated crop, makes it technically more difficult to create a reliable system for large scale multiplication and distribution of quality seed (planting material). The formal system for the supply of early generation cassava seed is currently underdeveloped and does not satisfy farmer demand. The informal sector accounts for about 98% of the overall market, with most of this seed coming from traditional farms, local markets, seed from other farmers through on-farm purchase, or stem cuttings given to farmers from neighbours or relatives. Since there is no certified system for cassava, the current supply of Quality Declared Planting Material (QDPM) has been used as the basis for the current supply case. The seed replacement rate of 3 years and a decreasing non-adopter percentage (from 69% to 50% and 40%) provide a baseline for developing the base and best case scenarios. This implies a current demand of 15,035 stem cuttings, while 24,250 stem cuttings and 29.100 stem cuttings as base case and best demand case respectively.

Figure 42 : Cassava - potential EGS demand for breeder basic and certified seed

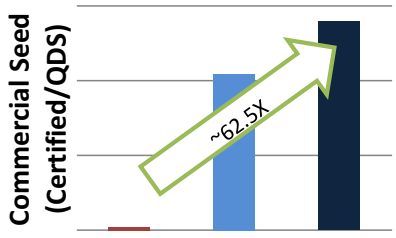
Demand Estimates ('000,000 Cuttings)	Sensitivity Analysis ('000,000 Cuttings)



Seed/Variety Replacement (Years)	Non-Adopter %			
	40%	50%	60%	69%
1	87	73	58	45
2	44	36	29	23
3	29	24	19	15
4	22	18	15	11
5	17	15	12	9
6	15	12	10	8



Seed/Variety Replacement (Years)	Non-Adopter %			
	40%	50%	60%	69%
1	0.006	0.005	0.004	0.003
2	0.003	0.003	0.002	0.002
3	0.002	0.002	0.001	0.001
4	0.002	0.001	0.001	0.001
5	0.001	0.001	0.001	0.001
6	0.001	0.001	0.001	0.001



Seed/Variety Replacement (Years)	Non-Adopter %			
	40%	50%	60%	69%
1	5,238	4,365	3,492	2,706
2	2,619	2,183	1,746	1,353
3	1,746	1,455	1,164	902
4	1,310	1,091	873	677
5	1,048	873	698	541
6	873	728	582	451

4.2 Production cost of Early Generation Seed

Introduction

Understanding the cost of EGS production is necessary as it informs the optimal market archetype for each crop. This is also a basis for up-scaling and sustainability of the seed system. The cost models for this study were developed based on best estimates of production cost provided by key stakeholders along the seed market value chain including seed companies, research institutions (NARIs), farmers and projects during field interviews. These were triangulated with the limited official and secondary data available. Significant variations in costs were observed in the data provided by various sources. It was also extremely difficult to obtain data from the multiple actors in the seed system such as information on initial investment costs, infrastructure costs, depreciation of fixed assets, varieties development costs, utility costs and other overheads.

Subsequently, the cost models developed in this study focused principally on variable costs and best estimates of fixed costs directly attributable to EGS production. EGS production cost tables below present the cost of production for all classes of seeds for five crops under consideration. It was difficult to obtain reliable data for some cost items such as cost of land, and depreciation costs. Thus, the cost models used the best estimates.

For some crops, breeder seeds production costs did not consider the full cost of germplasm evaluation, varietal development, isolation distance etc. These will have to be assessed separately if there is need or interest in evaluating whether research and development leading up to breeder seed is profitable and can be financially self-sustaining.

Cost of breeder seeds vary between $2,196/Ha for Sorghum and $8,698/Ha for cassava. The cost analysis also shows that the breeder seed cost (plus the margin) vary $0.07/kg for OPV maize to $0.15/kg for common bens; whereas the cost of foundation seeds vary between $0.06/kg for hybrid maize and $0.10/stem for cassava; and for certified seeds the price (plus margin) ranges from $0.05/kg for hybrid maize to $0.10/kg for cassava. As noted, the market determines the selling prices for breeder, foundation and certified seeds in Tanzania with moderation from the government. It must be noted that these prices are low because the cost of producing breeder and foundation seeds far exceeds most of these standard prices. Admittedly, better management and productivity enhancements as well as cost efficiency are required at the breeder and foundation seed production levels to increase EGS competiveness.

OPV maize

The production cost of OPV maize for all classes of seeds (breeder, foundation and certified) is mid-range among the crops under study. A bigger proportion of total cost is contributed by variable cost which takes approximately 70% of the total cost at breeder seed level, 60% at foundation seed level, and about 50% at certified seed level (Table 25).

Table 22: OPV Maize - EGS cost of production

	Breeder Seed	Assumptions	Basic Seed	Assumptions	Certified Seed	Assumptions
Demand MT	4.7		282		16,892	
Variable Cost $/Ha	$2,148	*Ploughing & Harrowing; Weeding; Winnowing; and inputs are ~36% of variable cost. Planting and security ~34% of variable cost.*	$964	*Inputs and planting seeds costs are ~47% and 12% of total variable cost respectively.*	$923	*Inputs only represents 49% of total variable cost*
Fixed Cost $/Ha	$967	*Salaries $568*	$955	*Salaries $409*	$655	*Salaries $245*
Total Costs/Ha	$3,115		$1,918		$1,577	
Margin	$311.5	*10% Base assumption*	$192	*10% Base assumption*	$158	*10% Base assumption*
Cost + Margin $/Ha	$3,427		$2,110		$1,735	
Cost + Margin $/Kg	$0.1	*3,500 Kg/Ha Yield*	$0.08	*2,500 Kg/Ha Yield*	$0.07	*2,500 Kg/Ha Yield*

Source: Research Team analysis (2016)

Hybrid maize

The cost of producing hybrid EGS tends to decline from breeder seed stage to foundation seed stage (58% of total cost of producing breeder seeds) and finally to certified seed stage (68% of the total cost of producing foundation seeds). While the share of variable cost to total cost is 51%, fixed cost takes 49% of the total cost. Note that, the cost for OPV maize is 75% of that of hybrid seeds (Table 26). This is largely because hybrid seeds require intensive management, with a high level of expertise to minimize risks of contamination and diseases as well as to maximize yield.

Table 23: Hybrid Maize - EGS cost of production

	Breeder Seed	Assumptions	Basic seed	Assumptions	Certified Seed	Assumptions
Demand MT					18,540	
Variable Cost $/Ha	$2,126	*Ploughing and Harrowing, Fertilizer application, Winnowing, Sorting and inspection are ~37% of total variable costs. Planting, Security and inputs are ~46% of total variable costs*	$1,006	*Planting seed and inputs are 14% and 45% of total variable costs respectively*	$955	*Planting seed is ~10% and inputs is 47% of total variable costs*
Fixed Cost $/Ha	$2,004	*Salaries $1,136*	$1,409	*Salaries $682*	$682	*Salaries $409*
Total Costs/Ha	$4,129		$2,415		$1,637	
Margin	$413	*10% Base assumption*	$242	*10% Base assumption*	$164	*10% Base assumption*
Cost + Margin $/Ha	$4,542		$2,657		$1,800	

Source: Research Team analysis (2016)

Common beans

The production cost is slightly higher than OPV maize because common beans demand higher production costs such as labor for wedding and harvesting and pest control (Table 27). A key opportunity to lower costs and improve profitability is through increasing yields, which would lower the unit cost.

