Uganda Early Generation Seed Study:

Unlocking Pathways for Sustainable Provision of EGS for Food Crops in Uganda

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NARO

ISSD Uganda

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Abstract
One of the major bottlenecks limiting farmers' access to good quality seed for food crops in Uganda is the shortage of early generation seed (EGS - breeder and foundation) to produce sufficient quantities of certified and/or quality declared) to satisfy the needs of farmers. A national study was conducted between October 2015 to March 2016 to analyse pathways for promoting commercial and sustainable production and delivery of EGS. Five crops (hybrid maize, rice, beans, sesame and finger millet) were selected. The analysis provides real examples of potential business models that could scale in a commercially sustainable manner. For areas that are best suited to public sector investment, opportunities for public-private collaboration and increased efficiencies in the sector are outlined. Generalizable principles and recommendations to guide key stakeholders as they pursue policies, investments, and interventions are proposed.

Keywords: seed systems, Uganda, early generation seed, ISSD

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Foreword

The use of good quality seed of high yielding varieties plays the most important role to increase crop production. For optimal benefit from it, quality seed must be availed in time and planted in the right environment. Additionally, it needs to be affordable for its access by many farmers. One of the major bottlenecks limiting access to good quality seed is the limited availability of and access to Early Generation Seed (EGS) required to produce sufficient quantities of quality seed (certified or commercial) that satisfy the needs of farmers.

Uganda's seed sector development started in 1968 with a public sector seed scheme involved in breeding, seed multiplication and marketing. In the last two decades, the seed sector has been liberalized and this has encouraged establishment of seed companies that now number over 25. However, save for maize, vegetables and some cash crops, smallholder farmers still have little or no access to new high yielding varieties, particularly for open-pollinated, self-pollinated, and vegetatively propagated crops or varieties. Some varieties developed and released by the National Agricultural Research Organisation (NARO) are rarely multiplied for commercial distribution due to limited resources for facilitating the diffusion processes.

Inability to differentiate seed as a product, variety and company brand; lack of accurate seed demand determination and tools for forecasting; limited technical skills and infrastructure capital across the entire seed value chain (research, seed producers and farmers); a weak institutional and policy framework for quality control and assurance mechanisms for EGS are key challenges facing the seed subsector.

The National Agricultural Research Organisation is currently the main source of seed for new and released varieties of most food security crops in Uganda. But inadequate funding, technological, institutional, policy, legal and socio-economic constraints significantly reduce its capacity to produce and supply adequate quantities of EGS. To address some of these challenges, NARO has established a private company holding in which production of foundation seed will be one of the legal entities. Additionally, with support from the Integrated Seed Sector Development (ISSD) program in Uganda, a regional seed testing laboratory has been established at Ngetta Zonal Agricultural Research and Development Institute (Ngetta ZARDI). This report is therefore timely as it consolidates information obtained from a national study involving key stakeholders in the seed subsector on: the current seed systems and crops, the structure of EGS, national potential seed demand and seed costs as well as operational strategies to promote production of EGS sustainably. Interventions recommended will guide government and donors to design policies and support for the development of a pluralistic and vibrant seed subsector in Uganda. They will also guide NARO in deciding on appropriate models for production of EGS.

I would like to thank all those who provided information and tirelessly worked towards the preparation of this report. Special thanks go to ISSD-Uganda and the Kingdom of the Netherlands for going an extra mile in supporting the on-going efforts of developing a viable seed subsector in Uganda.

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List of acronyms & abbreviations

AGRA-PASS	Agricultural Revolution for Africa-Program for African Seed Systems
ARIs	Advanced Research Institutions
ASBP	African Seed and Biotechnology Program
ASSP	Agriculture Sector Strategic Plan
ATAAS	Agriculture Technology and Agribusiness Advisory Services
BGMF	Bill and Melinda gates Foundation
BDS	Business Delivery Services
CBO	Community Based Organisation
CDI	Centre for Development Innovations
CDO	Cotton Development Organisation
CIAT	International Centre for Tropical Agriculture
CSO	Civil Society Organisation
DAO	District Agricultural Officer
DCIC	Department of Crop Inspection and Certification
DSIP	MAAIF Development Strategy and Investment Plan
DUS	Distinct Uniformity and Stability
EAAPP	East African Agricultural Production Programme
EGS	Early Generation Seed
EKN	Embassy of the Kingdom of the Netherlands
FDI	Foreign Direct Investment
FAO	Food and Agricultural Organisation
FGs	Farmers Groups
FOs	Farmers Organisations
FS	Foundation seed
IARCs	International Agricultural Research Centres
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IPR	Intellectual Property Rights
ISSD	Integrated Seed Sector Development
JICA	Japan International Cooperation Agency

LSB	Local Seed Business
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MT	Metric Tonnes
NAADS	National Agricultural Advisory Services
NaCRRI	National Crops Resources Research Institute
NARIs	National Agriculture Research Institutes
NARO	National Agriculture Research Organization
NaSARRI	National Semi-Arid Research Instituter
NBS	National Seed Board
NSCS	National Seed Certification Services
NSS	National Seed Strategy
NVRC	National Variety Release Committee
OPV	Open Pollinated Varieties
PBA	Plant Breeders Association
PBR	Plant Breeders` Rights
PPP	Public/Private Partnership
PVP	Plant Variety Protection
PVS	Participatory Variety Selection
QDS	Quality Declared Seed
QMS	Quality Management System
SC	Seed company
SQCC	Seed Quality Control and Certification
TASAI	The African Seed Access Index
UBOS	Uganda Bureau of Statistics
UCDA	Uganda Coffee Development Authority
UNADA	Uganda Agro-inputs dealers Association
USAID	United States Agency for International Development
USTA	Uganda Seed Trade Association
USP	Uganda Seed Project
WUR	Wageningen University and Research Centre
ZARDI	Zonal Agricultural Research Institute

Terminology

Early Generation Seed: is the earliest stage of the seed value chain representing breeder and foundation seed.

Breeder or pre-basic: 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. Breeder seed is multiplied through several generations to produce enough quantities to produce the next class of seed known as foundation of foundation seed.

Foundation or basic seed: is seed that is derived from breeder or pre- basic seed and is produced under conditions that ensure maintenance of 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. Although the Plant Seed Acts uses basic seed, the term foundation seed is widely used in Uganda and throughout the document.

Certified or commercial seed: is the progeny of foundation seed and its production is handled to maintain specific genetic identity and purity according to the standards prescribed for the crop being certified. Certified seed is produced through one or two rounds of multiplication depending on the crop and which has been shown to conform to the conditions as specified in the seed and plant regulations and guidelines. The first generation of seed derived is known as: 1st generation Certified Seed, and if this is multiplied once more to produce the 2nd generation Certified seed.

Quality declared seed (QDS): is seed produced by a registered seed producer (a small scale producer or a group of smallholder farmers) from foundation seed and conforms to the minimum standards for variety purity and germination.

Self-pollinating crops: are crops in which the majority of pollination occurs within the same plant as opposed to open-pollinating varieties (OPVs). Examples of self-pollinating species are beans, rice, finger millet, and sesame. Maize falls under hybrid and OPV crop groups.

Market archetype: is a framework that describes economic characteristics of seed in the value chain.

Executive summary

This report describes outcomes of a study conducted from October 2015 to March 2016 to analyse pathways for promoting commercial and sustainable production and delivery of Early Generation Seed (EGS) of food crops in Uganda. The specific objective was to identify actionable steps to address bottlenecks in the supply of early generation seed (EGS) in the right quantity to avail affordable high quality seed of preferred varieties to smallholder farmers. Five crops (hybrid maize, rice, beans, sesame, and finger millet) were selected for this study based on strategic considerations. A number of institutional bottlenecks affecting the seed value chain of these crops, particularly in variety development, production of EGS, demand for seed and cost of seed production were identified and recommendations made to ensure sustainable production and commercialisation of seed. The integrated Seed Sector Development (ISSD) Uganda, supported by the Embassy of the Kingdom of the Netherlands (EKN) funded the study. The National Agricultural Research Organisation (NARO); Uganda Seed Trade Association (USTA) and USAID Feed the Future AgInputs activity constituted the core study team.

Findings of the study

The Uganda Seed Sector

Uganda's seed sector development started in 1968 with a public sector seed scheme involved in breeding, seed multiplication and marketing. Since the 1990s the seed sector has been liberalised with investments in all segments of the seed value chain. The formal, informal and intermediate seed systems characterise the seed sector. Each seed system is further characterised by who is producing the seed, which crops and varieties, types of quality assurance and the way the seed is distributed. Six major food crop categories including hybrids (maize and sunflower); major cereals (OPV maize and rice); small cereal grains (sorghum and finger millet); food legumes (beans, cowpea, green gram); oil seed crops (sesame, soybean and groundnut); vegetatively propagated (cassava, Irish and sweet potato) were identified.

The current structure and Organisation of EGS

The structure and organisation of EGS were analysed in the context of seed value chain which include research and development (new varieties and germplasm enhancement), seed production, seed quality control, seed distribution and marketing. It was found that, except for hybrid maize seed, the public sector (i.e. publicly funded national and international research institutes) were the dominant suppliers of EGS. Analysis of incentives and disincentives to produce EGS of selected crops revealed that, hybrid maize varieties are attractive because of high yield potential; but with a disincentive of being highly technical to maintain parental lines and cannot be recycled. The OPVs and other self-pollinated crops

were not very attractive to seed companies because farmers can recycle the seeds for several years without returning to the market to purchase fresh seed stock.

Institutional bottlenecks affecting the seed value chain

Limited access to EGS by private seed companies and farmer groups/associations is a major constraint. Institutional challenges occur at each point of the seed value chain (i.e. research and development, variety evaluating and dissemination, seed production, processing, marketing, and quality control. Challenges also occur at farm level demand, policy environment, and seed companies). The main challenges are outlined below:

- NARO faces low funding levels for variety development, promotion and maintenance. There are no specific budgetary provisions for EGS production and delivery; limited capacity for post-harvest handling (i.e. equipment for drying, threshing, sorting and storage);and irrigation to produce breeder seed reliably to meet seasonal demand for foundation seed; no reliable data on the actual quantities of seed required by the various seed producers; and no coordinating mechanism for production of EGS at the institute level.
- Seed companies cite lack of qualified manpower especially breeders; seed technologists and agronomists to maintain varieties and parental germplasm for ecological adaptability; high cost of doing business (high bank interest rates, stringent measures in accessing agricultural loans, and high exchange rates); inadequate data/statistics on seed stocks (production and demand) as well as absence of regular update and sharing of information (confidentiality issues). Most seed companies in Uganda do not have their own seed distribution outlets and rely on a poorly developed network of agro-input dealers, who mainly operate in urban and trading centres that are often far away from seed buyers.
- Seed companies use many scattered smallholder farmers as seed out-growers, making seed quality control a challenging task. Contracts with out-growers are not enforceable and often pose social risks such as side selling.
- Lack of a seed policy and regulatory framework to ensure production and delivery of quality seed.

Seed demand and crop specific characteristics

Forecasting the national seed demand for crops and varieties is critical in planning for production of quality seed along the seed value chain. Crop and seed value chains are fragmented, making it hard to project potential seed demand and thus EGS requirements. The seed system in Uganda is dominated by the informal system which contributes up to 91% of seed for farmers. Between 30-63% of smallholder farmers get seed from the local grain markets for all selected crops in this study; which provides a potential growth market for commercial seed. Most regions of Uganda have two cropping seasons and individual farmers grow a particular crop and variety only once a year; either in season one or in season two, adding to the complexity of determining seed demand. The export seed market is not very developed, although bulk orders for maize, rice and beans go to Democratic Republic Congo and South Sudan and hybrid maize to Rwanda. Most seed companies target

Common Market for East and Southern Africa (COMESA) markets which are highly competitive, especially for maize seed.

The demand for foundation and breeder seed can be calculated by dividing quality seed demand by the seed multiplication ratio for foundation and breeder seed respectively. This provides the order of magnitude of foundation and breeder seed needed. Seed demand was determined at three scenarios of seed adoption (low, intermediate and best). To achieve volumes required for the best scenario, cereals require two rounds of bulking foundation seed, legumes three, sesame and small grains only one.

The target market for hybrid maize in 2020 was estimated at 10,000 MT. For this volume a small seed processing infrastructure to processes 200 MT, would be the minimum size of a seed company to work at economies of scale. The maize market is, therefore, large enough to accommodate the 26+ seed companies which produce maize seed. Of the 63 hybrid maize varieties released in Uganda, around 50 are marketed. To produce the estimated 10,000 MT of certified seed, 78 MT foundation seed is needed.

Twenty three (23) lowland and upland rice varieties are released of which six are being marketed by six local seed companies. The rice seed market is not well developed. It is projected to grow from 3,800 MT in 2014 to 4,000 MT in 2020. To produce 4,000 MT of certified seed, 158 MT of foundation seed is needed.

27 bean varieties are released and 7 seed companies are engaged in seed production. In the national seed strategy, the target for 2020 is 23,000 MT of which the largest proportion (75%) is produced as quality declared seed (QDS). This huge potential increase in marketed bean varieties, poses a challenge on the EGS system. A more realistic target is 7,000 MT. Seed companies and farmer groups will need 467 MT of foundation seed to produce this 7,000 MT. This is produced using three rounds of bulking. To have a continuous flow of foundation seed available, 408 ha is needed on an annual basis to produce sufficient quantities of foundation seed for the three rounds.

Three sesame varieties have recently been released and two seed companies, both operating in northern Uganda, market these varieties. Due to the high multiplication rates, small volumes of seed are required per unit area. It is projected that the bulk of increase from 50 MT produced in 2014 to 1,900 MT in 2020 will be produced under the QDS system. To be able to produce 1,900 MT seed, only 2.86 MT of foundation seed is required.

Only one Seed Company deals in finger millet seed and the market projection for 2020 is 440 MT. Since less than 5% of farmers buys finger millet seed from the formal system, intermediate scenario market is estimated at 99 MT. This would require 660 kg foundation seed.

Cost of seed production at each stage of the value chain

The cost of seed production varies according to the entity that is producing the seed. Currently, all breeder seed is produced by NARO with the exception of some hybrid maize varieties. The breeders rely on out-growers for part of the foundation seed production. Seed companies spend relatively large resources on processing, packaging and marketing. For both foundation and certified seed, companies also rely on out-growers and buy seed at a

per unit cost from them. Farmer groups produce QDS of self-pollinated varieties using low input and low output schemes. Seed is sold in the vicinity of the farmer groups. For all crops except millet, the cost of production is calculated for certified seed. Millet seed would make a loss, if produced as certified seed; but producing it as QDS has a positive result.

The cost analysis shows that except for sesame, breeder seed and foundation seed is sold at a much lower unit price than the cost of production. These hidden subsidies range from UGX 432,612 for on kg breeder seed for hybrid maize to UGX 1,643 for one kg of foundation seed for beans. Each value chain operates at an overall profit level, even if breeder and breeder seed are sold below the cost price. Although breeder seed for each crop type is heavily subsidised, the volumes needed are small. The profit margin of commercial seed outweighs losses on EGS seed. Considering the value chain profitability at each stage using cost-recovery practice and the intermediate market scenario; the overall profit could increases by roughly 10 fold for beans, sesame and millet. It roughly triples for rice, while for hybrid maize the overall value chain profit increases by 50%. The overall value chain profits using cost-recovery costing and intermediate market volumes are estimated at UGX 18 Billion for hybrid maize, UGX 2 Billion for rice, UGX 2 Billion for beans, UGX 1 Billion for sesame and 17 Million for finger millet.

Considerations for sustainable cost-effective EGS production

- Currently foundation seed is not formally certified. Thus, additional costs of field inspection, seed testing, certification and packaging must be included if foundation seed is to be sold to third parties.
- Most crops have an uncertain market demand which makes it hard for commercial seed producers to estimate the volumes they could sell on an annual basis. NARO has low incentives to produce and market EGS as revenues cannot be retained for further investment.
- Establishing a functional royalty system will provide an incentive for NARO as an institute to streamline EGS seed production and will allow third parties to multiply breeder seed into foundation and certified seed; creating an income stream for these institutes. This will generate funds to further breeding of new varieties and maintaining existing ones. Yet operationalising such system will be challenging as the variety owner is responsible for follow up with many smallholder farmers using their varieties.
- Most major breeding programmes in Uganda are externally funded and thus heavily subsidized.
- Sesame and millet require small land areas to produce foundation seed. As foundation seed can be produced with a profit, this may seem attractive to private sector. However, if too many companies get involved, this may cause too much foundation seed produced leading to oversupply and consequent reduction in the sale price. Too much competition will force all companies to produce at a loss.
- Seed production in Uganda is predominantly rain fed. For crops like beans, the three rounds of foundation seed multiplication could be accomplished in one year if irrigation facilities were available. This investment would add substantially to production costs; but will safeguard the crop from effects of drought spells.

EGS operational strategies – Optimal market archetype

Based on marginal economic value and level of demand for crops grown with quality seed of improved varieties, maize, rice, beans and sesame, fall under a public-private sector collaboration model (archetype 2). This is where quality seed of improved varieties has strong market demand but the cost of production or demand risk create barriers to private sector investment and innovation; thus requiring public sector involvement. Finger millet fell into a public sector model (archetype 3) –because the market for quality seed of improved varieties is very small and thus not profitable to produce. The crop is promoted by public sector to advance a public goal of food or seed security. Bottlenecks and proposed solutions for each crop archetype are presented.

Public Private Partnerships Mechanisms and solutions

A wide range of actors are involved in the seed value chain. This requires strategic partnerships to produce and supply quality seed. Successful partnerships depend on mutually perceived and accrued benefits. While maintaining consistent profits can be a strong motivator for reliable partnerships, it is also important to identify the "best fit" private partners in terms of size, ability, community penetration, and marketing experience for each location. It is essential that these partnerships grow from a shared vision with well-defined and agreed goals and objectives typically captured formally in Memoranda of Understanding documents.

Key Challenges

There are many challenges affecting the EGS production and delivery in general. The most significant challenges are:

- National agricultural research institutes responsible for breeding food crops do not have a coordinated EGS production programme and only focus on a few crops, especially those with external funding.
- Seed companies have limited capacity, human and financial resources, to generate own varieties and to produce EGS. National seed companies have limited capital and access to affordable credit for their operations and investment in infrastructure for seed processing and generate sufficient cash flow for contracts with out-growers.
- Farmers have a low adoption of improved varieties and are not in the habit of buying certified seed.
- Demand for seed is unpredictable and inconsistent due to lack of forward and transparent planning and fragmented markets.
- National Seed Certification Services (NSCS) has limited capacity (personnel and logistics) to inspection and monitor seed produced by many scattered out-growers and seed dealers. This compromises seed quality.
- The enabling environment is currently challenged by inadequacies in the implementation of the seed policy, and strategy and enforcement of available regulations that are essential to provide guidance and a level playing field for seed sector stakeholders.
- There is a high prevalence of counterfeit/fake seed on the market.

Recommendations

Crops and system wide recommendations are:

- Increase the price of EGS to represent real cost of production and remove hidden subsidies.
- Train research scientists and seed companies on intellectual property rights systems to ensure equitable use of publicly developed varieties.
- Strengthen seed certification with the private sector to ensure quality of all seed classes.
- Strengthen capacity of seed companies to manage EGS and internal quality control.
- Finger print all maize parental lines.
- Develop a searchable database to share information on varieties, seed availability and levels of commercialisation.
- Strengthen linkages between research with farmers through a well-coordinated extension and advisory service programme to enhance adoption of quality seed by all farmers.
- Establish a foundation seed enterprise at NARO to ensure availability of good quality foundation seed of crops that seed companies are not keen on producing due to low on no profit margins.
- Ensure an effective policy and regulatory environment is critical to enhance the performance of the seed sector.

Proposed actions for government of Uganda are:

- Review Non Tax revenue policy
- Develop cost effective EGS road maps per crop
- Explore licencing options for commercial varieties and publicise arrangements
- Finger printing of parental materials
- Set up a professionally managed foundation seed unit, recruit a seasoned business manager and develop a realistic business plan for EGS Unit
- For those ZARDI's that produce EGS, attach an agribusiness staff
- Develop an efficient methodology to determine annual seed requirements
- Support establishment of a national seed forum to articulate on the seed subsector issue
- Strengthen extension and advisory services at the sub-county level to educate farmers in the use of agricultural inputs to increase crop yields

Proposed actions for development partners are

- Support intermediate seed system transitioning to formal seed system to create a pluralistic, vibrant and market-oriented seed sector in Uganda.
- Support the proposed EGS production models adapted for crops characteristics, profit margins and demand.
- Support capacity building of seed producers through a public-private partnership with clear roles and responsibilities for each entity.

- Support efforts that provide an evidence base indicating which of the proposed archetypes is working well and which don't and support development of efficient methods for demand prediction.
- Support efforts that make new technologies available and affordable to curb poor quality seed. Examples are finger printing of all existing varieties, starting with Hybrid maize parental lines.
- Further support different quality assurance mechanisms, including accreditation of private inspectors and delegated authority towards local government. thus organisation and implementation of quality assurance mechanisms for all seed classes.
- Support development of a strong supporting Environment: Quality of physical infrastructure (e.g., roads, irrigation, markets etc.); access to capital and financing; capacity and legal framework for farmers' organizations and participation in seed systems.

1. Introduction

1.1 Background to the study

Access to quality seed and farmer adoption of improved varieties remain low across many countries in Sub-Saharan Africa. This is partly due to disengaged seed value chains starting from early generation seed (EGS) production. In Uganda the key bottlenecks hampering the growth of the seed sector are related to the disconnect between seed demand from farmers and production of required varieties as well as limited quality assurance mechanisms available. Most crop varieties in Uganda are public-bred by the National Agricultural Research Organisation (NARO). At a certain point in the seed value chain, most public varieties with commercial potential become private commodities marketed by seed companies. The remainder of the public crop varieties find their ways to farmers through informal networks or remain on the shelf.

Seed production involves several generations of multiplication. The earliest generation is breeder seed (pre-basic), which has been the responsibility of National Agricultural Research Institutes (NARIs) that released the variety. The production and maintenance of breeder seed requires significant resources. Without specific donor funds available, sufficient breeder seed of many varieties has often been a problem, thus limiting the possibilities for further seed multiplication. Breeder seed is used to produce the, foundation seed. Together, breeder seed and foundation are called early generation seed (EGS). Until recently, this has been the sole responsibility of the NARIs. A number of concerns about the efficiency performance of this arrangement have been raised. The seed law allows other entities besides NARIs to produce and market foundation seed. This provides an opportunity to explore sustainable solutions to address the concerns on quality and efficiency of EGS production.

In the formal seed system, many constraints exist in accessing public varieties. Policies tend to place all EGS of all crops in one basket and propose a one size fits all solution for delivery to the private sector. Generally, maize is the most commercialised crop with both public and private varieties. Most investments have gone into commercialising maize seed value chain. Maize is, therefore, taken as a guideline on how EGS for other crops should be commercialised. However, different crop groups have different characteristics that require different solutions to scaling EGS and seed production. As a result, formal seed systems remain small, improved varieties are not effectively commercialised, and farmer access to quality seed is limited. Scaling formal seed systems for EGS production will be critical in increasing availability of quality seed of improved varieties to farmers.

To address challenges of low availability of the right varieties at the right time, this report seeks to develop a generalisable framework that enables policy makers and donors to tailor their policies and interventions to the needs of specific crops based on prevailing market conditions.

This framework has two dimensions:

- Commercialisation potential of quality seed of improved varieties as a product
- Level of demand for varieties and crops grown with quality seed of improved varieties.

The purpose of a functioning EGS system and efficient seed value chains is to enable farmers have access to affordable public varieties. The study pays specific attention to the interface between public plant breeding and private seed production and proposes partnerships that facilitate easy transition from public variety to private product for each of the selected crops and giving due attention to characteristics of each crop.

1.2 Objectives of the study

The main objective of this study was to identify actionable steps to address bottlenecks in the supply of EGS of food security crops to avail affordable high quality seed of preferred variety to smallholder farmers in Uganda. Specific objectives were to:

- analyse the seed sector in Uganda and its relationship to EGS supply constraints;
- identify key bottlenecks hindering EGS production and supply;
- assess challenges affecting the seed value chain;
- provide insight into the common pathways for overcoming constraints in EGS production and delivery;
- identify the most cost-effective EGS business models, based on four market archetypes;
- define specific catalytic interventions to sustain production and delivery of EGS of food crops.

1.3 Methodology and data sources

The methodology was guided by common terms of reference provided by the Bill and Melinda Gates Foundation (BGMF) and United States Agency for International Development (USAID) for EGS study in Sub-Saharan Africa (Monitor-Deloitte EGS Study 2015). This included the following activities:

a) *Identification and analysis of the dominant seed systems within the national seed sector*: The tool guides the description of each seed system by the following characteristics (i) domain; (ii) types of crops; (iii) major crops; (iv) types of varieties; (v) seed quality assurance; and (vi) seed dissemination mechanism. Secondary data was mainly from the Integrated Seed Sector Development (ISSD) Uganda, a project funded by the Embassy of the Kingdom of the Netherlands (EKN) and implemented by Wageningen University & Research Centre – Centre for Development Innovation (WUR-CDI) (progress reports, proceedings of seed subsector stakeholder meetings and workshops, brochures, baseline study etc.); the draft National Seed Strategy (MAAIF 2015); analytical framework Reports of the seed sector (MAAIF 2012); and Framework for implementation of the National Agricultural Sector Strategic Plan (2015/16-2019/20) (MAAIF, 2015). Other sources were from published reports, journal articles and web searches.

b) *Identification of relevant crop groups and food crops*: Crop types were defined in terms of the seed system in combination with their reproductive systems, e.g. hybrids, major cereals, small grains, legumes, oil seeds and vegetatively propagated. The choice of crops for analysis was made by National breeders at a round table in October 2015.

c) *Current structure and organisation of EGS supply:* This tool uses the structure of the seed value chain; made up of operators, service providers and enabling environment. The analysis emphasised EGS production and delivery. This analysis was further guided by questions on: enabling environment; organisation of EGS production; availability and supply; incentive structure and financial mechanisms; disincentives; access to public varieties and variety replacement. Information was derived from secondary data sources, ISSD reports, national seed sector stakeholder meetings (2013, 2014, and 2015), national breeders meetings organized by ISSD Uganda and interaction with key stakeholders.

d) *Calculation of potential EGS demand:* The potential demand for breeder, foundation and quality seed (certified) was calculated using a template considering national acreage, seed rates (multiplication rates), estimates of seed/variety replacement rates, national statistics (UBOS, 2015); volumes of seed produced and targets in the draft National Seed Strategy (NSS) 2015 and relevant multiplication ratios for dissimilar seed classes (e.g. inbred lines) and crops. Other sources of information were interviews with selected seed companies, breeders, household surveys (ISSD, 2014) and a roundtable in which the initial figures were validated and adjusted.

e) *Assessment of the cost of production for EGS:* The costs of production for target crops at each stage of the seed value chain were calculated for breeder, foundation and certified seed/QDS. These estimates included total costs (both fixed and variable), total margin (as a percentage), subtracting probable losses, based on clear assumptions from information provided through secondary data, interviews with seed companies and breeders. A roundtable of key stakeholders was convened to validated and adjust the initial calculations. It was not possible to establish the costs of production for cassava planting materials.

f) *Matching National EGS Demand with revenue/cost:* Revenue, cost, and possible profitability projections were derived from guidelines using excel sheets to link the calculation of the cost for EGS production with national demand. The result of this exercise indicates the potential revenue/cost for EGS production and delivery (building the case for private sector investments); and estimates the required public investment associated with national demand (thus public investment and engagement in the development of public-private partnerships). This is critical for the next step of the analysis, which is to identify existing and optimal market archetypes for EGS supply.

g) *Identify the optimal market archetype for EGS supply*: A generalised framework was used to highlight the economic characteristics of seed with implications for a commercial and sustainable seed value chain. The framework consists of a matrix of four archetypes intended to enable policy makers and development partners to tailor their policies and interventions to specific crop potentials based on market conditions. These "archetypes" are related with product characteristics of quality seed of improved varieties and the level of demand for quality seed of those varieties. For each of the major food crops for

which the seed value chain analysis was done, the optimal market archetype was identified for fostering Private-Public Partnerships (PPPs) to enable commercial sustainability of these crops.

h) *Analysis of key challenges to achieve PPPs*: In order to determine the optimal market archetype key challenges that prevent the seed value chain from performing in a cost recovery/commercial and sustainable manner were analysed; changes needed to reach that optimal stage described; and major challenges in light of the enabling environment to reach that optimal stage identified. Interviews with breeders and a roundtable of key stakeholders were the main sources of input for the analysis and validation.

i) *Assess partnership mechanisms:* Institutional arrangements that underlay partnerships are key for success. Analysis was done by looking at the bottlenecks with seed characteristics, demand characteristics, regulatory and EGS production. Proposed solutions, roles and responsibilities of the various actors elaborated.

j) *The process:* A multi-faceted methodological approach was used:

- Constitution of Core EGS Team comprising of NARO, USAID FtF AgInputs, ISSD and USTA);
- A desk review of published and unpublished relevant research and reports on seed sector issues (Oct. 2015 – April 2016);
- Inception meeting with national breeders to deliberate on the study, identify crop groups and select crops of focus. (Oct. 2015);
- A national seed stakeholders workshop to articulate on partnerships to ensure seed quality production and delivery (Nov. 2015);
- Elaboration of a timeline (Nov. 2015);
- Core team review of progress (Feb. 2016) and plan for a roundtable workshop
- Roundtable workshop to validate seed costs (Feb. 2016);
  Participate in Africa convening in Addis Ababa, Ethiopia to share experiences and develop vision for EGS in Uganda (Feb. 2016);
- A series of meetings with targeted stakeholders to validate the report;
- Presentation to NARO Top management (9 August 2016).

1.4 Limitations of the study

EGS production records accumulating annual production data over the past years were not available at the NARIs. ISSD Uganda, USTA, AgInputs attempts to retrieve documented information on commercial seed production was unsuccessful. This was largely due to inconsistent records from the various entities including the Ministry of Agriculture Animal Industry and Fisheries (MAAIF), breeders & NARO, National Seed Certification Services (NSCS), seed companies and USTA. Certain statistics have remained constant throughout the literature for the last 8-10 years. For example the most recent agricultural census that details crop areas per region is that of 2008/09. Other examples include the seed supply levels which have remained around 18,000 MT per annum. Actual seed demand is not known, although potential seed demand is at 120,000 MT. These simple statistics suggest that certified seed production satisfies only about 10% of national requirements. However, the original basis for these numbers and formulas on which they are calculated are unclear.

The draft National Seed Strategy uses similar statistics for the 2013/2014 season and cites a compilation of sources, including MAAIF, USTA, NARO and NSCS. These factors impact negatively on reliability of calculations of seed demand and costs of EGS production.

The starting point guiding this study was the assumption that a certain economic model with four archetypes will be able to address shortages of EGS. However, during the study, it became apparent that to match an economic archetype with demand is only part of the solution. Several institutional challenges will continue to hamper sustainable production and commercialisation of EGS. It was further assumed that individual entities are able to produce the right volumes at the right time; indicating that seed producers would not have unsold stock at the end of each season. Yet this closely relates to how well the value chain actors are able to predict the demand for the crops and varieties they produce and market. For value chain integration, fostering sector wide institutional change will be critical, no matter which archetype is chosen as a solution to address bottlenecks in EGS supply.

Lastly, although cassava was originally selected for this study, to represent root and tuber crop group, it was impossible to establish relevant national demand figures and costs of production. This was further compounded by the discrepancies in the units of measurement (i.e. bundles of cuttings vs kilograms). During the same period the National Crops Resources Research Institute ((NaCRRI), was conducting a study into the cost of cassava planting materials production at all stages of the value chain. This vital data was not available before finalising this study and it was decided to exclude cassava in this report.

2. Seed systems in Uganda

2.1 Development of the seed sector

Before 1968, the seed sector in Uganda was predominantly informal and improved crop varieties were passed on from farmer-to-farmer. When a critical number of maize, soybean and groundnut varieties had been developed and required maintenance, the government started a seed scheme in the Ministry of Agriculture. The scheme maintained and marketed all crop varieties except vegetatively propagated crops (MAAIF, 2010). By 1995, the scheme that later became Uganda Seed Project (USP) was unable to promote and market all new varieties developed by the NARIs. The retail marketing network was still in its infancy and most seed was distributed via government channels. This proved inefficient and seed often remained unsold. The project activities of production, processing and marketing of seed had become commercialised and complicated to be handled by a government department under civil service regulations. The project was then transformed into a public liability company-Uganda Seed Ltd., which was later handed over to a private seed company. This encouraged private entrepreneurs to establish other seed companies. To date, more than 26 registered local seed companies are registered in Uganda and are involved in seed production, processing and marketing. Most of them also sell other agro-inputs like fertilizers, chemicals and farm equipment.