Table 24: Common Beans - early generation seed cost of production

	Breeder Seed	Assumptions	Basic seed	Assumptions	Certified Seed	Assumptions
Demand MT	1.2		19		223	
Variable Cost $/Ha	$2,030	*Seed cost and fertilizer applications are both approximately 13% of total variable costs*	$891	*Breeder seed represents approximately 9% of total variable costs*	$823	*Planting/harvesting and fertilizer costs are each ~25% of total variable costs*
Fixed Cost $/Ha	$1,322	*Breeder salaries ~$909*	$1,045	*Breeder salaries ~$477*	$736	*Salaries $259*
Total Costs/Ha	$3,352		$1,936		$1,559	
Margin	$335	*10% base assumption*	$194	*10% base assumption*	$156	*10% base assumption*
Cost + Margin $/Ha	$3,687		$2,130		$1,715	
Cost + Margin $/Kg	$0.15	*1,500 Kg/Ha yield*	$0.09	*1,500 Kg/Ha yield*	$0.09	*1,500 Kg/Ha yield*

Source: Research Team analysis (2016)

Sorghum

At a total cost of $2,196 (breeder seed), $1531 (foundation seed), and $1142 (certified seed) per Ha, production cost for sorghum is the lowest amongst cereals for the selected commodities arising out of the low cost of disease management, seed cleaning/conditioning and low yields (Table 28).

Table 25: OPV Sorghum - EGS cost of production

	Breeder Seed	Assumptions	Basic Seed	Assumptions	Certified Seed	Assumptions
Demand MT	0.003		1		378	
Variable Cost $ per Ha	$1,433	*Herbicides and pesticides are ~4% of variable costs; seed costs are ~0.8% of total*	$713	*Herbicides and pesticides are ~2% of variable costs; seed costs are ~4% of total*	$696	*Inputs represent ~57% of total variable costs*
Fixed Cost $ per Ha	$763	*Breeder salaries $382*	$818	*Breeder salaries $341*	$445	*Salary allocation $205*
Total Costs/Ha	$2,196		$1,531		$1,142	
Margin	$220	*10% base assumption*	$153	*10% base assumption*	$114	*10% base assumption*
Cost + Margin $/Ha	$2,415		$1,684		$1,256	
Cost + Margin $/Kg	$0.08	*2,500 Kg/Ha yield*	$0.07	*3,000 Kg/Ha yield*	$0.05	*3,500 Kg/Ha yield*

Source: Research Team analysis (2016)

Cassava

At a total cost of $8,698 (breeder seed), $7,619 (foundation seed), and $7,619 (certified seed) per Ha production cost for cassava (Table 29) is the highest amongst crops for the selected commodities arising from the high cost of disease management, labour requirement, and transportation due to bulkiness and perishable characteristics.

Table 26: Cassava (Normal cuttings) - early generation seed cost of production

	Breeder Seed	Assumptions	Basic Seed	Assumptions	Certified Seed	Assumptions
Demand (Stem)	3,007,000		18,042,000		180,420,000	
Variable Cost $/ Ha	$5,780	*1st, 2nd and 3rdRatoon are ~22% each, of total variable costs. Other costs and inputs are ~5% of total variable costs*	$5,719	*1st, 2nd and 3rdRatoon are ~22% each, of total variable costs.*	$5,719	*1st, 2nd and 3rdRatoon are ~22% each, of total variable costs.*
Fixed Cost $/Ha	$2,918	*Salaries $1,136*	$1,900	*Salaries $1,136*	$1,900	*Salaries $1,136*
Total Costs/ Ha	$8,698		$7,619		$7,619	
Margin	$870	*10% Base assumption*	$762	*10% Base assumption*	$762	*10% Base assumption*
Cost + Margin $/Ha	$9,568		$8,381		$8,381	
Cost + Margin $/Kg	$0.12	*82,500 stem cutting/Ha yield*	$0.10	*82,500 stem cutting/Ha yield*	$0.10	*82,500 stem cutting/Ha yield*

Source: Research Team analysis (2016)

4.3 Eary Generation Seed matched with revenue/cost

It is evident that all the five crops (except cassava) are profitable at the breeder, foundation and certified seed development levels when revenues are matched with costs. Hybrid maize is the most profitable at all three stages, while common bean is the least profitable crop at all the three stages; namely breeder, foundation and certified development levels. Overall, hybrid maize is followed by OPV maize and sorghum except for breeder seed level where sorghum ranks second. These trends are also reflective of the high public sector influence in EGS production systems and the fact that gradually their operations are guided by profit motives.

There is still a significant untapped yield potential. Productivity improvements to enhance yields and outputs and better cost efficiency will greatly improve outcomes. Opportunity exists for the private sector to invest in foundation production for all the five crops to the required margins and volumes. With better cost management, and given the turnover volume, beans, sorghum as well as cassava also stand to make a significant impact. Additionally, technical requirements, expertise and management are much higher at both the foundation as well as certified levels and thus it will be advisable for a few qualified companies to take up the opportunity.

Despite its potential as a food, feed and industrial crop, cassava does not seem to be profitable largely because of low price of the stem cuttings and high handling costs as cassava stem cuttings are heavy and voluminous. As noted in the previous sections cassava is the least attractive crop in terms of private sector involvement and will therefore require a greater level of public support and aggressive promotion given its importance to food and nutritional security.

Table 27: Early generation seed Matched with revenue/cost

			Breeder/Pre-basic seed				
Crop	Price/ Output/kg	Cost + Margin/kg	Yield (Kg/ha)	Demand (MT)	Total revenue (ha)	Total cost	Contribution (Ha)
Maize Hybrid	$5.60	$0.10	2500	3.1	14000	$4,129	9871
Maize OPV	$3.60	$0.07	1500	4.7	5400	$1,577	3823
Beans	$1.80	$0.15	1500	1.2	2700	$1,559	1141
Sorghum	$2.80	$0.08	2500	0.003	7000	$2,196	4804
Cassava Stems	$0.13	$0.12	40,000	3,007	5200	$8,698	-3498
Cassava T/culture*1	$0.13	$0.25	NA		NA	NA	
			Basic seed				
Crop	Price/ Output/kg	Cost + Margin/kg	Yield (Kg/ha)	Demand (MT)	Total revenue (ha)	Total cost	Contribution (Ha)
Maize Hybrid	$5.50	$0.06	2500	340	13750	$2,415	11335
Maize OPV	$3.60	$0.08	1500	282	5400	$1,918	3482
Beans	$1.80	$0.09	1500	19	2700	$1,936	764
Sorghum	$1.50	$0.07	3000	1	4500	$1,531	2969
Cassava Stems	$0.11	$0.10	40,000	18,042	4400	$7,619	-3219
Cassava T/culture*1	NA	NA		NA	NA		NA
			Commercial seed				
Crop	Price/ Output/kg	Cost + Margin/kg	Yield (Kg/ha)	Demand (MT)	Total revenue (ha)	Total cost	Contribution (Ha)
Maize Hybrid	$3.50	$0.05	4000	18,540	14000	$1,637	12363
Maize OPV	$1.60	$0.07	3500	16,892	5600	$1,396	4204
Beans	$0.90	$0.08	3000	223	2700	$1,377	1323
Sorghum	$0.80	$0.05	3500	378	2800	$1,142	1658
Cassava Stems	$0.09	$0.10	45000	180,420	4050	$7,619	-3569
Cassava T/culture*1	NA	NA		NA	NA		NA

Note: T/culture*1: Only breeder seed costs could be computed as the tissue culture system is still been developed by NARS in collaboration with 5CP project

Source: Research Team analysis, 2016

Table 28: Summary of OPV Maize assessment

OPV Maize	Assessment	Comments
Marginal economic value of improved varieties		
Differential performance of improved varieties	Low/Med	The current crop yield using improved varieties is about 3X and 2X times that of traditional OPVs and the national average respectively; but yield potential of improved varieties has not been adequately demonstrated
Frequency of seed replacement	Low	Farmers plant saved seed for 3 or more years without experiencing significant yield decrease, thus creating decreased market pull
Differentiating characteristics	Low	There are a few differentiated characteristics like processing traits. However, final output market prices do not reflect differentiating characteristics
Fragility of seed	Med.	Hardy, not bulky, stable with low perishability but requires good storage facility to maintain quality
Cost of quality seed production	Med.	Moderate requirements of technical and regulatory capacities, but the outbreak of MLND will challenge the national seed certification and quality control capacities and capabilities.
Overall value of improved varieties	**Med.**	**Marginal Economic Value of improved varieties is relatively low but can be improved with product promotion of the varieties**
Market demand for quality seed of improved varieties		
Total demand for seed	Med/high	Demand for OPVs in lowland and marginal areas is high but low in the highland and fertile zones. Tanzania has the second largest area planted with maize in Africa.
Requirement for quality assurance	High	OPV maize is stable and attributes are easily maintained. However, the prevalence of counterfeit or fake seeds, contamination and lack of seed purity and quality is one of the serious challenges affecting quality of seeds in Tanzania
Farmer demand for specific varieties	Med	Generally limited but in some areas of Tanzania farmers demand specific varieties such as TMV1 and Situka for poundability and yield advantage traits
Market demand for specific varieties	Low/med	No clear specific variety demand because promotion and industrial processing is limited
Overall demand for quality seed	**Med/high**	**The current demand for improved OPV maize is low duet to many prevailing obstacles including limited promotion and absence of demand projections by suppliers**

Table 29: Summary of Hybrid Maize assessment

Hybrid Maize	Assessment	Comments
Marginal economic value of improved varieties		
Differential performance of improved varieties	High	Hybrids offer large yield advantage over improved or local OPVs
Frequency of seed replacement	High	Purchase every year to maintain desirable characteristics and hybrid vigour
Differentiating characteristics	High	Quality Hybrid seeds is highly valued and farmers are prepared to pay premium price
Fragility of seed	Low	Hybrid Maize is hardy, not bulky, stable with low perishability but requires good storage facility to maintain quality
Cost of quality seed production	High	Hybrid seeds require intensive management, a high level of expertise to maintain seed quality. Furthermore, the outbreak of MLND in the north of Tanzania will increase the demands for robust seed certification and quality control systems
Overall value of improved varieties	**High**	**The Marginal Economic Value (MEV) is very high. Exceeded only by some high value crops like vegetables**
Market demand for quality seed of improved varieties		
Total demand for seed	High	Very high especially in highland and fertile soils. Demand in the marginal areas also increasing because of availability of varieties adaptable to stressed environments. Maize accounts for 31% of the total food production and constitutes more than 75% of the cereal consumption in Tanzania.
Requirement for quality assurance	High	High quality standards are required to protect the market. Tanzania has serious problems with counterfeiting and seed quality. Therefore, there is a great need for quality assurance, enforcement of regulations and capacity improvement of TOSCI
Farmer demand for specific varieties	High	High specialized demand for varieties carrying specific characteristics such as storability and poundability
Market demand for specific varieties	Low/med	No clear specific variety demand because promotion and industrial processing is limited
Overall demand for quality seed	**High**	**Demand is high and will continue to grow as hybrids adaptable to marginal ecologies become available. Innovations in improved traits are valued by the market.**

Table 30: Summary of Common Beans assessment

Common Beans	Assessment	Comments
Marginal economic value of improved varieties		
Differential performance of improved varieties	Medium	Performance difference is about four times yet adoption rate of improved variety is still low largely due the absence of promotion and lack of awareness
Frequency of seed replacement	Low	Farmers plant saved seed for 6+ years to reduce cost of production as the yield can remain stable if there are no disease problems
Differentiating characteristics	Low/Med	There are different characteristics in terms of color, taste, size, cooking quality etc. However, only a few varieties fetch premium prices
Fragility of seed	Low	Seed durability is not a serious problem because the seed is fairly easy to maintain
Cost of quality seed production	High	Multiplication rates and yields are low. May require intensive management in areas where disease is a problem
Overall value of improved varieties	**Low-Med.**	**The Marginal Economic Value (MEV) is significantly low-medium particularly when the potential return on investment is low and premium pricing minimal**
Market demand for quality seed of improved varieties		
Total demand for seed	Medium	Demand for common beans EGS is average but has the potential to increase due to high demand of beans as a cheap source of protein. The area occupied by common bean is second to maize, accounting for nearly 11% of the total cultivated land.
Requirement for quality assurance	Med	Hardy seed and requirements for ensuring quality are average
Farmer demand for specific varieties	Med	Farmer demands used to be low but of recent farmers are looking for varieties with good colour and fast cooking
Market demand for specific varieties	Low	No clear specific variety demand because promotion and industrial processing is limited
Overall demand for quality seed	**Medium**	**It is a crop with good potential but the demand may remain low unless strategies are put in place to demonstrate the benefits of improved seeds**

Table 31: Summary of Sorghum assessment*1

Sorghum	Assessment	Comments
Marginal economic value of improved varieties		
Differential performance of improved varieties	Low	Most improved OPVs outperform the local varieties but adoption rates are low because farmers can still get reasonable yields from recycled seeds or local OPVs
Frequency of seed replacement	Low	Farmers plant saved seed for 5+ years to reduce cost of production, but also due to lack of promotion
Differentiating characteristics	Med	There are a few differentiating characteristics like colour. Lake zone prefer brown while the rest of the country prefer white but this difference does not reflect any significant difference in final producer pricing.
Fragility of seed	Low	Seed durability is not a serious problem because the seed is not bulky and fairly easy to maintain and transport
Cost of quality seed production*1	Med/**High**	Moderate requirements of expertise and crop husbandry. However sorghum required for brewing will have high cost because of the need to maintain the characteristics required by beer brewing companies
Overall value of improved varieties	**Low/Med**	**The Marginal Economic Value (MEV) is low-medium largely for normal sorghum because the investments associated with improved seeds are not acknowledged**
	High	**The Marginal Economic Value (MEV) for sorghum required for beer brewing is very high and investments in innovations is appreciated by the industry/markets. The value however will decrease once the beer production capacity is met**
Market demand for quality seed of improved varieties		
Total demand for seed	Low	The demand for improved sorghum varieties is still low because the crop has low variety turnover rate as improved OPV can be saved and reused without significant decline in seed quality or varietal performance
Requirement for quality assurance	Med/ **High**	Sorghum is stable and attributes are easily maintained. However, seed quality demand investment in quality assurance particularly the varieties needed for beer brewing.
Farmer demand for specific varieties	Low	Farmers have preferential interests for particular traits like color and taste but this difference does not reflect any significant difference in final producer pricing
Market demand for specific varieties	Low/ **High**	Market demand for specific variety is low but in future, varieties with brewing requirements will have high demand and command premium prices
Overall demand for quality seed	**Low**	**Low demands due to low market pull. It is grown in marginal areas like Dodoma and Singida where famers are resource constrained and prefer the traditional land races.**
	Med/High	**Sorghum required for brewing has High demand for quality and innovation efforts are valued by the market. However once beer production is at full capacity there is no additional demand**