Most crop varieties that are sold as seed have been developed principally by the National Crops Resources Research Institute (NaCRRI and National Semi-arid Agricultural Resources Research Institute (NaSARRI), under NARO. A few varieties have also been developed by Makerere University. These public plant-breeding efforts draw on germplasm available through various international networks, most notably those managed by the International Agricultural Research Centres (IARCs). Most funding for plant breeding research comes directly or indirectly from government and donor projects, resulting in a pattern where specific crops are privileged or neglected during a particular period depending on both national and donor priority. Although all crop varieties have come through the NARIs, the Seed and Plant Act 2006 allows for privately developed varieties from both domestic and foreign sources. Donor funded projects are at times hidden subsidies. This report documents at which node of the value chain these subsidies occur and which crops have comparatively larger indirect subsidies in seed production.

2.2 Current seed systems

Seed systems in Uganda are characterised on the basis of the domains in which they operate (public, private, formal, informal and intermediate); the types of crops produced (food and cash crops); the type of variety used (land races, improved, exotic, and hybrids); the type of quality assurance mechanisms operational (informal, quality declared, truthfully labelled and certified); and the seed supply mechanisms (local exchange, agro-input dealers, and

subsidised distribution). Each seed system is further characterised by who is producing the seed, which crops and varieties, types of quality assurance and the way the seed is distributed. The main features of these systems are presented in Table 2.1 and details in Annex 1.

2.2.1 Formal seed system

The formal system is responsible for improved and certified seed production through a structured system of variety development, release, multiplication, quality control, distribution, and marketing. The major players are public institutions (government, international and national research) and the private sector (seed companies, farmers associations and cooperatives, NGOs, development agencies, community-based organisations and farmers). An analysis of the seed sector in Uganda by ISSD Uganda in 2015 revealed that the formal system is estimated to contribute 10-15% of certified seed used for planting and the majority of seed sold is maize seed. The National Seed Certification Services (NSCS regulates the system - from variety listing through to final seed certification.

There are more than 26 registered seed companies producing an estimated 18,000 MT of seed annually (MAAIF, 2014). Seed distribution in local markets is carried out through an agro-inputs dealers' network. The system also includes seed trade in importation of vegetable and other seeds for the domestic market, and export to regional markets.

2.2.2 Informal seed system

The informal system is responsible for 85% of seed planted. Seed is sourced mainly from farm-saved seed from previous season's crops and community based seed multiplication and dissemination. The system is unregulated.

2.2.3 Intermediate seed system

There is growing awareness that the formal system as such (the legally prescribed adherence to defined quality standards) may not be able to solve the problem of shortage of quality seed in the short-term. In an effort to modernise agriculture, the Government of Uganda (GoU) recognises that the formal system depends on the potential of the traditional and informal seed systems. These are well adapted to the local seed requirements for annual food crops produced under variable cropping systems and agro-ecologies. The seed supply relies on simple technology and low costs and can provide seed at a low price, with a low entrepreneurial risk. Market-oriented farmer groups are beginning to invest in the production of Quality Declared Seed (QDS) of major food crops in which seed companies are not fully involved. This has created an intermediate system of QDS to deliver quality seed to smallholder farmers who cannot afford more expensive certified seed. They are being linked with centralised seed certification in order to function optimally. Success will depend on adaptation of technologies, a flexible seed legislation and regulation, enforcement, and institutional capacity.

NARO institutes provide improved varieties for food and nutrition security crops through extension services, NGOs, farmers' associations and donor funded seed projects to farmers' groups for further multiplication. Skilled and enterprising farmers involved in in production of QDS are being empowered to become specialised seed producers. This is expected to create a vibrant, market-oriented and pluralistic seed sector in Uganda. It is projects that the QDS seed class will contribute an additional 25% share of certified seed by 2020, while the share of certified seed will increase to 40% overall.

2.2.4 Seed classes

Seed classes recognised in Uganda are pre-basic (breeder), basic (foundation), certified seed (generation 1 and generation 2) and Quality declared. Each of these classes requires a unique regulatory and certification process.

Table 2.1 Current Seed systems in Uganda

Characteristic	**Farmer saved (informal)**	**Farmer-to farmer entrepreneur (informal)**	**Community based seed multiplication (informal)**	**Local seed business (Intermediate)**	**National seed companies (formal)**	**Multinational companies (formal)**	**Cash crop value chains (formal)**	**Other closed value chains (formal)**
General description	Traditional for food crops.	More entrepreneurial for local crops	Development-oriented with support through NGO programmes	Market-oriented farmer groups, and individual farmer entrepreneurs	Emerging and vibrant companies with strong focus on maize but including other crops	Privately owned varieties; Mostly imported seed, with Ugandan distributors	Semi public and private system with distribution through commodity organizations	Closed systems with export commodities
Type of crops	Food crops	Food and cash crops	Major food and cash crops	Food and cash crops	Food crops	Major food and cash crops	Smallholder cash crops	Plantation and greenhouse cash crops
Major crops	OPV maize, beans, pigeon pea, cowpea, green grams, millets, sorghum, banana, sweet potato, cassava	Indigenous vegetables, spices and medicinal plants	Beans, rice, maize, sorghum, millet, cassava, banana, sweet potato, potato, fruits	Beans, green gram, pigeon peas rice, sorghum, millet, cassava, potato, sesame, soybean, groundnut	Maize (hybrid and OPV), sunflower hybrid and OPV), brewing sorghum, beans, rice, groundnut	Maize (hybrids), sunflower (hybrids) and, vegetables, pasture crops	Coffee, cocoa, cotton	Sugar cane, tea, oil palm, tobacco, flowers
Type of varieties	Local varieties and recycled improved varieties	Local indigenous varieties and recycled improved varieties	Improved varieties released through public programmes and local varieties	Improved varieties released through public programmes, self-pollinated crops	Improved varieties released through public breeding research institutes	Improved varieties released through private breeding companies	Improved varieties released through public breeding programmes	Improved varieties released through private breeding programmes
Type of seed quality assurance	Farmer-saved (informal)	Farmer-saved (informal)	Standard	Quality Declared Seed	Certified	Certified (truth-in-labelling for Vegetables & pastures)	Internal quality assurance	Internal quality assurance
Type of distribution and marketing	Farmer-saved and exchange, local grain markets	Local markets	NGO distribution and community exchange	Local distribution and marketing	Marketing through agro-dealers and input schemes	Direct marketing and through agro-dealers	Distribution and marketing	Seed import for use within value chain

Source: Adapted from ISSD Africa Briefing note September (2012), USTA (2010), Pelum MISEROR (2012).

2.3 Selected food crops for EGS archetype analysis

A diversity of food crops is grown in Uganda. Six major categories were identified (Table 2.2) and five crops including hybrid maize, rice, beans, sesame, and finger millet were selected. Maize, rice, and beans are strategic commodities in the National Agricultural Sector Strategic Plan (NASSP) for Uganda (MAAIF, 2015). Their choice is based on the following criteria: return to investment, priority within agro-ecological zones, number of households involved, contribution to exports, multiplier effect, size effect, and potential future impact. Sesame and finger millet on the other hand, are important for food security, nutrition and income (UAC, 2008/2009) for smallholder farmers, particularly in the northern and eastern districts of Uganda. The criteria for the selected crops are presented in Table 2.3. As mentioned in the limitations to the study, cassava was eventually not included in the study, due to lack of reliable data.

Table 2.2 Major groups and food crops in Uganda

Hybrid	Major Cereals	Small grain cereals	Legumes	Oil seed crops	Roots/tuber/bananas
Maize*	OPV Maize	Finger millet*	Beans*	Groundnut	Cassava
Sunflower	Rice*	Pearl millet	Cowpea	Sesame*	Sweet potato
		Sorghum	Pigeon pea	Soya bean	Potato
			Field pea	Sunflower	Yams (cocoyam)
			Green grams		Bananas & plantains
			Bambara nuts		
			Chickpea		

* Selected crops for the study, Source: Third annual breeders' meeting 2015

Maize is an important non-traditional agricultural export crop in Uganda. It is grown in all major agricultural zones. The maize sector provides a source of livelihood to about two million households, 1,000 traders/agents, and 600 millers (UBOS, 2015). The total annual production of is above 2.5 million MT. Although most of the national maize production is consumed domestically, a surplus of about 15 percent is exported to regional markets, especially Kenya and South Sudan.

Rice has become an important food and cash crop and is ranked fourth in importance among the cereal crops, following maize, finger millet, and sorghum. It is mostly grown by small scale farmers (80%) with less than two hectares under rice. Since the introduction of upland rice in 2002, the number of farmers deriving their livelihood from rice farming has increased from 4,000 to over 96,000 farmers in 2010 (MAAIF, 2012). This rapid shift to rice production is because it has a higher return on investment among smallholder crop enterprises (NAADS, 2012). The number of rice millers has also increased from 100 in 2000 to 591 by 2010 (MAAIF, 2012). The growth in domestic rice production has led to a drop in rice imports; saving the country foreign exchange expenses. Though still small, rice exports are rising. It

is anticipated that Uganda will be a net exporter of rice to the region from 2018 onwards given its potential to expand production (MAAIF, 2012).

Beans provide both food and cash to farmers. As a food, its protein is cheaper than the animal form, making it highly competitive and important in dietary regimes of most rural and urban people. It is also widely used in institutions including schools, army, hospitals, and prisons. Beans fix atmospheric nitrogen contributing to improving and sustaining soil health. The bean crop accounts for 7% of the national agricultural Gross Domestic Product (GDP) and ranks fifth in importance after bananas, cassava, sweet potatoes and maize (CIAT, 2008).

Sesame, commonly known as simsim, is grown in northern and some parts of eastern and western Uganda (UBOS, 2009). It is a high-value crop with ready domestic, regional and international markets. Sesame is produced by smallholder farmers who grow it for home consumption and as a cash crop. With the recent surge in global demand for sesame and sesame oil, farmers in Uganda have turned increasingly to growing sesame as a cash crop, earning it the nickname 'white gold' in northern Uganda (Munyua et al, 2013).

Finger millet (*Eleusine coracana* L.) is a major staple crop and is rated second to maize in importance among the cereals. Finger millet production is largely in northern, eastern and western regions of the country (Tenywa et al, 1999). The crop contributes greatly to incomes of rural households, particularly women. It is brewed into local beer or sold directly as grain in local markets. Furthermore, finger millet plays a major role in providing for the dietary needs of the rural people. It is a major preventative food against malnutrition, owing to its high content of essential amino acids. Finger millet is drought tolerant and its grain has an extended shelf life of several years without significant damage by storage pests. Therefore, it offers food security opportunities for the country. A summary of strategic considerations for selecting representative crops for the study are presented in Table 2.3.

Table 2.3 Five selected crops based on strategic considerations

Crop	Production (000MT)*	Ag. HHs (m)*	Cultivated area(000ha)*	Other considerations**
Maize	2,564	2.0	1,103	Key grain of national strategy with regional grain market
Rice	273	0.1	95	Nationally a strategic food security and export to neighbouring countries
Beans	1,011	2.0	674	High domestic usage and regional trade, national strategic crop
Sesame	1,450	0.32	207	Has ready domestic, regional and international trade and domestic niche market
Finger millet	175	0.42	236	Food security and income in eastern, northern and southwestern regions

Source: *MAAIF, UBOS statistics 2015, ** Value chain reports; Legend: Ag. HHs= Agricultural households

3. Structure & organisation of EGS supply

The current structure and organisation of EGS supply are analysed in the context of the seed value chain (Fig 3.1). The chain includes development of new varieties and germplasm enhancement, EGS production, quality seed production, quality control, distribution and marketing. These represent the different pathways in which newly released varieties are disseminated to farmers. The regulatory framework and quality assurance run along the entire value chain. Most operators play multiple roles in the value chain. The main objective of the analysis is to understand the different actors and their functions in the chains. Other aspects such as integration with the crop value chain are also presented.

Figure 3.1 Overview of seed value chain components

3.1 Actors and providers of EGS

The main actors responsible for specific activities within the seed value chain and EGS providers are presented in Table 3.1 and Table 3.2. More detailed description of each crop value chain is presented in Annex 2.

Table 3.1 Overview of actors responsible for specific activities within each seed value chain

Value chain point	Description	Type of actors
Research and development	Research and development of germplasm with desirable farmer and market traits	Breeders in national agricultural research institutes (NARIs) and International Agricultural Research centres (IARCs) –(Public)
Variety selection and dissemination	Variety evaluation using participatory approaches and release	NARIs and IARCs -(Public)
Breeder seed production and maintenance	Production of several generation of breeder seed from nucleus seed and variety maintenance	NARIs (Public), IARCs (Public) and some multinational seed companies and national seed companies that have exclusive rights of particular crops (especially maize hybrids) and varieties (Private)
Breeder seed production	Production from breeder seed	• Direct production- NARIs (Public) • Direct production- NARIs with contract farmers (Public-Private) • Seed companies (Private), Farmer cooperatives and local seed businesses (Public-Private)
Certified and Quality declared seed production	Production from breeder seed	Seed companies (Private), farmer cooperatives and local seed businesses (Private), individual farmers and groups (Private)
Marketing and distribution	Distribution through agro-dealer networks, farmer groups and local markets	Sales in open markets, agro-input dealers, seed/grain traders, seed exchange through local seed systems (seed fares, social networks etc.)-(Private)
Seed quality control and certification	Variety registration, official inspection and certification	National Seed Certification Services (NSCS) of MAAIF (Public)
Seed Trade	Facilitate regional and domestic seed trade	Uganda Seed Trade Association (USTA) composed of registered local seed companies (Private)
Seed users/uptake	Adoption of improved varieties and other agro inputs	• Farmers (small, medium and large) (Private) • Direct farmer to farmer diffusion (Private) • Government distribution programme (e.g. Operation Wealth Creation) (Public)

Source: Monyo et al (2014) for beans and MAAIF (2012) analytical reports for maize, and rice, NaSARRI (2015) for finger millet and breeders interviewed

Table 3.2 Overview of seed providers of selected crops

Crop/Seed value chain	Breeder seed	Foundation seed	Certified seed	Quality Declared seed
Maize (hybrid and OPV)	NARIs, IITA, local seed companies, Multinational Corporations (MNC)	NARIs, and seed companies with exclusive rights for hybrid seed, MNC	Seed companies through out-growers	Not a QDS crop
Rice	NARIs, IARCs, Africa Rice and seed companies	NARIs, IARCs and Seed companies	Seed companies through out-growers	Farmer groups and cooperatives
Beans	NaCRRI, CIAT	NaCCRI through Farmer groups, CEDO	Some seed companies, farmer groups and NGO projects	Farmer groups, individuals and cooperatives
Sesame	NaSARRI,	NaSARRI	Seed company	Farmer groups and individuals
Finger millet	NaSARRI, ICRISAT	NaSARRI, seed company	Seed company	Farmer groups

MNC=Multinational seed companies; Source: Monyo et al (2014)for beans and MAAIF (2012) analytical reports for maize, and rice, NaSARRI (2015) for finger millet and breeders interviewed

Table 3.1 and Table 3.2 show that R & D activities to produce new and improved varieties are dominated by publicly-financed crop improvement programmes. They also produce the corresponding breeder and foundation seed. Seed companies are more involved in the production of certified seed. The dominance of NARIs as providers of foundation seed of most food crops constitutes one reason for the persistent low seed production and delivery to seed multipliers as this is not their core function. Improving access to foundation seed requires innovative approaches and initiatives to create alternative sources. The seed law allows entities with capacity to produce foundation seed. It is expected that as the seed sector evolves, NARIs will devolve the foundation seed production and hand this activity over to the appropriate entities.

3.2 Incentives/disincentives for investments in EGS supply

The diversity of crops with fragmented seed markets characterise the seed sector. Therefore, there are both incentives and disincentives that need to be considered when investing in EGS of the different crops. These were analysed and the results are presented in Table 3.3.