Table 32: Summary of cassava assessment[*2]

Cassava	Assessment	Comments
Marginal economic value of improved varieties		
Differential performance of improved varieties	Medium	Improved varieties like Kiroba have higher yield advantage and improved varietal performance in terms of disease resistance than the local landraces
Frequency of seed replacement	Low/**High**	Farmers plant seed from their farms for 4+ consecutive years before replacement but in high disease pressure areas such as lake zone, farmers will go for frequent replacements
Differentiating characteristics	Low	There are different characteristics in terms of taste, size, cooking quality etc. However, the different characteristics do not reflect any significant difference in final producer pricing
Fragility of seed	Med/**High**	Cassava seeds (stems and cuttings) are bulky perishable and hence expensive to produce at scale. Fragility levels will be even higher if the seed system will involve tissue culture
Cost of quality seed production[*2]	Low	The costs are relatively low for producing planting material using normal cuttings for CMB and CBCD-free areas
	High	Quality maintenance costs will be very high where virus-free tissue culture (TC) planting materials are required. Quality assurance requires heavy investment in tissue culture, virus cleaning and indexing facilities. Additional costs will also be required to establish foundation seed multiplication blocks in isolated areas free of disease.
Overall value of improved varieties[*2]	**Low/Medium**	**The Marginal Economic Value (MEV) is low in disease-free areas where normal cuttings are used as farmers can reuse seed for many years before repurchasing quality seed thus reducing the incentive to produce quality seeds**
	High	**The Marginal Economic Value (MEV) is med/high in areas affected by disease (where CBCD and CMD virus-free TC plants are used) as returns to investment in cassava seed is high and farmers can afford to pay premium prices**
Market demand for quality seed of improved varieties[*2]		
Total demand for seed	Low/**High**	Demand for planting materials is low in disease free areas. In disease prone areas demand will be high but for a limited period of time. Once the disease subsides the demand will decrease or disappear
Requirement for quality assurance	Low/**High**	Investments in quality assurance for areas with high disease pressure is high while low disease areas will require low investment
Farmer demand for specific varieties	Med/ **High**	Generally limited, but in some conditions farmers demand varieties with specific traits such as taste, and disease tolerance
Market demand for specific varieties	Low/ **High**	Generally no clear specific variety demand because promotion is limited, but in case of disease, demand is high and may attract premium price
Overall demand for quality seed[*2]	**Low/med.**	**Cassava is planted widely, but in disease free areas where normal cuttings are used demand will remain low unless the potential of varieties is adequately demonstrated and promoted. However, there is a high potential demand for cassava in the future if the end use for starch, animal feed and food processing can be promoted**
	High	**There is a high demand of virus indexed TC planting materials of cassava. However the demand would be either temporary or permanent, depending on area and/or disease prevalence because the demand can drop significantly or disappear as the disease levels drop**

Note

Sorghum assessment[*1]: sorghum assessment based on the fact that improved sorghum material can also have a niche market demand. Varieties required for this market have high marginal economic value and high demand for maintaining quality.

Cassava assessment[*2]: Cassava assessment is based on the fact that improved planting material of cassava can be produced using two different systems- normal cutting and tissue culture. Normal cuttings is used to produce planting materials where there is no disease while Tissue culture plants will be used in areas with high disease pressure to produce disease/virus free planting materials.

Chapter 5: Early Generation Seed operation strategies

5.1 Optimal market archetype

Hybrid maize, beans, cassava, sorghum and OPV maize have been classified into specific market archetypes based on the respective marginal economic value of quality of improved varieties and the level of demand of crops grown with quality seed of improved varieties. Table 33 summarises this study assessment across a range of factors.

Table 33: Summary of Crop Assessments

Assessment Summary	OPV Maize	Hybrid maize	Beans	Sorghum		Cassava	
				Normal	With brewing qualities	Normal cuttings	Tissue culture
Marginal economic value of improved varieties							
Differential performance of improved varieties	Low/ Med	High	Med	Low	High	Med	Med
Frequency of seed replacement	Low	High	Low	Low	High	Low/Med	Low/Med
Differentiating characteristics	Low	High	Low/ Med	Med	High	Low	Low
Fragility of seed	Med	Low	Low	Low	Low	Med	High
Cost of quality seed production	Med	High	High	Med	High	Med	High
Overall value of improved varieties	**Med**	**High**	**Low/ Med**	**Low/Med**	**High**	**Low**	**Med/High**
Market demand for quality seed of improved varieties							
Total demand for seed	Med./ High	High	Med	Low	High	Low	High
Requirement for quality assurance	High	High	Med	Med	High	Low	High
Farmer demand for specific varieties	Med	High	Med	Low	High	Med/High	Med/High
Market demand for specific varieties	Low/ Med	Low/Med		Low	Low/Med	Low	High
Overall demand for quality seed	**Med/ High**	**High**	**Med**	**Low**	**Med/High**	**Low/Med**	**High**

Based on the marginal economic value of quality seed of improved varieties and the level of demand for quality seed of the selected crops (Table 31-35) the EGS study team grouped the priority crops/crop groups into two archetypes – the private sector dominant and public private partnerships (PPP) in Figure 43. The details of the proposed archetype are as follows:

Private sector dominant archetype

- Hybrid maize

Private-Public Collaboration archetype

- Hybrid maize (Public and licensed)
- Tissue culture cassava
- OPV Maize

Public-Private Collaboration archetype

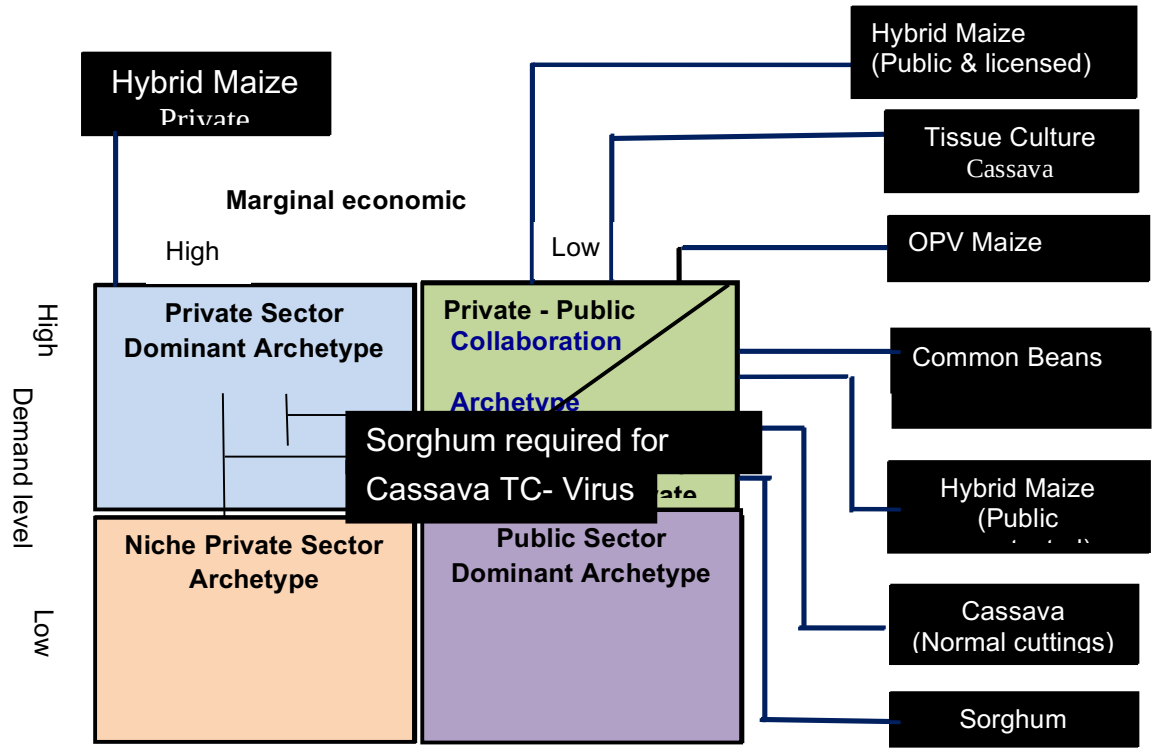
- Hybrid maize (unprotected)
- Cassava – Normal cuttings
- Sorghum

Niche archetype

- Cassava –TC virus free
- Sorghum

Figure 43: Optimal archetype classification

- **Figure 1: Optimal archetype classification**



Source: Research Team analysis (2016)

5.2 Key challenges

In order to reach the identified optimal market archetypes for each respective crop, there are crop specific and cross crop challenges to overcome, which are outlined in Table 37.

Table 34: Summary of key success factors and existing limitations

	Ideal state	Current state					
	Key factors	**Obstacles to overcome**	**Hybrid maize**	**OPV maize**	**Beans**	**Sorghum**	**Cassava**
Policy	Regionally harmonised seed policy	SADC/ EAC, Tanzania are actively involved but full implementation not yet	√	√	√	√	√
	Adequate land earmarked for seed production	Inadequate land for isolation distance	√	√			√
	Efficient and liberalised export and import policy	Unstable trade policies, export ban, disrupting market	√	√			
	Effective system for Licensing of public varieties	In place but there are operational challenges	√	√	√	√	√
	Robust mechanism for coordinating seed activities	Collaboration and institutional linkage missing	√	√	√	√	√
Regulation and quality	Laws and quality control regulations enforced	Not fully enforced - failure to regulate seed quality- fake seeds (25-30%), fines/ penalties too lenient	√	√	√	√	√
Assurance	Competent quality control and certification staff	Grossly inadequate, allow third party, require training	√	√	√	√	√
	State of the art equipment and laboratory	Existing facilities in very poor state, no molecular lab or IT	√	√	√	√	√
	Full compliance with International bodies	Speed up ISTA/OECD accreditation for facilitating trade	√		√	√	
Technical	Adequately trained extension staff	Understaffed and with limited training	√	√	√	√	√
and Mgt	Policy for maintenance breeding in place	No resources for maintaining breeding lines	√	√			
Capabilities	Seed producers have market and business skills	Capacity in market intelligence and business is lacking	√	√	√	√	√
	Competence in breeding and seed technology	C Capacity challenges - limited breeders & seed technologists	√	√			√
Demand	Robust demonstration for enhanced adoption	In place but inadequate especially for OPVs		√	√	√	√
Creation &	Mechanism for forecasting demand in place	Put a system for awareness and demand forecasting	√	√	√	√	√
Market linkages	Quality varieties meeting farmers expectations	To some extent but poor adoption for some crops		√		√	√
Incentives &	Financing support to farmers and seed companies	Limited access to finances, lending interest rate 16.3%	√	√	√	√	√
access to capital	Public institutions well financed	Limited funding to support breeders and seed technologists					

Source Research Team analysis (2016), USAID (2013)

5.4 Public Private Partnership mechanisms and solutions

Rationale

As already pointed out in the previous sections, the most significant challenges confronting EGS of beans, cassava, OPV maize and sorghums in Tanzania stems from the lack of efficient systems for EGS supply due to an under-resourced public sector (MALF/DRD) and limited interest from the private sector because of the low economic value and the farmers' current practice of saving/ recycling seed, which lowers demand and reduces profitability.

Furthermore, because the crops have low market pull, the Tanzania's priority and indeed the private sector's is production of seeds for high value crops such as hybrid maize. This trend has shifted both public and private sector focus away from food security crops such as cassava, common bean and sorghum; disproportionately affecting smallholder farmers in areas where these crops are grown.

The challenges and opportunities identified in the crops recommended for EGS-PPP are not identical, but in all cases a public-private partnership (PPP) could be established as the foundation for building efficient EGS systems. The differences in the crops warrant slightly different approaches, but the end product is the same – a high-performance EGS systems. An effective EGS-PPP would significantly reduce or even eliminate government responsibility for production of EGS for certain crops and stimulate the development of a robust private seed sector. This would allow the government to redirect resources away from EGS production and provide additional support for research and extension activities to ensure a steady supply of improved varieties and enable farmers to realize more of the potential inherent in improved varieties.

Mechanisms and solutions

Each EGS-PPP would have three key strategic objectives:

- Produce enough EGS to meet current and future demand.
- Produce seed in the most cost effective way while continuing to meet quality standards.
- Stimulate demand for improved varieties and quality seed at the farm level.

Quantity of seed: To achieve a system capable of meeting current and future needs, the EGS-PPP would have an in-house production program, coordinated by the Seed Unit of the MALF and would engage farmers, cooperatives, and local seed companies as contract producers of EGS to add capacity to the system. Using existing ARIs and ASA infrastructure would allow the EGS-PPP to focus on adding people and equipment to the program rather than using its financial resources to acquire or rent land. ASA is a trustee of 9 Government seed farms that are strategically located to serve EGS-PPP in the main agro-ecological zones.

Cost effectiveness 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 DRD, the ASAA, and public universities that 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: A major limitation of the current public and the local seed company seed systems is the lack of resources and strategies to promote and market their products. 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 substantiate the hypothesis in Tanzania especially for cassava, sorghum and 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 the use of agronomic best practices.

The EGS-PPPs should be established under a legal and administrative structure that allows it to generate and retain operating profits. The only way to ensure the EGS-PPPs 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 DRD and university breeding programs would receive royalties on sales of EGS and potentially on the sales of certified or QDS 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 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 efficient and 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 of the EGS-PPPs. The Tanzania private seed sector is rather weak. Although there are a few promising companies, the majority are not sufficiently established to be a key private partner. Government needs to be innovative in the search for private sector partners with expertise and interest in seed and seed-related products.

Public-private partnerships in OPM maize, cassava, sorghum, public hybrids and common bean Early Generation Seed

Analysis of operational strategies and future seed needs suggests that the crop that can fit in the proposed EGS-PPP framework is OPV maize, cassava, sorghum, public hybrids and common beans.

5.5 Public hybrid and OPV maize

As pointed out in section 3.1, Tanzania has the second largest area planted to maize in Africa, after Nigeria and it is well positioned to be a regional supplier of maize given the size of the country and availability of arable land. The priority objective for maize therefore, to is to expand and enhance EGS production capabilities to meet current and future demand of public hybrid maize and OPM maize through public-private collaboration.