Table 3.3 Incentives and disincentives in producing high quality seed for sale (EGS and quality seed)

Crop Group	Incentives	Disincentives
Hybrids (Maize)	• Large yield advantages over OPVs translating into profits • High predictable seed demand • Seed can efficiently be distributed to farmers • High standards of quality	• High cost of production • Requires specialised skills in production and maintenance of parental lines • Requires large land area for isolations • Planted only once, thus need for continuous purchase of seed by farmers each season • Relatively high prices of seed
Major cereals (OPVs)	• Ready grain markets • Industrial use for food and feeds • Staple foods • Low input during production	• Long seed replacement period (3-4 years) • Labour intensive e.g. rice • Prone to pests and diseases • Low differentiation between seed from grain
Legumes	• High nutritional value-legume-based products • Potential for processing industry (food and feeds) • Ready grain market	• Long seed replacement period • Prone to pests and diseases • Perishable (short shelf life) • Bulky – costly to market • High seed rates
Oil crops	• Nationally ranked and prioritized as key crops for industrial use • Import substitution for vegetable oils • Ready grain market	• Neglected by national research • Low storability (short shelf life • Long seed replacement period
Small grains	• Processed flours • Stress tolerant (drought) • Low input in production system • Climate change resilient and food security	• Labour intensive (weeding) • Low yield • Long seed replacement period • Neglected by research

Source: National breeders' meeting November 2015

Other than hybrid maize, farmers often save seed for the next season, resulting into long seed replacement periods. The non-distinction between grain and seed by smallholder farmers is a significant disincentive for investing in seed production for sale. Linking seed to grain markets appears to be a strong push factor for high quality seed demand and thus EGS requirements.

3.3 Bottlenecks affecting the seed value chain

The NARIs are responsible for variety development and release. Crop improvement for maize, rice, beans is the mandate of NaCRRI, located in the central region; while NaSARRI, located in the eastern region is responsible for sesame and finger millet improvement. These institutions are also the main source of EGS of these crops. Some seed companies also obtain maize varieties from international research centres which have to be tested by NaCRRI and approved by the National Variety Release Committee (NVRC) of MAAIF for wide scale production and commercialisation. For all other crops seed companies and Local Seed Businesses (LSBs – farmer groups producing QDS) rely on NARIs for foundation seed to produce certified and QDS seed. Key bottlenecks hindering the production and supply of adequate quantities of EGS are both institutional and system wide. These are discussed in the subsequent sub-chapters.

3.3.1 Research and Development

Breeder seed is the earliest generation of the seed value chain. Weaknesses at this node negatively impact on the entire seed sector. Crop breeders are suppliers of breeder seed for their research purposes (variety evaluation and selection). Only small quantities are often available for further seed multiplication. Breeders require substantial quantities of seed to conduct multiplication on-station, and on-farm trials needed to identify candidate entries for release. Even within this core function, breeders face multiple bottlenecks to produce this seed. These include:

- Low funding and human capacity for variety development, promotion and maintenance. NARO has few experienced breeders (only 11), which poses a difficult balance between research and seed production;
- There are no specific budgetary provisions for EGS production and delivery and revenues are too low to recover operational costs. As a public institution, any revenue from the sale of seed must be remitted to the national treasury as a non-tax revenue (NTR);
- Most self-pollinated crops have long replacement periods (>3 years) which makes planning EGS production difficult. The crop and seed value chains are fragmented, making it hard to project potential seed demand and thus, the EGS requirements;
- Lack of regulations to operationalise the Plant Variety Protection (PVP) law (2014) that provides for plant breeders' rights;
- Limited infrastructure – post-harvest handling (equipment for drying, threshing, sorting and storage) and irrigation facilities to produce reliably to meet seasonal demands for foundation seed;
- Lack of information on projected seed demand nationally;
- Pre-basic and subsequent foundation seed production is entirely under the control of individual crop breeders who have their own priorities. Thus, his/her capacity to produce and deliver adequate quantities of EGS seed is dependent on external sources of funding; and
- A weak institutional and policy framework for independent quality control and assurance of EGS.

3.3.2 Seed companies

Registered seed companies and local seed businesses largely depend on NARIs for source of breeder and foundation seed for most food crops and are vulnerable to the challenges the research institutes face. Key bottlenecks seed companies face include:

- Lack of qualified manpower especially breeders, seed technologists and agronomists to develop, maintain private varieties and parental germplasm for ecological adaptability;
- Three-way cross maize hybrids commonly require high technical skills to manage;
- High cost of doing business (high bank interest rates, stringent measures in accessing agricultural loans, fluctuating exchange rates);
- Limited capital to invest in the necessary infrastructure for seed production (e.g. agricultural machinery, irrigation), processing and storage; and office space;
- Most seed companies contract small-scale farmers who rarely use fertilizers and have no access to irrigation facilities to produce seed securely. These out growers are mainly scattered small fields which make it difficult for field inspection, thus compromising quality;
- Contract farmers normally have limited knowledge of the required seed quality standards;
- Inadequate data/statistics on seed stocks (production and demand) as well as absence of regular update and sharing of information (confidentiality issues);
- EGS production requires several rounds of bulking without sales, which is a disincentive for seed companies who have to make profits from their investments;
- Limited knowledge of variety attributes due to lack of a variety catalogues and descriptors; and
- Seed counterfeiting is rampant leading to lack of faith in certified seed by farmers.

3.3.3 Seed market

Farmers are the main users of seed. The reasons for buying seed are driven by the need for quality, income generation, high yields, and acquisition of new seed stock. Market for seed is uncertain as the major buyers are usually NAADS and NGOs whose orders are not predictable. The orders are also only to selected seed companies leaving the others with no market for their seed.

3.3.4 Seed quality assurance

The seed law does not impose quality assurance of EGS. For foundation seed, a letter from the breeder certifying that the seed being sold is of good quality is what is required. Often, seed from NARIs has low germination percentages or a high proportion of off-types. According to the International Seed Testing Association (ISTA) rules, foundation seed also needs to be inspected externally. However, NSCS has limited capacity (financial and staffing) to inspect all seed classes. Another limitation is that simple variety descriptors are not easily accessible.

3.3.5 Policy and regulatory framework

Although Uganda has made strides in developing an institutional, policy and regulatory framework for the seed subsector, implementation and enforcement remain a challenge. Government investment in human and financial resources in NSCS is inadequate. This has led to limited enforcement of seed quality standards. The seed policy and regulations are yet to be implemented. The PVP Act 2014 has no regulations to operationalise and is being contested in court , thus hampering the development of regulations. Institutional and policy weaknesses limit the development of a competitive, vibrant and pluralistic seed sector in Uganda.

3.3.6 Crop value chain challenges

Apart from the reasons mentioned in the previous sub-chapters, the output market for small scale farmers is also a major constraint in promotion of uptake of quality seed. Output markets are undifferentiated with very limited premiums available for higher graded products. Immediately after harvest, prices are often very low. As such, farmers have no motivation and incentive to produce more by using inputs such as quality seed and fertilizers. These constraints discourage farmers to invest in certified seed. Thus, building coalitions between actors in the seed supply chain (seed producers, grain producers, traders, and processors), can pull the seed value chain.

3.3.7 Summary of key bottlenecks and causes

Based on the above analysis, the key bottlenecks centre on common themes, which are related to seed characteristics as a commodity, national seed demand, EGS production constraints, policy and regulatory framework. A summary of these bottlenecks and causes is presented in Table 3.4. Issues around seed demand, seed as seed as a product and the cost of production are addressed in Chapter 4. Proposed solutions to address the identified bottlenecks are presented in Chapter 5.

Table 3.4 Summary of key EGS bottlenecks, causes and explanation

Theme	Bottleneck	Cause/Explanation
1 EGS production	Limited capacity in research and development	• Insufficient budgetary allocation to research. No specific funds are allocated to EGS production and supply • Focus is on very few crops, and there is limited promotion of improved varieties • Limited human capacity to address all major research constraints
	Low capacity of national seed companies to generate own breeder seed	• National seed companies rely on NARO to supply breeder seed. The latter however, have limited capacity to raise enough breeder seed to meet the demand • Limited capital and access to affordable credit for investment in qualified personnel and infrastructure for seed production and processing • Small profit margins for EGS
2. Seed demand	Low adoption rates of improved varieties by farmers.	• Inadequate research–extension–farmer linkages to facilitate demand-driven research and increased use of improved seed • The gap between user needs and the characteristics of the developed varieties; lack of knowledge about improved varieties; high cost of certified seed; unreliability of quality; economic and climatic risks; mind-set that use of certified seed of improved variety requires high inputs which increase production costs without a guaranteed profitability • Negative publicity by some NGOs about the use of improved varieties
	Unpredictable seed demand/market	• The diversity of producers' sources of seed, including low or non-market channels; the use of seed produced on the farm; subsidy programs; unreliable agricultural statistics; limited marketing studies etc.
3. Seed characteristics	Prevalence of counterfeiting	• Limited capacity (personnel and logistics of the NSCS for inspection and monitor seed produced by many scattered out-growers and seed dealers • Lack of operating standards/guidelines for internal quality assurance by seed companies • Erratic demands from government leading to some dealers selling fake/adulterated seed to meet demand
4. Regulatory	Weakness in the policy and regulatory framework	• Low capacity for certification • No intellectual property system operational • NTR a disincentive for research institutes to produce EGS efficiently

3.4 Conclusions and potential sector wide solutions

The above analysis suggests weaknesses that are hindering EGS production and supply in Uganda revolve around the operation and management of the sector at various levels of the

chain and not only around EGS production alone. Institutional and/or policy weaknesses at all points of the seed value chain are at the core of the key challenges. This calls for urgent action on the part of policy and institutional level stakeholders in dealing with these challenges. The public sector is dominant in EGS production and delivery. While seed companies would like to manage their parental lines for hybrid maize for example, they lack personnel with skills to maintain parental lines. Thus, an appropriate public-private partnership model, where the government and development partners invest in variety maintenance and facilitate easy access of parental materials by capable seed companies is critical. Exclusivity for varieties specific to the different agro-ecological zones should be encouraged with clear guidelines and minimise competition among the beneficiary companies. Further, lack of capital can be solved through availability of favourable credit facilities to seed entrepreneurs directly or through risk sharing arrangements with commercial banks. Otherwise, seed companies and other seed entrepreneurs will not be competitive with regional and multinational seed companies; especially for hybrids. The transfer of genetic materials between public and private sectors should be improved to allow easy access to suitable and adapted varieties.

In order to enhance EGS production and supply, the following sector wide solutions are proposed:

- Develop appropriate tools and methods for a more reliable assessment of demand for seed in the different links of the value chain;
- Encourage transparent forward planning and seed road maps to facilitate seed forecasting at each node of the seed value chain and pre-book EGS on a commercial basis;;
- Encourage seed companies to conduct reliable market studies and share aggregated data in order get information on national volumes of seed sales over the years. This information can be used to analyse popularity of specific varieties and average life-span and dissemination process of newly introduced varieties;
- Facilitate private companies to access improved germplasm from international research centres to develop their own varieties and produce EGS;
- Strengthen modalities for coordination of public and private research and business service providers for effective transfer and dissemination of seed related technologies;
- Develop a system which enables different rights on public varieties such as exclusive rights, shared rights or any other inclusive system that is deemed most beneficial to increase the adoption rates of new varieties by farmers. NARIs should initiate licensing agreements for seeds companies to promote specific crop varieties, within a specified ecological zone;
- Facilitate seed companies to access affordable credit to invest in seed production and processing infrastructure.
- Operationalise in-service training on variety maintenance and seed multiplication for private and public sector technicians, CBOs and LSBs; and
- Promote awareness on the different seed classes using tools that effectively reach all actors in the informal seed system including women.

4. Seed demand and cost of EGS production

4.1 Potential national commercial / quality seed demand

Forecasting national seed demand for crops and varieties will help improved planning and availability of quality seed along the seed value chain- from breeder seed to commercial seed (certified and quality declared seed). However, as stated in chapter 3, the crop and seed value chains are fragmented, making it hard to project potential seed demand and thus the EGS requirements. It should be noted that the information used to calculate market shares and potential demand is based on best available data and is aimed at providing the directionality of the seed demand. The methodology and supporting data for estimating national seed demand and cost of seed production at each stage of the seed value chain is presented in Annex 3.

National seed demand is the quantity of seed farmers require at a given point in time; often on an annual basis. It is different from seed use which includes home-saved seed by farmers. On the other hand, potential demand only looks at the volumes of seed that are demanded through markets and government/donor programmes. For released varieties, national seed demand depend on the adoption rate of improved varieties, consumer preferences and economic factors like price, product availability and output markets. Potential seed supply is the volume of quality seed produced expressed in MT per annum.

Table 4.1 provides an overview of the potential seed demand in Uganda and quality seed (certified and QDS) targets for 2020 using UBOS statistics (2015) and the draft National Seed Strategy (2015). The area cultivated per annum (UAC, 2008/09) serves as a basis for calculating potential seed demand. Multiplying the acreage by the seed rate gives the estimated seed use per annum. Dividing the estimated seed use by the seed replacement ratio, gives the potential seed demand. The seed replacement ratio indicates the frequency that farmers should replace their old seed stock with fresh seed to maintain vigour, plant health and purity. It is assumed that although most crops can be grown in both season in Uganda, individual farmers grow a particular crop and variety only once a year; either in season one or in season two.

The last two columns in Table 4.1 show the estimated quantity of certified seed produced by the formal system in 2014 as provided in the National Seed Strategy (NSS Draft 2015) and the target for 2020, combining both certified seed and QDS. The targets take into consideration the seed market in 2015 and projected potential growth of seed companies and of QDS producers. It should be noted that certified seed figures for 2014 are volumes of seed supplied to NAADS - government's Operation Wealth Creation (OWC) programme of free handout and may not represent realistic figures. Free handout volumes are not a good indicator for potential seed demand as it does not include willingness/ability to pay for quality seed (certified and QDS).

Table 4.1 Potential seed demand for certified seed and QDS

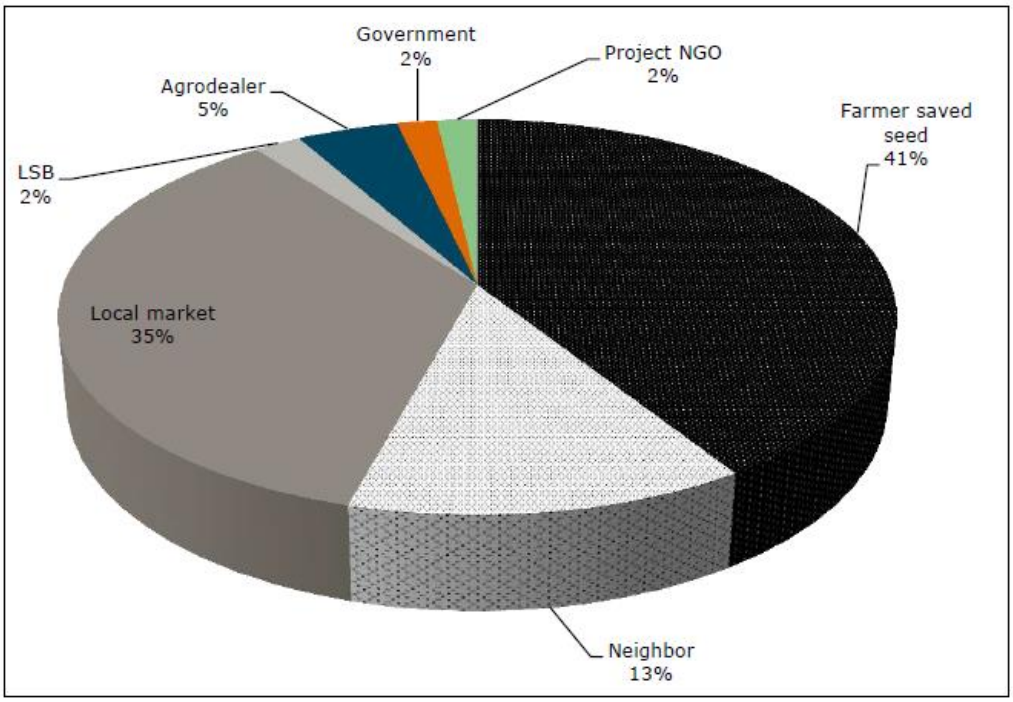
SEED	Area (%)	Area (ha)	Area harvested (ha)	Seed rate (kg/ha)	Estimated seed use per annum (MT)	Seed replace-ment ratio	Potential seed demand for 2015 (MT per annum)	Certified seed produced in 2014 (MT)	Annual seed targets 2020 (MT)
Maize Hybrid	10%	1,103,000	110,300	25	2,758	1	2,758	8,000	10,000
Maize OPV	90%		992,700	25	24,818	3	8,273	6,000	6,262
Rice (upland)	100%	95,000	95,000	50	4,750	3	1,583	2,000	4,000
Beans	100%	674,000	674,000	80	53,920	4	13,480	4,000	22,952
Sesame	100%	207,000	207,000	8	1,656	4	414	50	1,914
Millet	100%	175,000	175,000	5	875	3	292	200	439

Source: Area - UBOS (2015); production 2014 & Annual seed targets 2020 - National Seed Strategy; seed rate & replacement ratio – breeders (oral).