Following market liberalisation and the new Plant Breeders' Rights Act, (PBRA) No. of 2012 that grants plant breeders' rights to crops, the maize in Tanzania can be categorized into four segments: Private Hybrids, Protected and Licensed Public Hybrids, Unprotected Public Hybrids and OPV maize. The results of the market characterisation suggests that the Private Hybrids would fit in the private sector archetype while the Protected and Licensed Public Hybrids would be better served by the private-public sector archetype and Unprotected Public Hybrids by the public-private archetype (Figure 44).

The public hybrid maize EGS-PPP seed system structure and potential stakeholders are as shown in Figure 44 and Table 38, respectively.

Figure 44: Public hybrids and OPV maize seed production activities

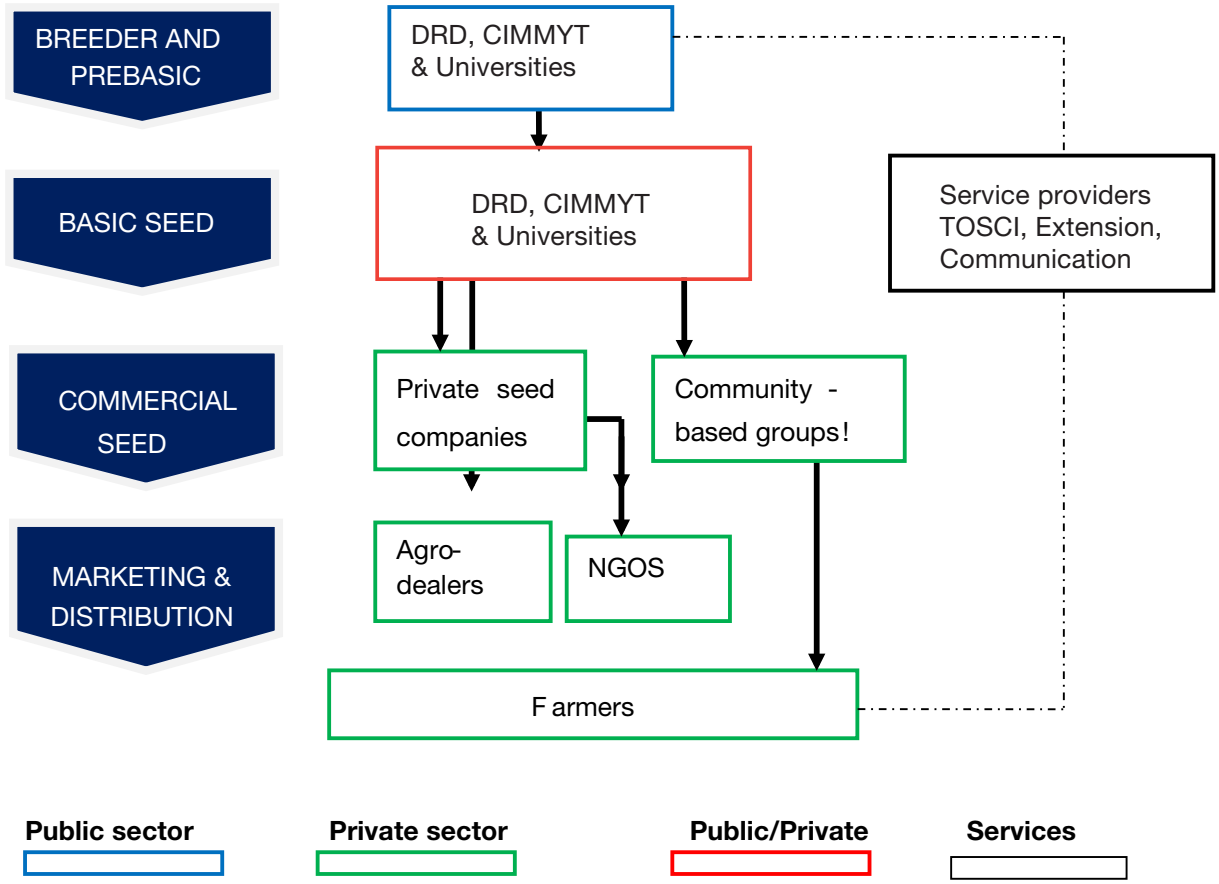


Table 35: Public maize hybrid and OPV maize EGS-PPP potential stakehoders

Category	Actor	Contribution	Benefits
Public	MALF/ ASA	Funding, policy, land, facilities	Improved varieties reaching farmers
	DRD/Universities	Varieties, EGS seeds, land, breeders	Funds for research and maintenance breeding
	TOSCI/ local GOVT	Quality assurance, extension services	Increased revenues
	CGIAR-CIMMYT	Breeding line, technical backstopping	Enhanced partnership, adoption of varieties
Private	Agro-dealers, community groups local seed companies	Seed production, deployment, marketing & distribution	Increased revenue
	NGOs –MEDA	Training, demo plots	Social benefits

5.6 common bean and OPV sorghum

Although farmers face an unmet demand for bean and sorghum seed, the low marginal economic value makes it an unattractive investment for the private sector. For both crops, farmers can re-use the seed/variety for long periods of time (5-6 years) thus reducing the incentive by private sector to invest in EGS. Based on the economic analysis, the high costs of breeding should be borne by the public sector and basic seed supply should be the responsibility of EGS-PPP. As it is not easy to reliably predict the demand and market trend of the two crops, the EPP should also be involved in the promotion and demand creation in collaboration with NGOs.

The bean and OPV sorghum EGS-PPP seed system structure and potential stakeholders are as shown in Figure 45 and Table 39, respectively.