The targets mentioned in Table 4.1 for 2020 are domestic targets. The export market is not very developed. However, bulk orders for maize, rice and beans go to the Democratic Republic Congo and South Sudan and maize hybrid to Rwanda. Although most seed companies target COMESA markets, other COMESA countries also target the same markets. Within COMESA, only Tanzania and Rwanda are net importers of seed. Each COMESA member country is developing its seed market, which may narrow scope for the regional seed sales. At the same time, Uganda has a comparative advantage because it has two seed growing season in agro-ecologies while Tanzania and Kenya have only one major cropping season.

4.2 National seed demand scenario planning

ISSD Uganda conducted a household survey in West Nile, northern Uganda and south western Uganda to determine sources of seed that farmers use (ISSD Uganda, 2014). Three hundred (300) farmers were interviewed in each zone. Survey results showed that farmers obtain 91% of the seed from the informal system which include local markets, social network (neighbours) and farmer-save seed (Figure 4.1).



Source: ISSD Uganda, 2014

Figure 4.1 Smallholder farmers' sources of seed in West Nile, northern and south western Uganda

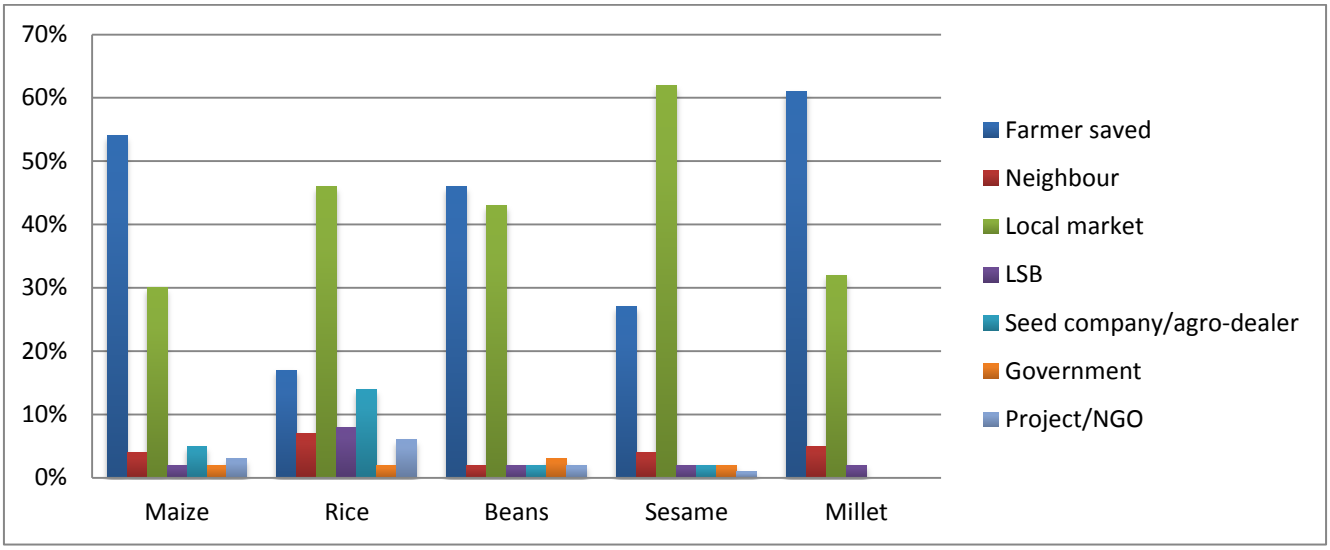
For planning purposes, three scenarios on demand levels are defined. These are:

1) Current demand scenario: takes seed demand based on existing available data and estimated volumes seed produced and sold in 2014 and takes into consideration the current household sources of farmer seed (ISSD Uganda, 2015);
2) Intermediate demand scenario is a growth scenario that would be achievable in the next five years and is based on growth potentials if adoption rates increase and for some crops also with an increase in acreage; and
3) Best demand scenario is a growth scenario that is only possible with the optimum farmer adoption rate and more intensive agriculture. This scenario is in line with the National Agricultural Policy (NAP) 2013 of modernising farming and also in line with targets for 2020 in the national draft seed strategy (2015).

Thus, the scenario planning is based on two factors: a) adoption rate of certified/QDS seed by farmers and b) acreage cultivated per crop.

The analysis starts by looking at seed sources per crop that farmers cultivate in the three zones where the access to seed household survey was conducted. The results are presented in Figure 4.2. For all crop groups, farmers access seed mainly through the informal seed systems. The percentage of seed accessed through the informal seed system is taken as the current situation non-adoption rate. The local market (green bar), shows potential to increase seed demand as it currently supplies mainly implicit seed (grain sold/used as seed). This implies that small scale farmers do not always have the right quantities of seed and/or

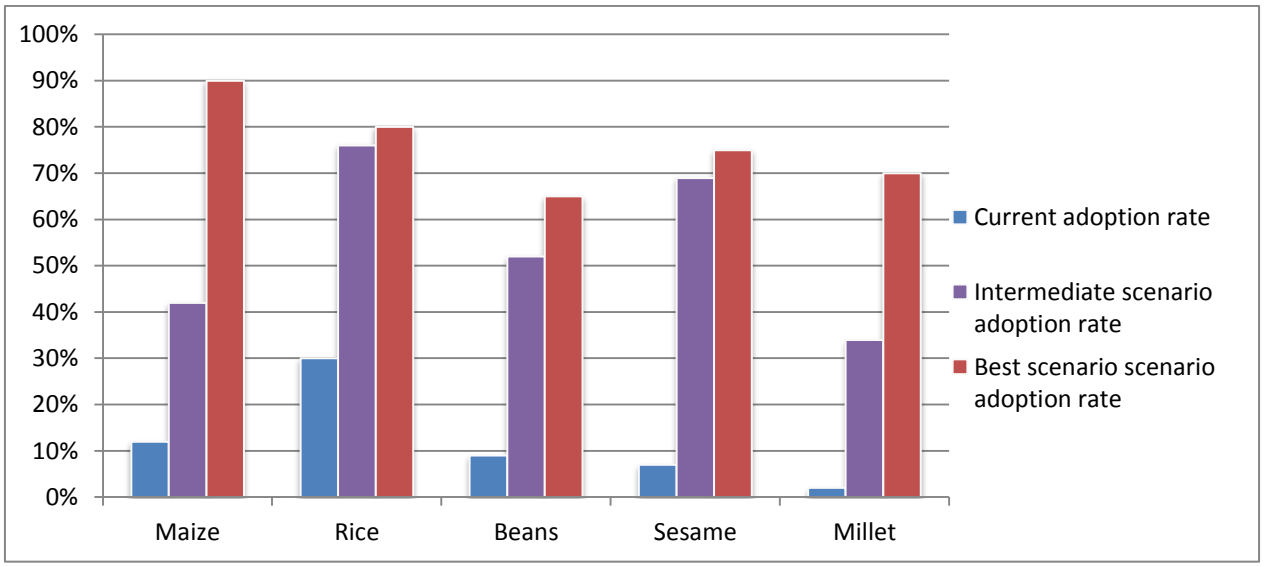
varieties at home. Results from the survey showed that 30-63% of smallholder farmers get seed from local markets for all selected crops. Subsequently, the size of the local market is taken as the growth potential for quality seed for the intermediate demand scenario. For maize, the potential growth will be higher as the three areas surveyed were not major maize growing areas. Note that for millet, no seed was sourced through the formal system (seed company, government, projects).



Source: ISSD Uganda, 2014

Figure 4.2 Proportion of seed sources of farmers for crops representing groups (%)

The scenario planning is based on the ISSD Uganda access to seed household survey data. The current adoption rate is taken as the percent of farmers that bought seed from agro-dealers, LSBs or received seed from an NGO or NAADS. The intermediate scenario uses the percentage of farmers that buy grain from the local market and plant that as seed. For the best demand scenario, adoption rates were adjusted upwards to meet demand as projected in the draft National Seed Strategy (2015). Table 4.2. and Figure 4.3 present estimated adoption rates for the different seed demand scenarios.



Source: ISSD Uganda, 2014

Figure 4.3 Estimated farmer adoption rate for use of quality seed for different scenarios (%)

The second variable in scenario planning is the land under cultivation for each crop and is presented in Figure 4.4. As the land size per crop is based on UBOS 2009 data and considering that land is used more intensely compared to 2009 (less fallow; peace in Northern Uganda), the area under production increases under the different scenarios.

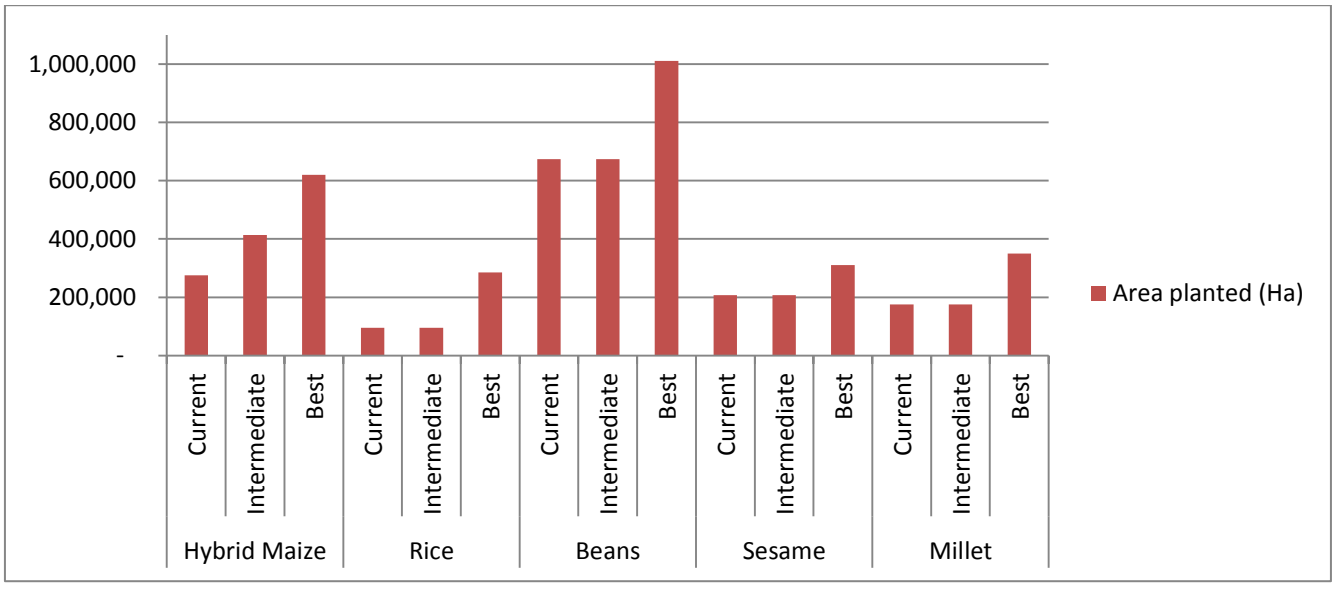


Figure 4.4 Scenario planning for area planted (ha)

For hybrid maize, the adoption rate is taken as 90% because ideally that seed needs to be replaced every season. Table 4.2 presents how much commercial/quality seed, foundation

and breeder seed is needed for each of the three scenarios. The best scenario is created to line up with the targets in the National Seed Strategy, except for beans and sesame which seem unattainably high (Table 4.1). For each crop, the analysis starts by estimating the area under cultivation (Figure 4.4), the seed rate per hectare, estimated seed replacement rate and adoption rate (Figure 4.3). The seed replacement rate is the same for all three scenarios.

The demand for EGS seed is calculated by dividing quality seed and foundation seed demand, respectively, by the seed multiplication ratio. This provides the order of magnitude of foundation and breeder seed needed. To achieve volumes required for the best scenario, cereals need two rounds of bulking, legumes three, while sesame and small grains require one round of bulking.

Table 4.2 Quantities of commercial, foundation and breeder seed for selected crops under three scenarios

	Hybrid Maize			Rice			Beans			Sesame			Millet		
	Current	Middle	Best	Current	Middle	Best	Current	Middle	Best	Current	Middle	Best	Current	Middle	Best
Commercial / Quality Seed Demand															
Area planted (Ha)	275,750	413,625	620,438	95,000	95,000	285,000	674,000	674,000	1,011,000	207,000	207,000	310,500	175,000	175,000	350,000
Seed rate (Kg/Ha)	25	25	25	50	50	50	80	80	80	8	8	8	5	5	5
Estimated seed replacement (years)	1	1	1	3	3	3	4	4	4	4	4	4	3	3	3
Adopters (%)	90%	90%	90%	30%	76%	80%	9%	52%	65%	7%	69%	75%	2%	34%	70%
Demand (MT)	**6,204**	**9,307**	**13,960**	**475**	**1,203**	**3,800**	**1,213**	**7,010**	**13,143**	**29**	**286**	**466**	**6**	**99**	**408**
Foundation / Demand															
Rounds of bulking	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**
Annual national demand Commercial / Quality seed (MT)	6,204	9,307	13,960	475	1,203	3,800	1,213	7,010	13,143	29	286	466	6	99	408
Estimated seed yield for FS to Quality seed production (MT/Ha)	2.88	2.88	2.88	1.20	1.20	1.20	1.20	1.20	1.20	0.80	0.80	0.80	0.75	0.75	0.75
Estimated area to produce QS (Ha)	2,154	3,231	4,847	396	1,003	3,167	1,011	5,841	10,953	36	357	582	8	132	544
Seed rate for FS production (Kg/Ha)	24	24	24	50	50	50	80	80	80	8	8	8	5	5	5
Demand (MT)	**52**	**78**	**116**	**20**	**50**	**158**	**81**	**467**	**876**	**0**	**3**	**5**	**0**	**1**	**3**
Correction for bulking (seed mult. rate * rounds)	1	1	1	24	24	24	225	225	225	1	1	1	1	1	1
Demand FS seed(MT)	**51.70**	**77.55**	**116.33**	**0.82**	**2.09**	**6.60**	**0.36**	**2.08**	**3.89**	**0.29**	**2.86**	**4.66**	**0.04**	**0.66**	**2.72**
Breeder Seed Demand															
Annual nat. demand FS seed (MT)	51.70	77.55	116.33	0.82	2.09	6.60	0.36	2.08	3.89	0.29	2.86	4.66	0.04	0.66	2.72
Est. seed yield for BS to FS production (MT/Ha)	2.88	2.88	2.88	1.5	1.5	1.5	1.2	1.2	1.2	0.8	0.8	0.8	0.75	0.75	0.75
Est.area to produce BS round 1 (Ha)	17.95	26.93	40.39	0.55	1.39	4.40	0.30	1.73	3.25	0.36	3.57	5.82	0.05	0.88	3.63
Seed rate for BS production (Kg/Ha)	24	24	24	50	50	50	80	80	80	8	8	8	5	5	5
Demand Breeder seed (Kg)	**431**	**646**	**969**	**27**	**70**	**220**	**24**	**138**	**260**	**3**	**29**	**47**	**0**	**4**	**18**
Demand (MT)	**0.43**	**0.65**	**0.97**	**0.03**	**0.07**	**0.22**	**0.02**	**0.14**	**0.26**	**0.00**	**0.03**	**0.05**	**0.00**	**0.00**	**0.02**

4.3 Crop specific seed market characteristics

4.3.1 Hybrid maize

The target market for hybrid maize in 2020 is 10,000 MT. Considering that a small seed processing infrastructure of US$ 400,000 processes 200 MT, this would be a minimum size of seed company to work at economies of scale. The maize market is, therefore, large enough to accommodate the 26+ seed companies. 3,300 hectares are needed to produce 10,000 MT seed. Sixty three (63) hybrid maize varieties are released in Uganda (USTA seed variety database 2016), of which around 50 are marketed.

Farmers that use hybrid maize generally use fertilizer and yields are around 2.4 MT per hectare. The output market does not differentiate for quality of maize grain. Therefore, farmers do not get a premium for quality grain. A Harvard study found that 40% of maize varieties are not true to type (Bold et al , 2015). Seed companies and public breeding face challenges to maintain purity of parental lines. Twenty three (23) companies produce maize seed. International companies active in the market are Pannar, Monsanto and Kenya seed. Until recently, maize was sold in 5 kg and 10 kg packs only, while 2 kg packs are now available. Approximately 10% of the maize seed is inspected by NSCS (Draft NSS, 2015).

Taking the intermediate scenario, seed companies will jointly need 3,231 ha to produce 9,307 MT certified seed. Since there are two seasons, this would mean 1,615 ha per season. Three seed companies have each around 100 ha, the remaining seed is produced using out-growers. Jointly the seed companies will need 78 MT of foundation seed (1 cross and 1 parental line). The foundation seed producers will need 27 ha to produce this quantity.

4.3.2 Rice

For both upland and lowland rice, 20 varieties are released in Uganda, of which 6 are being marketed by 6 local seed companies (USTA variety register). The rice seed market is not well developed. In 2013, 22% of seed farmers used in West Nile, south western and northern Uganda came from agro-dealers (14%), government (2%), and NGOs (6%) (ISSD Uganda, 2014). Rice is currently not a QDS crop, however, a number of farmer groups are producing and marketing rice seed, particularly in eastern Uganda. With the newly released varieties on the market, farmers have a little more choice and there is scope to develop the quality seed market from 3800 MT in 2014 to 4000 MT in 2020. To produce 3,800 MT of seed, requires 3,126 ha and 158 MT of foundation seed with 2 rounds of bulking.

Taking the intermediate scenario, seed companies will need 1,003 ha to produce 1,203 MT of certified seed. Since there are two production seasons, this would mean on average 500 ha per season. Seed companies mainly use out-growers to produce certified seed.

4.3.3 Beans

According to the variety release database, 27 bean varieties have been released by NARO and seven seed companies are involved in bean seed production. In 2014, bean seed was

the second largest crop in terms of seed production with 4,000 MT. The target for 2020 is 23,000 MT of which the largest proportion (75%) is produced as quality declared seed. This huge potential increase in marketed bean varieties poses a challenge on the EGS system; especially when it needs 3 generations of bulking before sufficient EGS is available.

Taking the intermediate scenario, 5,841 ha is needed to produce 7,010 MT of certified seed and QDS. This means 2,920 ha per season. Almost all certified seed is produced through out-growers, while QDS is produced by farmer groups (LSBs). Farmers on average produce seed on 0.5 – 1 ha.

Seed companies and farmer groups will need 467 MT of foundation seed. This is produced using three rounds of bulking. The first round of bulking uses 138 kg of breeder seed on 1.73 ha, yielding 2.08 MT of foundation seed. The second round starts with 2.08 MT planted on 26 ha. This yields 31.2 MT of FS. The second round of bulking uses this 31.2 MT planted on 380 ha. This yields 468 MT of foundation seed that will be used to produce certified seed and QDS. To have a continuous flow of foundation seed available, each year needs to produce the first, second and third generation of foundation seed. Therefor in total, 408 ha is needed on an annual basis to produce sufficient quantities of foundation seed.

4.3.4 Sesame

Three sesame varieties are released in Uganda and two seed companies, both operating in northern Uganda market these three varieties. Due to the high multiplication rates, small volumes of seed are required and sesame is normally sold in 1 kg – 5 kg packs. In 2014, 50 MT of seed were produced and it is anticipated to increase to 1,900 MT, of which the bulk will be is produced under the QDS system.

Taking the intermediate scenario, seed producers will jointly need 357 ha to produce 286 MT of certified seed and QDS on an annual basis. They will need 2.86 MT of foundation seed, which can be produced on 3.57 ha.

4.3.5 Millet

Seven finger millet varieties and three pearl seed varieties are released in Uganda. One seed company deals in millet seed. In 2014, 200 MT were produced. The target for 2020 is 440 MT. This is still very small. This has implications on cost of production and economies of scale.

Taking the intermediate scenario, seed producers will need 132 ha to produce 99 MT of seed. They will need 0.66 MT of foundation seed. The foundation seed producers will need 0.88 ha to produce 0.66 MT of foundation seed.

4.4 Cost of seed production at each stage of the value chain

To calculate the cost of production, bulking provides a challenge as each additional round, adds production costs without generating income. It should be noted that seed production is predominantly rain fed. Currently, research institutes can only bulk for two seasons in one

year as they are depending on rains. This would mean that it takes at least two years before required quantities of foundation seed for legumes can be produced.

The cost of seed production varies according to the entity that is producing the seed. Currently, all breeder seed is produced by NARO with the exception of some hybrid maize and sunflower varieties. The breeders rely on out-growers for part of foundation seed production.

Seed produced by seed companies is assumed to follow all required standards and procedures for production. Seed companies spend relatively large amounts resources on processing, packaging and marketing of seed. For both foundation and certified seed companies rely mostly on out-growers and buy-back seed at a per unit cost. Farmer groups produce QDS of self-pollinated varieties using low input low output schemes. They do not spend the same amount on seed processing, packaging and transport since seed is sold in the vicinity of the farmer groups. Therefore, QDS seed is sold at a lower price than certified seed. For all crops except for millet, the cost of production is calculated for certified seed. Due to the small volume, millet seed production as QDS is more cost-effective.

The cost of quality seed production is based on the following assumptions and methods:

- Cost of seed production was standardised per hectare and then converted to a kilo price using the estimated yield per hectare. Unit costs per hectare are used to calculate cost of production of quality seed (both certified and QDS);
- Casual labour was standardised and higher for crops that require more labour intensive activities and slightly lower for less labour intensive crops;
- All crops and at each stage of the value chain use a standard rate of 120 kg mineral fertilizer and 10 litres of chemicals per hectare (out-growers may not use fertilizers and chemicals, but will also have a lower yield as a trade-off);
- Cost of interest from bank loans are not taken into consideration;
- Fixed costs are most difficult to estimate. For most crops, it was assumed that a seed companies employs 2–3 technical staff to supervise out-growers. The remainder of the fixed costs were taken as a percentage of the variable costs. As the volume of seed production is low for foundation seed, the total fixed costs, except for staff related costs are relatively low for foundation seed;
- Except for breeder seed, irrigation is rarely used. Most breeding stations do not have sufficiently large functional irrigation systems to produce the required quantities of EGS securely;
- To calculate the unit cost of production, the yield per hectare is based on the seed multiplication ratio and seed rate. The estimated yields in 2015 are not always reached because of low input agronomic practices, and unfavourable weather. This results in a lower cost of production, although this is compensated by the larger acreages needed to produce the required quantities. Since labour is the highest cost for seed production, this averages out; and
- Cost of seed inspection is taken at UGX 100/kg including government issued tamperproof labels. Except for hybrid maize, this is considered the rate for commercial seed inspection. Currently, the official rates for field inspection and laboratory testing are extremely low (as per the regulations), however, additional indirect costs include travel of inspectors.

Table 4.3 presents the current cost of seed production and at each stage of the value chain and if seed would be produced on a cost recovery basis. Annex 3 gives details on how the costs are derived. The cost price for breeder and foundation seed provides a margin of 10% to manage risks of losses during harvesting, storage and planting. For certified seed, the cost of production includes seed treatment, processing and marketing. Marketing costs are taken as if all seed is for retail market (no bulk sales). For certified seed/QDS, the margin is not included as the total margin, including potential profit is depicted by the difference between cost of production and the current sales price.

Table 4.3 Cost of seed production at each stage of the seed value chain (UGX/kg) for current practice and cost-recovery practice

Cost of seed production	**Hybrid maize**		**Rice**		**Beans**		**Sesame**		**Millet**	
(UGX per kg)	Current	Cost recovery	Current	Cost recovery	Current	Cost recovery	Current	Cost recovery	Current	Cost recovery
Breeder seed (incl. margin)	927,612	927,612	49,573	49,573	142,811	142,811	64,375	64,375	76,289	76,289
Foundation seed (incl. margin)	49,758	56,869	9,234	11,277	5,643	15,382	4,201	4,799	10,316	10,788
Certified seed/ QDS (excl. margin)	2,771	3,079	2,250	2,491	2,928	3,687	2,259	2,207	3,275	3,321
Margin (UGX)	2,229	1,921	1,750	1,509	1,072	313	3,741	3,793	225	179
Margin (%)	80%	62%	78%	61%	37%	8%	166%	172%	7%	5%
Certified seed price	5000	5000	4000	4000	4000	4000	6000	6000	3500	3500

Sources: SC interviews, breeder interviews, ISSD records and roundtable

The cost of seed production at each stage in the value chain is calculated for two practices using the current seed sale prices for breeder and foundation seed as input in the cost of production (Table 4.4), while the cost-recovery practice uses the unit costs for breeder seed and foundation seed based on actual costs of production (including 10% margin). These figures are calculated under the current demand scenario. For example, in 2015, seed companies and LSBs paid UGX 10,000 for one kilogramme of breeder seed for bean; while the actual cost of production of one kilogramme of breeder seed was UGX 142,811. Thus to calculate the cost of foundation seed under the current scenario, the cost price for breeder seed (input in foundation seed production) is UGX 10,000 per kilo, while in the cost recovery scenario UGX 142,811 per kilogramme was taken as input cost.

Table 4.4 Sales prices for breeder, foundation and certified seed in 2015.

	Breeder seed price (UGX/kg)	**Foundation seed price (UGX/kg)**	**Certified seed price (UGX/kg)**
Maize Hybrid	495,000	20,000	5,000
Rice	5,500	5,500	4,000
Beans	10,000	5,000	3,000
Sesame	10,000	10,000	6,000
Millet	12,000	12,000	3,500

Source: roundtable

4.5 Profitability of seed value chains and hidden subsidies

To identify whether each value chain has an overall positive balance and generates profit, the cost and revenues at each stage are calculated using different scenarios and cost recovery practices. There are three assumptions underlying value chain profitability analyses:

- Volume of seed produced is also sold, keeping seed losses at the minimum. This requires proper market predictions.
- The calculations do not differ for different varieties. Depending on how segmented the seed market is for various varieties, this may affect the economies of scale.
- For legumes, if foundation seed is bulked one more round at the seed company/farmer group level, the input cost for commercial seed would go down by approximately UGX 600-700 per kg.

Table 4.5 provides the total value chain cost and revenue for breeder, foundation and commercial seed production, using the seed unit cost for current practices and the volumes estimated under the current demand scenario. Annex 3, provides the tables with the volumes and cost /sales price used to calculate the profit at each stage of the value chain.

Table 4.5 Value chain profit at each stage in UGX (*1,000) – using current costing practice and current demand scenario

	Maize Hybrid	Rice	Beans	Sesame	Millet
Breeder seed cost	399,670	1,363	3,422	187	20
Breeder seed revenue	213,275	151	240	240	3
Profit/Loss	*-186,395*	*-1,212*	*-3,183*	*53*	*-17*
Foundation seed cost	2,572,635	182,763	456,369	1,217	401
Foundation seed revenue	1,034,063	108,854	323,520	2,898	156
Profit/loss	*-1,538,572*	*-73,909*	*-132,849*	*1,681*	*-246*
Quality seed cost	17,195,167	1,068,948	3,552,149	65,466	19,106
Quality Seed revenue	31,021,875	1,900,000	4,852,800	173,880	20,417
Profit loss	*13,826,708*	*831,052*	*1,300,652*	*108,414*	*1,311*
Overall VC profit	*12,101,741*	*755,931*	*1,164,620*	*110,148*	*1,048*

Legend: VC= Value chain

From table 4.5 it is obvious that breeder and foundation seed, except for sesame is sold at a much lower unit price than the cost of production; although each value chain can operate at a profit. Although the EGS volumes and profit margins are small; benefits from commercial seed outweighs losses. As noted earlier, it is not possible to have a profit on millet seed, unless it is produced and marketed as QDS. These losses can be considered as subsidies as EGS are available on the market. Table 4.6 shows the level of subsidy per kg of seed produced for breeder and foundation seed. Since few seed companies are currently

maintaining parental lines and/or produce foundation seed; the subsidy is mainly covered by the public sector. For breeder seed, this is mainly salary costs of staff at the institutes as no depreciation costs are taken into consideration. These costs are mainly opportunity costs for salaries which are catered for through the national budget. Additional costs include training and field allowances. It is noted that the highest subsidy is for hybrid maize, although the overall profit of the value chain is the largest.

Table 4.6 Level of subsidy for one kg of breeder and foundation seed (UGX) using current costing practice

	Hybrid maize	Rice	Beans	Sesame	Millet
Breeder seed per kg	432,612	44,073	132,811	-	64,289
Foundation seed per kg	29,758	3,734	1,643	-	-

Table 4.7 provides the overall value chain profit in case the current EGS volumes are produced and sold on a cost-recovery basis. The value chain that would be affected most is the bean value chain as the overall profit would be reduced from 1.1 Billion to 380 Million UGX. It could well be, that the level of hidden subsidy is hampering production of sufficient quantities of foundation seed for beans, thus hampering growth of the formal seed market. Increasing the unit price for breeder and foundation seed would make theses stages more attractive for actors to produce.

Table 4.7 Overall Value chain profit current demand scenario and production at cost recovery (*1,000 UGX)

	Maize Hybrid	Rice	Beans	Sesame	Millet
Overall VC profit	11,920,465	716,710	380,074	109,921	1,047

Table 4.8 provides an overview of the value chain profit at each stage using cost-recovery production practice and the intermediate demand scenario. The certified seed price is kept at the same price (Table 4.4). The overall profit increases by roughly tenfold for beans, sesame and millet. It roughly triples for rice, while for hybrid maize the overall value chain profit increases by 50%. Therefore, increasing the seed market, thus promoting higher adoption rates by farmers, will increase the economic incentive to produce seed at all stages of the value chain.

Table 4.8 Overview of value chain profit at each stage in UGX (*1,000) – cost-recovery practice and intermediate demand scenario

	Maize Hybrid	Rice	Beans	Sesame	Millet
Breeder seed cost	599,506	3,452	19,774	1,839	336
breeder seed revenue	599,506	3,452	19,774	1,839	336
Profit/Loss	*0*	*0*	*0*	*0*	*0*
Foundation seed cost	4,410,458	565,432	7,188,117	13,709	7,132
Foundation seed revenue	4,410,458	565,432	7,188,117	13,709	7,132
Profit/loss	*0*	*0*	*0*	*0*	*0*
Quality seed cost	28,652,114	2,997,669	25,842,415	630,449	329,288
Quality Seed revenue	46,532,813	4,813,333	28,038,400	1,713,960	347,083
Profit loss	*17,880,698*	*1,815,664*	*2,195,985*	*1,083,511*	*17,795*
Overall VC profit	*17,880,698*	*1,815,664*	*2,195,985*	*1,083,511*	*17,795*

4.6 General Considerations

Analysing the national seed demand, cost of EGS production and overall value chain profitability a number of general considerations can be drawn:

1) Currently, the most commercial crops and hybrids, receive the largest amount of hidden subsidy, yet these crops have the highest profit margin. Producing EGS on a cost recovery basis will reduce the hidden subsidies and distribute revenue according to where costs are made. This may be a stimulation for seed companies to invest more in producing their own EGS.
2) Adoption rates by farmers are very low. Therefore, the seed market remains small. The intermediate demand scenario is more likely than the best scenario. To reach the intermediate demand scenario investments in seed extension showing benefits of buying quality seed is essential.
3) Another way that could increase adoption may be to reduce the price of certified seed. The value chain analysis shows that except for hybrid maize and rice, the margins are too small for a price reduction. A pilot could be done with smart subsidies reducing the certified seed price for farmers. At the same time, free seed distributions through government and NGO programmes should be stopped. This will provide an opportunity for seed companies to develop strong brands for varieties and increase predictability of demand and subsequently demand of EGS.
4) Using a planning scenario of increased seed demand and stimulation of cost recovery practices, will increase efficiency along the value chain and re-distribution of extra-ordinary profits from the private sector to public sector and will create an incentive for the institutes and private sector to produce foundation seed as a business.

5) Some crops, such as millet have such a small demand, that a single entity could produce all the required foundation seed. For such crops, market control is needed to prevent competition that may result into overproduction and price collapse.

The above considerations lead to an analysis of the best way to produce and market EGS on a sustainable basis for the different crop types. This is the subject of chapter 5.