Figure 45: Common bean and OPV sorghum EGS-PPP seed production activities

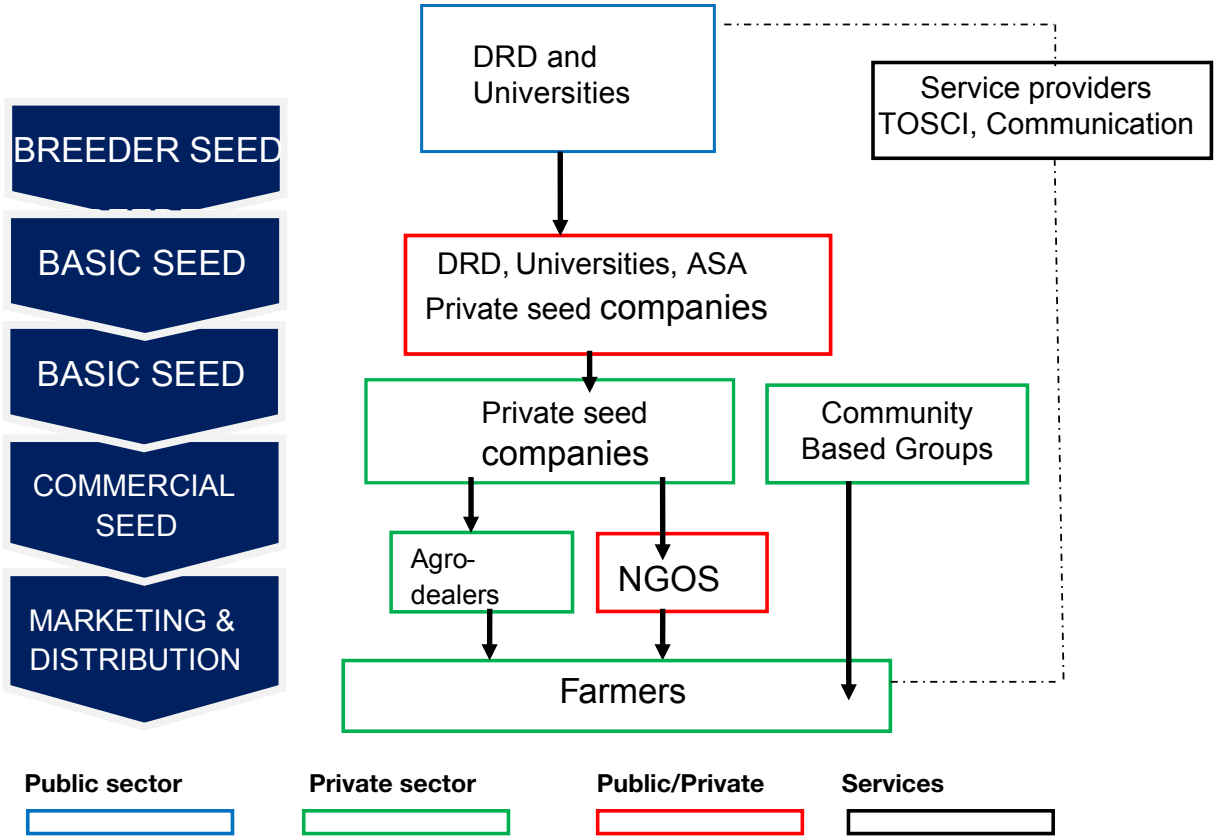


Table 36: Common bean and OPV sorghum EGS-PPP potential stakeholders

Category	Actor	Contribution	Benefits
Public	MALF/ ASA	Funding, policy, land, facilities,	Improved varieties reaching farmers
	DRD/Universities	Varieties, EGS seeds, land, breeders	Funds for research and maintenance breeding
	TOSCI/ local GOVT	Quality assurance, extension services	Increased revenues
	CGIAR-CIAT/ ICRISAT	Breeding line, technical backstopping	Enhanced partnership adoption of varieties
Private	Agro-dealers, community groups local seed companies	Seed production, deployment, marketing and distribution	Increased revenue
	NGOs	Training, demo plots	Socio benefits

Cassava quality planting materials

Cassava seed in the form of stem cuttings are in demand by farmers in all cassava growing areas. However, for the private sector, the low marginal economic value is a disincentive as is its bulkiness and the fact that unlike common beans and maize, cassava is a perishable commodity. Furthermore, farmers can re-use the seed/variety for long periods of time (5-6 years) thus reducing the incentive by private sector to invest in EGS. Based on the economic analysis, the high costs of breeding should be borne by the public sector and basic seed supply should be the responsibility of EGS-PPP. As it is not easy to reliably predict the demand and market trend of the crop, the EGS-EPP should also be involved in the promotion and demand creation in collaboration with NGOs. The cassava EGS-PPP seed system structure and potential stakeholders are as shown in Figure 46 and Table 40, respectively.

Figure 46: Cassava EGS-PPP seed production activities

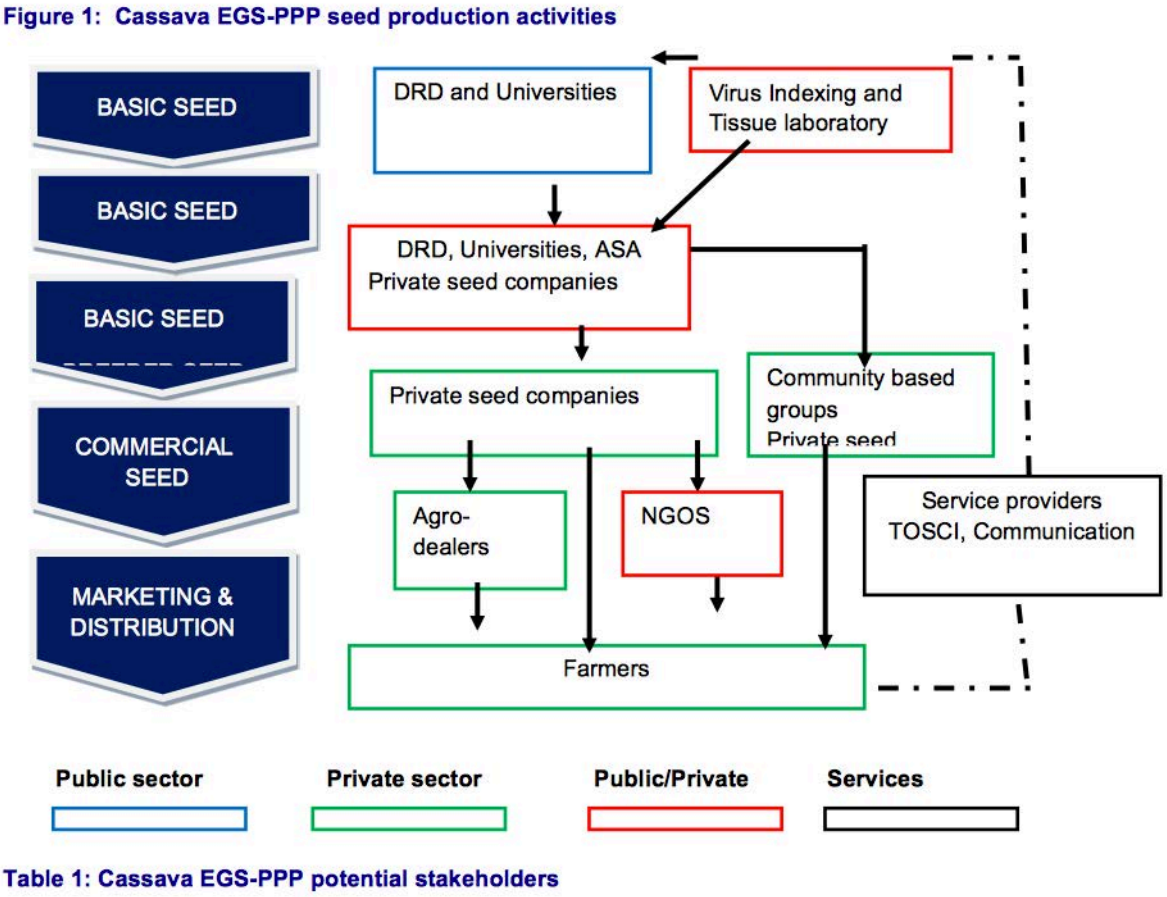


Table 37: Cassava EGS-PPP potential stakeholders

Category	Actor	Contribution	Benefits
Public	MALF/ ASA	Funding, policy, land, facilities	Improved varieties reaching farmers
	DRD/Universities	Varieties, EGS seeds, land, breeders	Funds for research and maintenance breeding
	TOSCI/ local GOVT	Quality assurance, extension services	Increased revenues
	CGIAR-IITA	Breeding line, technical backstopping	Enhanced partnership adoption of varieties
Private	CBS	Tissue culture facilities	Business, revenue
	Agro-dealers, community groups local seed companies	Seed production, deployment, marketing and distribution	Increased revenue
	NGOs	Training, demo plots	Social benefits

Recommendations

To build an innovative and successful EGS-PPP system for the priority crops the study has made the following cross-cutting and crop specific recommendations:

5.7 Cross-cutting recommendation

Establish a steering committee/ working group

A steering committee comprising of public, private and development partner representation should be established to develop an EGS plan of action and oversee production of EGS to meet the current and future demand for seeds in Tanzania. The committee will be coordinated by Seed Unit of the MALF. Proposed institutions for this committee include:

- **Public:** Seed Unit, TOSCI,DRD, ASA, PBR and Legal Unit
- **Private:** TASTA, Small Grains, Maize, Legumes, RTB, Local Seed Companies Forum

Laying the groundwork for establishing a vibrant and successful EGS production system through PPP

- Conduct stakeholders mapping to identify key EGS-PPP potential partners. Ensure the involvement of a diverse set of players including representation from legal, finance and planners disciplines, industry and regional and international organisations.
- Convene a round table discussion to conceptualise the EGS-PPP idea and agree on the mission and principles
- Identify partners' strength and weakness
- Conduct technical and financial feasibility study
- Develop implementation strategies and business road map
- Identify the shared costs/resources
- Develop benefit sharing modalities based on win-win arrangement
- Recruit and train partners
- Formalise the partnership by preparing a contractual arrangement/Memorandum of Understanding (MoU)

Strengthen the quality control and seed certification process

The supply of quality seed is critical to the seed industry. TOSCI mandated to certify and regulate quality of seeds but it has insufficient staff, equipment and technical capacity to carry out its responsibilities. Given its importance TOSCI should be provided with additional resources including funding and human capital to enable them address the critical challenges facing the industry such as inadequate inspection services, contamination and counterfeit seeds

Address the challenges of licensing varieties

The private sector participation in licensing has been rather poor as only 3 companies have applied for licences and only 4 varieties have been licensed. Stringent conditions and administrative delays in processing and issuing permits have been cited by most stakeholders as one of the shortfalls in the pursuit of licenses. There is a need to study the implementation of the circular and look for ways of addressing the challenges experienced by the seed companies.

Strengthen linkages and coordination of seed development efforts

Data and information sharing is poor and seed development initiatives are poorly coordinated. There is need to strengthen linkages and cooperation among different actors and establish a platform for data management and coordination of seed sector activities to avoid duplication of efforts and wastage of resources. The platform would also act as a data bank for up- to-date information and statistics that can be used by different seed actors for forecasting demand and making solid and informed market and policy decisions

Sign up to the international seed certification standards of ISTA and OECD

Cross border trade is limited because Tanzania is yet to sign up the international seed certification standards issued by ISTA and OECD. Capacity challenges within TOSCI made it difficult to meet regional requirements, leading to difficulties in cross-border trade. However, Tanzania has initiated

the process of adopting OECD and ISTA standards and progress made so far is encouraging and will soon receive OECD/ISTA accreditation.

5.8 Crop specific recommendation

The following recommendations are specific to the selected EGS-PPP:

5.9 Common bean and OPV sorghum

Common bean and OPV sorghum will attract the same investment strategies because they are both constrained by low margins, unattractive to private sector and have potential with the processing industries. The priority objective is to expand and enhance EGS production capabilities to meet current and future demand through public-private collaboration. This can be achieved through increasing the marginal economic value of the crops and building a robust and cost effective system that ensures sustainable demand and profitable EGS production without compromising quality. For the EPP to be attractive to the private sector, the government could in the long run consider including other leguminous crops such as pigeon peas, groundnuts and soybeans. To achieve these objectives, the following are specific recommendations:

Stimulate farmer's adoption of improved varieties and quality seed

Farmers' adoption of newly released varieties is strongly correlated to their access to information. To increase farmer and market demand the study recommends that the PPP do the following:

- Develop and execute on-farm demonstration trials to compare the performance of farmer-saved seed and quality seed. These comparative trials would serve to demonstrate not only the yield potential of the improved seeds, but also the value of improved seed which in turn would stimulate adoption from farmers.
- Provide financial and technical assistance to the extension service providers to enable them train and educate farmers on the costs and benefits of improved varieties as well as agronomic best practices.

Increase marginal economic value of common bean and OPV sorghum

- Develop and implement cost-effective strategies so as to increase the marginal value of the two crops
- Educate farmers on the socio-economic impacts of using improved varieties such as improving income levels and standard of living of households. This will help raise their consciousness and therefore overall demand
- Promote innovate traits in improved varieties such as bio fortification etc. to ensure that the traits are valued by farmers and markets

5.10 Cassava

Quality planting materials for cassava and other root and tuber crops are relatively expensive to produce and deliver because they are bulky and perishable. Production and delivery of EGS is also challenged by low marginal economic value, catastrophic diseases such as CBSD and CMD and lack of protocols for certification and quality control. The priority objective is to expand and enhance EGS production capabilities to meet current and future demand through public-private collaboration. This can be achieved through increasing the marginal economic value of cassava and build a robust and cost effective system that ensures sustainable demand and profitable EGS production without compromising quality. While the current study focused on cassava, the government could consider including other RTB crops such as sweet potato. In order to achieve these objectives, the following are specific recommendations:

Increase farmer's adoption of improved varieties and quality planting materials

Private sector attraction to invest in EGS for cassava has been very low due to supply and demand risks. To increase the market pull the PPP should focus on the following:

- Raise farmer's awareness on the use of disease-free planting materials. This will increase adoption and hence raise demand
- Conduct on-farm demonstrations/trials to demonstrate the benefits of using improved seed which in turn would stimulate adoption by farmers.
- Partner with the extension service providers to develop training programs for farmers and extension officers. This will help raise awareness and uptake of improved planting materials

Increase marginal economic value of cassava

- Develop and implement cost-effective strategies so as to increase the marginal value of cassava
- Stimulate production value added traits such as starch content, bio fortification and ensure that the innovative traits are valued and demand by both farmers and processors is increasing
- Educate farmers on benefits using quality disease-free planting materials. This will help raise the demand and marginal economic value of the crop

Facilitate establishment EGS PPP facility for production of certified cassava

- Establish facility for virus elimination and indexing
- Provide resources for establishing/upgrading tissue culture and micro-propagation facilities for rapid mass propagation of quality cassava planting material
- Facilitate development and adoption of certification protocols for cassava and other RTB crops

5.11 Public hybrid and OPV maize

Market analysis of OPV maize and maize hybrids developed from public varieties has shown that the seeds from the two maize categories are less attractive to private sector when compared to privately bred or licensed hybrids. The priority objective is to expand and enhance EGS production capabilities to meet current and future demand through public-private collaboration. This can be achieved through increasing the marginal economic value of the crops and building a robust and cost effective system that ensures sustainable demand and profitable EGS production without compromising quality. In order to achieve these objectives, the following are specific recommendations:

Increase farmer's adoption of improved varieties and quality planting materials

Private sector attraction to invest in hybrids developed from public varieties and OPVs has been low due to supply and demand risks. Unlike the private hybrids these categories of maize are not adequately promoted or marketed due to lack of resources. To increase the market pull, the PPP should focus on the following:

- Develop and implement programs that sensitize and raise farmer's awareness on the availability of improved varieties. This will increase adoption and hence raise demand
- Conduct on-farm demonstrations/ rials to demonstrate the benefits of using improved seed which in turn would stimulate adoption by farmers.

Enhance the marginal economic value of public hybrids and OPVs

- Develop and implement cost-effective strategies so as to increase the marginal economic value of the two crop groups.

Facilitate establishment of Molecular biology lab for disease diagnostics

- Facilitate establishment of molecular laboratory to detect MLND and other important diseases. This bottleneck has affected the seed production in the country as companies in Arusha and other regions in the north cannot supply EGS for fear of spreading the disease. The country is currently using the Kenya Plant Health Inspectorate Service (KEPHIS) facility in Kenya for MLND diagnostics.

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