4.7 Conclusions

The cost of seed production varies according to the entity that is producing the seed. Currently, all breeder seed is produced by NARO with the exception of some hybrid maize varieties. The breeders rely on out-growers for part of the foundation seed production. Seed companies spend relatively large amounts resources on processing, packaging and marketing. For both foundation seed and certified seed, companies also rely on out-growers and buy seed at a per unit cost from them. Farmer groups produce QDS of self-pollinated varieties using low input and low output schemes as they do not spend the same amount on seed processing, packaging and transport and seed is sold in the vicinity of the farmer groups. Millet seed would make a loss, if produced as certified seed; but producing it as QDS is the most cost-effective.

5. EGS operational strategies – Optimal archetypes

5.1 Introduction

To define the optimal cost-effective way to produce and market EGS, crop groups are allocated in one of four archetypes. These archetypes are defined based on the level of predictable and stable demand for the seed and on whether seed as a product can be easily differentiated from other products such as different varieties and home-saved seed. Deloitte in a study for BMGF and USAID defined four archetypes that have the potential to address EGS bottlenecks. These are presented in Table 5.1.

Table 5.1 Market archetypes

		Possibility for exclusive product	
		High	**Low**
Level of demand for crops grown with quality seed of improved varieties	**High**	**1. Private sector**: Quality seed of improved varieties that is both attractive for private sector actors to produce and that produces crops the market demands, resulting in robust private sector investment with minimal public sector involvement	**2**. **Public-Private Collaboration**: Quality seed of improved varieties for crops with strong market demand but for which the cost of production or demand risk create barriers to private-sector investment and innovation resulting in public sector involvement. **2a.** PP- public sector mitigates demand risk: seed that is attractive for private sector companies to produce, but for which they cannot reliably forecast demand leading to high demand risk and high cost of capital **2b.** PP-costly/complex production. Public sector supports breeder and foundation seed production. Seed that is reliably demanded by consumers, but which are unattractive to produce EGS for due to high effort or technology intensity, risk or post-production loss or generally low margins.
	Low	**4. Niche private sector**: Quality seed of improved varieties for crops with niche market demand, profitable to produce with minimal public involvement	**3**. **Public Sector**: Quality seed of improved varieties that are not highly desirable or profitable to produce, but which are promoted by public sector to advance a public goal such as food security or seed security

Source: Terms of reference for EGS study with endorsement by roundtable workshop held on 10 February 2016

Key variables determining the level of excludability of seed as a product include but are not limited to:

- Frequency with which quality seed must be bought to maintain performance and vigour of an improved variety;
- Existence of differentiating characteristics that command a price premium;
- Hardiness/Shelf-life of seed or planting material to withstand storage and transportation with minimal loss;
- Presence of significant upstream demand for continuous improvement innovation (increased productivity and yield from technological improvements); and
- Labour, input and technology intensity of producing seed.

Key variables that determine the level of seed demand include but are not limited to:

- Total demand for all varieties of the crop in applicable markets;
- Market quality standards;
- Sophistication of farmer demand for varieties, which may be linked to different geographical markets and end markets for processed products;
- Sophistication of end-market consumers of the crop product, which may be connected to different geographic markets;
- Specialisation of demand for varieties with specific defining characteristics, such as Aroma, colour etc.; and
- Common economic framework that highlights the economic characteristics of seed that have implications for ideal state value chains.

5.2 Considerations for selection of Archetypes for crop types

Current output market is largely undifferentiated in Uganda, except for some niche markets, such as sorghum variety for breweries. Sophistication for demand for varieties includes improved and local varieties that have the preferred traits. End-product consumers are closely related to output markets. Table 5.3 presents the key variables that influence the potential archetypes for each of the crop groups.

Table 5.2 Overview of key variables that influence potential archetypes for EGS production.

Variable	Hybrid Maize	Rice	Beans	Sesame	Millet
Total demand for all varieties of the crop in applicable markets	High	Medium	High	Medium	Low
Market quality standards	Undifferentiated	Undifferentiated	Undifferentiated	Undifferentiated	Undifferentiated
Sophistication of farmer demand for varieties, which may be correlated to different geographical markets and end markets for processed products	High	Low	Medium	Low	High
Sophistication of end-market consumers of the crop, which may be correlated to different geographic markets	Low	Low	Low	Low	Low
Quantity of foundation seed required, considering multiplication rate and area	Medium	Medium	High	Low	low

In addition to the key variables presented in Table 5.3, a number of general considerations should also be taken into account. These are based on the analysis in chapter 3 and 4.

- Compared to current practices whereby EGS is not inspected, certified and marketed, two additional costs should be included if the seed is to be sold to third parties. These cost are: a) seed inspection and certification fees; and b) packaging. These were taken into consideration in the cost-recovery scenarios as NARO moves towards formal inspection of foundation seed.
- Most crops have an uncertain market demand which makes it hard for commercial seed producers to estimate the volumes they could sell on an annual basis. This calls for broader sector collaboration.
- At the moment there is a low incentive for NARO institutes to produce and market early generation seed as all income generated-non-tax revenue (NTR) in the institute needs to be returned to the Ministry of Finance at the end of the financial year. Therefore, breeders try various other ways to ensure continued production of EGS.
- Most public institutes do not operate on business principles resulting into above average revenue = marginal revenue line mode.
- Establishing a functional royalty system will provide an incentive for NARO to streamline EGS seed production and will allow third parties to multiply breeder seed into foundation seed, creating an income stream into the institute. This will generate funds to support further breeding of new varieties and maintaining existing ones.
- Costs of research and variety development were not taken into consideration in the cost of seed production and will need continued government and Development Partners support. Cost of breeder seed would go up considerably, if R&D needs to be earned back from the sale of seed; especially for crops with a low market demand. Most major crop breeding programmes in Uganda are externally funded and thus heavily subsidized.
- The land size required to produce breeder seed for crops with high multiplication rates (e.g. sesame and millet), foundation seed is very small. As foundation seed can be

produced with a profit, this may seem attractive to private sector. However, if too many companies get involved, this may cause oversupply in the market. Too much competition will force all companies to produce at a loss.

- It should be noted that seed production is predominantly rain fed. For crops like beans, the three rounds of foundation seed multiplication could be accomplished in one year if irrigation facilities were available. This investment would add substantially to the production costs, if it is to be earned back through sales and sustained higher yields.

5.3 Proposed Archetypes for each of the crop groups

Figure 5.1 to 5.4 provide an overview of the major bottlenecks for each crop group and the proposed solutions to address them.

5.3.1 Hybrids (Maize): Private sector archetype and Public-private archetype

Although the cost of EGS production can be integrated into that of certified seed that would fit the private sector archetype, the current institutional setting is not conducive. Main challenges that affect the market demand are related to the quality of seed in relation to genetic purity and high level of counterfeit seed in the market. The latter is largely attributed to a weak seed quality control and certification of EGS. There is a shortage of breeders and skilled technical personnel in national breeding institutions (on average one breeder per crop). Seed companies do not have infrastructure and personnel to generate their own varieties. Therefore, a public-private partnership, where international and national research centres should invest in developing new varieties and breeder seed, with seed companies producing foundation seed is the most appropriate in the short-term. This will take care of the inherent losses incurred in breeder seed production and would also serve as a hidden subsidy by the public In the long-term, hybrid maize development should be entirely private sector-led. In addition a fully private sector-led archetype is operational for varieties developed by the private sector. This will need favourable import regulations and an operational intellectual property rights system.

5.3.2 OPV of major cereals (e.g. rice): Public-private archetype

With newly released rice varieties on the market, farmers have a little more choice and there is scope to develop the quality seed market from 3,800 MT in 2014 to 4,000 MT by 2020. EGS is produced at a loss. Looking at the 5 selected crops, rice generates the second smallest value chain turnover and profit; just before millet. This suggests that partnerships along the rice value chain are critical. In addition, farmers' knowledge about quality seed needs to be improved through extension services. An efficient and regulated seed distribution system is needed to enhance seed uptake by farmers.

5.3.3 Legumes (beans): Public-private partnership archetype

According to the variety release database, 27 bean varieties have been released by NARO and seven seed companies are producing seed. In 2014, bean seed was the second largest crop in terms of seed production with 4,000 MT. The target for 2020 is 23,000 MT of which the largest proportion (75%) is produced as quality declared seed. This huge potential increase in marketed bean varieties, poses a challenge on the EGS system. Considering that currently, foundation seed is hardly bulked. However to meet the demand for quality seed will need three rounds of bulking, as it is being done using farmer groups. This should continue but more emphasis will be needed on tracking the number of rounds of bulking, inspection of seed fields and seed testing in the laboratory for purity and germination. The three rounds of bulking could be done by the private sector for those varieties that they market (these are only seven companies and seven varieties), however lack of exclusivity and the need for QDS to meet the demand, reduces the attractiveness of producing foundation seed. Most popular varieties should be taken up by a Foundation Seed Enterprise (FSE) that operates under NARO Company Holding Ltd as a social enterprise. Note that there are no profits to be made in multiplying foundation seed. Varieties specific for particular zones could be multiplied by seed companies for their own seed production and ZARDIs and farmer groups under supervision of breeders for QDS.

5.3.4 Oil seed (Sesame): Public archetype, public-private partnerships and niche market archetypes

As mentioned earlier in the report, the crop group oil seed consists of leguminous crops such as groundnut and soybean. Therefore, no separate illustration is presented as no common solution could be proposed. With reference to sesame, the seed sector produced 50 MT of seed and it is anticipated that this increases to 1,900 MT, of which the bulk is produced under the QDS system. To produce sufficient quantities of sesame seed, only approximately 10 hectares are needed for foundation seed production. Due to the low acreage needed, sesame can be considered as a niche market crop, in which farmers only buy seed when a new variety is released and market demanded. Those two seed companies engaged in sesame seed production can produce their own foundation seed from breeder seed bought from NaSARRI. One ZARDI can fulfil the remaining seed needs. The market should be controlled to avoid too many farmer groups investing in seed production and then not be able to sell seed at a premium. There are no records on production of EGS for Sesame from NaSARRI. The reason that sesame is mainly archetype 2, is that it needs public private sector collaboration to control the market to avoid overproduction of seed and to promote good varieties to farmers. There could be an additional option of a niche market for a private variety that has particular niche market traits. That particular variety could be archetype 4 niche market which is fully catered for by the private sector.

5.3.5 Minor cereals (Millet): Niche market archetype and public archetype

One seed company deals in millet seed. In 2014, 200 MT was produced in collaboration with NaSARRI. The target for 2020 is 440 MT. This is still very small. The overall turnover and value chain profit is only 1.5% of hybrid maize and 5% of rice seed value chains. The

market is so small that the public varieties should be produced by NaSARRI in collaboration with NGOs and farmer groups. To increase interest from farmers in small cereals, mechanization at planting, weeding, harvesting and threshing may be a stimulant for growing the crop. In addition irrigation facilities would help since some varieties mature in 65 days and can therefore be grown three times a year. It should be noted that millet can only be a niche crop for specific varieties; which have a premium price. For example there is a variety with special characteristics for production of malt drinks (e.g. Bushera) and local brew (ajono).

Hybrids (major cereals) Public-Private Archetype

Bottlenecks

Seed characteristics
- Hybrids are highly exclusive
- High multiplication rates
- High level of counterfeits/ seed not true to type
- 3 way crosses require high technical skills

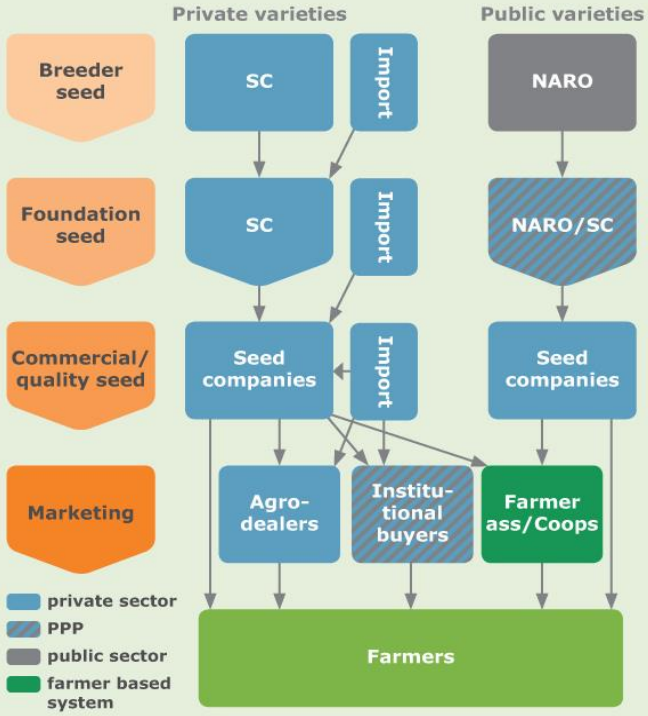
Demand characteristics
- Little market pull for improved varieties
- Limited knowledge farmers on difference between hybrid varieties and OPVs
- Free Distribution hampers brand building seed companies

Regulatory
- Low capacity for certification
- No intellectual property system operational
- No formalised exclusivity arrangements
- NTR disincentive for institutes to produce EGS efficiently

EGS production
- Limited technical capacity of breeders, seed company and out-growers
- 2 rounds seed bulking needed to create 3 way crosses
- Fragmented value chain – no clear EGS demand forecasting
- Lack of trust amongst producers on quality issues
- Lack of appropriate facilities at institutes and seed companies

Private archetype for private sector developed varieties
Objective: import parental lines and produce high quality hybrid seed locally

Public Private partnership for public varieties
Objective: sharing of parental lines & stimulating uptake of Ugandan bred varieties through exclusive licencing. Exclusive licencing will stimulate brand development by SC



Roles and responsibilities public private partnership

Breeder seed
- Breeders produce sufficient parental lines at institute
- SC pay full production cost (appr. UGX 1M/kg)
- NARO provides DNA finger printing services
- External inspection by NSCS / AgVerify (private sector)

Foundation seed
- Exclusivity contracts between NARO and SC
- 1st and 2nd crosses produces at seed company farm or SC outsource crossing to breeder/ institute
- Breeder provides supervisory support & capacity building to SC staff at a fee
- External inspection by NSCS/ AgVerify

Commercial seed
- Seed companies produce seed on farm or use out-growers
- Marketing through formal channels
- External inspection by AgVerify

Figure 5.1 Hybrids (maize) – public private archetype

OPVs-major cereals (Rice) Public-Private Archetype

Bottlenecks

Seed characteristics
- Relatively high multiplication rate
- Relatively high isolation distance (4m)
- No visual difference between grain and seed
- High level of seed not true to type
- Farmers only need to replace seed every 3-4 years

Regulatory
- Low capacity for certification
- Profit margins would allow for private certification
- No intellectual property system operational
- NTR disincentive for institutes to produce EGS efficiently
- QDS not allowed for maize and rice

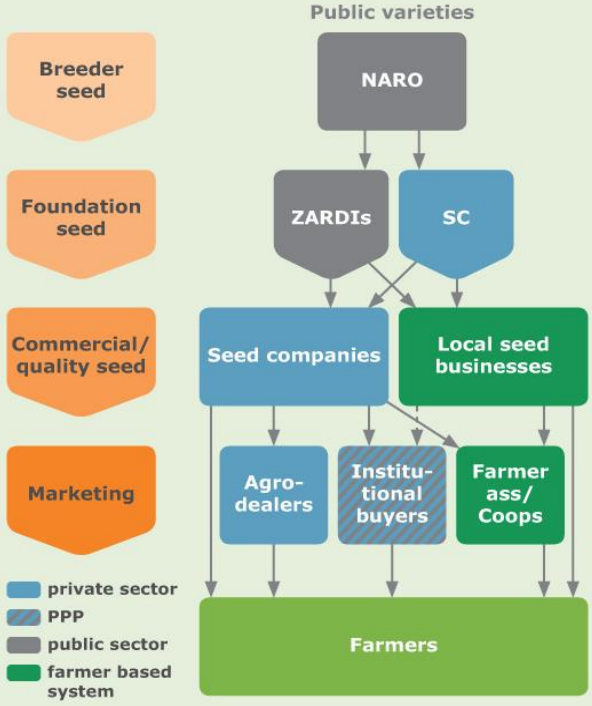
Demand characteristics
- Little market pull for improved varieties
- High re-use of seed (beyond 3-4 years)
- High prevalence of fake and non-certified seed
- Free distribution hampers brand building seed companies

EGS production
- Breeders use out-growers with limited supervision
- Fragmented value chain – no clear EGS demand forecasting
- Lack of trust amongst producers on quality issues
- 1 extra generation needed to produce sufficient quantities.

Proposed solutions to bottlenecks

Public Private partnership for public varieties, allowing QDS

Objective:
- Increase volumes of high quality EGS for seed production
- Reach more farmers through QDS for selected OPVs (excluding Maize) with low market penetration



Roles and responsibilities public private partnership

Breeder seed
- Breeders produce sufficient quantities breeder seed at institute
- SC pay full production cost (appr. UGX 50,000/kg)
- NARO provides DNA finger printing services
- External inspection by NSCS/AgVerify (private sector)

Foundation seed
- Conditional exclusivity contracts between NARO and SC;
- Foundation seed produced at Institute (ZARDIs), SC, LSBs under supervision
- Breeder provides supervisory support & capacity building to SC staff at a fee
- External inspection by NSCS/ AgVerify/accredited inspectors

Commercial seed
- Seed companies produce seed on farm or use out-growers
- Certified seed marketing through formal channels
- External inspection by AgVerify for certified seed.
- Allow QDS when dissemination of variety is slow
- QDS inspection by DAOs

Figure 5.2 OPV major cereals (rice): public private partnership archetype

Legumes (Beans) Public-Private Archetype

Bottlenecks

Seed characteristics
- Low multiplication rate
- High cost of production
- Bulky
- Large difference in seed price and grain price

Demand characteristics
- High use of landraces, little pull for improved varieties
- High reuse of home saved seed
- QDS increased demand
- Free distributions by government and relief agencies

Regulatory
- Low capacity for certification
- No intellectual property right system operational

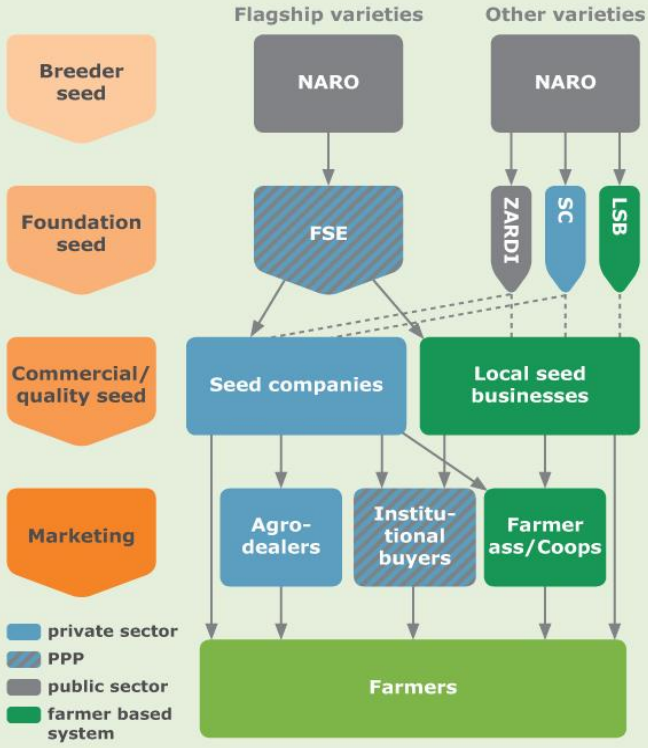
EGS production
- Breeder contracts + outgrower
- 3 Rounds of bulking of FS required
- Fragmented seed value chain – no clear EGS demand forecasting
- Lack of trust amongst producers on quality issues

Proposed solutions to bottlenecks

Establish Bean and Groundnut Foundation Seed Enterprise (FSE)

Ownership structure
- Entity under NARO Company holding Ltd
- Social enterprise
- Joint venture NARO/Dev't partners

Objective
- Bulk sufficient quantities of quality FS for most marketable varieties
- Build trust amongst value chain actors



Roles and responsibilities

Breeder seed
- Breeders produce sufficient quantities at research stations
- 2 flagship varieties exclusively provided to FSE; other varieties produces for S.C, ZARDI, LSBs
- FSE pays full production costs (± 150,000 UGX/kg)

Foundation seed
- FSE produces and markets most commercial varieties at recovery cost (± 15,000 UGX/kg)
- FSE coordinates supply & demand through pre-booking system
- NSCS to inspect & certify FS
- ZARDIs, SCs and LSBs to produce and sell commercial seed varieties
- Inspected by NSCS/delegated inspectors/Breeders

Commercial seed
- SC to produce certified seed for bulk orders & retail marketing
- Registered entrepreneurs & LSBs to produce QDS for local market
- Delegated inspection and certification QDS through DAOs and/or accredited inspectors
- NSCS and/or private accredited seed inspectors for certified seed

Figure 5.3 Legumes (beans) public private partnership archetype

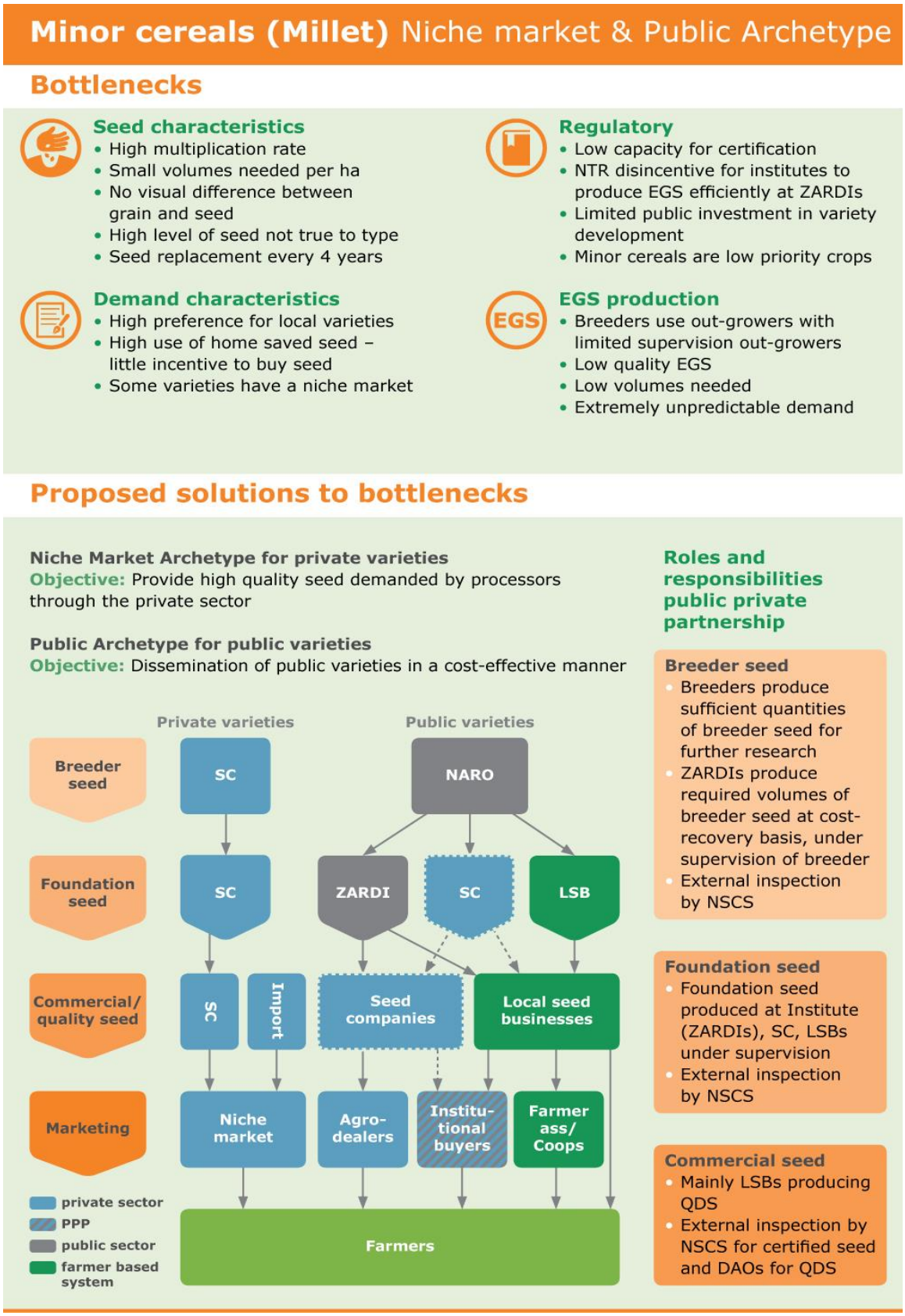


Figure 5.4 Minor cereals (millet) Niche market archetype and public Archetype

5.4 Conclusion

The analysis of the EGS bottlenecks, seed demands potentials and cost of production has led to tailor made archetypes for each of the crop groups. Although in the longer run, more potential exist for fully private sector-led archetypes. The current variety portfolio is predominantly public varieties. Therefore, all crop groups, except for minor cereals have a public-private partnership archetype to address EGS bottlenecks in the short- and medium-term. The public archetype seems most suitable for minor cereals, whereby the objectives of NARIs should be deployment of climate resilient varieties rather than profit making, as seed characteristics are not favourable for profit making. Common bottlenecks in the EGS system for all selected crops are:

- Limited potential for seed as a product to differentiate between varieties and company brands
- Lack of accurate seed demand determination and tools for forecasting
- Insufficient human and infrastructure capital across the entire seed value chain (research and seed producers)
- A weak institutional and policy framework for quality control and assurance mechanisms for EGS

Despite these challenges, a great deal of potential exists to enhance production and commercialisation of EGS to strengthen the nascent seed sector in Uganda. Building capacity for development of farmer-and market–preferred varieties; delivery and use of these products, outreach communication activities and support for regulations will create an efficient seed value chain. This will require identifying potential public-private partnership mechanisms to support information sharing, local evaluation capacity, and distribution systems for new seed technologies. These mechanisms are described in chapter 6.

6. Public Private Partnerships Mechanisms

6.1 Introduction

Analysis of the cost of production at each node of the value chain, profitability of the entire value and considerations for sustainable cost-effective production of EGS has guided in determining of an appropriate archetypes for each crop and institutional arrangements required. It was revealed that public-private partnerships (PPPs) can be very helpful in ensuring that local farmers are able to obtain viable, high quality seed that they desire to grow.

The government recognises the importance of PPPs to enhance the competitiveness of the agricultural and agribusiness sectors and highlights increasing support for PPPs in agricultural value chains as a strategy to increase access to and sustainability of markets (DSIP 2010-2015). A new PPP policy was adopted in 2010. PPPs are seen as a tool for the provision of public services and public infrastructure which better allocate and utilise public funds, more efficiently develop and delivery public infrastructure, provide better quality public services, and increase economic growth and foreign direct investment (FDI). The recommended process for choosing PPP partners is through a consistent, transparent system of competitive tendering (MoLG and UNDP 2010).

In Uganda, investment opportunities exist across the seed value chain. While a better seed production and processing system will provide access to the right quality seed suitable for the local climatic and ecological requirements, improved seed marketing and distribution systems will ensure timely access by farmers at affordable costs. Under this model, the public sector focuses on research and variety development, while the private sector shares the responsibility of seed production, marketing, distribution and dissemination of improved varieties. This means that public research institutions need to adopt a targeted research plan and provide access to genetic material and scientific expertise to both local and multinational private players to facilitate the delivery of better crop varieties that are more suited for the cropping systems and climate in Uganda.

6.2 Potential partners and examples of existing PPPs

In Uganda the key potential actors in the PPPs and examples in the seed sector are listed in Table 6.1 and Table 6.2.

Table 6.1 Overview of potential actors in a public private partnership

Public	Private
• Central and local governments through the Ministry of Agriculture (MAAIF) for policy and regulations; and provision of extension services • Research institutions and universities (e.g. NARO, Makerere and IARCs) for research and development of new improved varieties and production of EGS • Donors/Development partners providing support to government programmes and research institutions in seed sector domains	• Local and MNC companies - produce certified seed and hybrids • Agro-input dealers distribute and market seeds, fertilizers and pesticides) • Financial institutions (banks and SACOs) - provide credit to seed entrepreneurs and producers • SMEs and producer associations, e.g. LSBs - main users of seed • Civil society organisations (NGOs)-providing support in seed production and delivery to smallholder farmers

Table 6.2 Common examples of key partners in seed production and commercialisation

Seed Production and commercialization	Promising seed multiplication technologies
• Public Research Institutes produce breeder and foundation seed Private seed companies produce and market certified seed • Contract growers bulk seed from foundation to certified • LSBs produce QDS	• Research institutes (e.g. NARO, Namalere) develop prototype farm machinery (planters, harvesters, threshers etc.) • Manufacturing company and/ or fabricators mass produces the equipment • SMEs/farmers adopt the technologies

One example to illustrate partnerships in research and development and delivery of research products (varieties and seed) is the "Enhancing maize productivity in Uganda through the Water Efficient Maize for Africa (WEMA) project (www.aatf-africa.org/.../WE...). This was launched to mitigate production constraints associated with drought. It is a public-private partnership project formed in 2008 and coordinated by the African Agricultural Technology Foundation (AATF). The partnership is funded by the Bill and Melinda Gates and Howard G. Buffett Foundations. The project aims at developing and deploying royalty-free drought-tolerant maize varieties using a combination of conventional breeding, marker assisted breeding and biotechnology techniques and applications. AATF works with the publicly-funded International Maize and Wheat Research Centre (CIMMYT); Monsanto, a private agricultural company; and the National Agricultural Research Systems (NARS) in eastern and southern Africa in this effort. In Uganda NARO is the public institution involved. Each partner brings unique expertise to the project. AATF contributes expertise in leadership, public-private partnership management, technology stewardship and project management. CIMMYT provides high-yielding maize varieties that are adapted to African conditions and expertise in conventional breeding and testing for drought tolerance. Monsanto provides proprietary germplasm, advanced breeding tools and expertise, and drought-tolerance transgenes. NARO, farmers' groups, and seed companies, participating in the project contribute their expertise in field testing, seed multiplication and distribution. Table 6.3 shows the benefits that can arise from such partnerships.

Table 6.3 Benefits that can arise from such partnership

Public	Private
• Leverage investment • Access to new technology & research methods • Improve management skills • Generate income from licensing/royalties • Fostering innovations	• Reduces risk of entering new market • Access local genetic materials • Protect Intellectual Property (IP) • Access extension networks • Fostering innovations

Real examples of potential business models that could scale in a commercially sustainable manner are described in chapter 5. Opportunities exist for greater integration of the formal and informal seed systems meaningful partnerships. The current organisation of research into ZARDI, emergence of market-oriented farmer groups (e.g. LSBs) producing quality seed is ideal for fostering an effective PPP to enhance access to quality seed of food crops in Uganda. Full support from government agencies, civil society organisations, donor agencies, academia, researchers, non-governmental organizations, seed companies, private seed entrepreneurs, seed producers, co-operatives, is essential.

6.3 Challenges with fostering sustainable PPPs

A range of challenges in fostering sustainable public private partnerships were identified through interactions with key stakeholders and secondary information and include the following:

- There is often mistrust between public and private sector entities - breeders still feel uncomfortable giving their varieties to seed companies to maintain;
- Lack of understanding of the contribution of each entity;
- Mistrust on who owns Intellectual Property (IP) and poor understanding of it;
- Non- legal binding contracts signed with out-growers;
- Profit generation is a strong motivator for consistent and reliable partnerships;
- The relatively small quantities of EGS that are required and the exceptional care needed in its production, does not offer significant profit-making opportunities for seed companies;
- NARIs are unable to produce enough breeder and foundation seed;
- A general lack of knowledge of quality seed production and post-harvest handling; and
- inadequate capacity to inspect seed fields by the NSCS

6.4 Building sustainable PPP mechanisms

The above challenges can be addressed. A literature review of successful PPPs revealed the following aspects to be important in brokering and managing good PPPs:

- Different types of PPPs require different institutional arrangements as illustrated in chapter 5.
- All parties must have a clear understanding of objectives and constraints.

- A researcher or lawyer that understands the industry is necessary for long and fruitful negotiations.
- Identify strategic barriers for the success of an initiative and formulate a collective strategy on how to overcome these barriers and how to scale success to the national level.
- Provide time for adequate planning, understanding the common interest base, complementary strengths, and investment of time
- Developing a relationship of mutual trust, respect for intellectual property, and commitment to timelines. Communication is key.
- Have a clear understanding of partners' reputations. Protect reputations. National partners need to better understand operational risks, financial costs, and reputational risk, and how to minimize these through good communications.
- Capacity building and empowerment of local partners and institutions should be fundamental components of every PPP.
- Clearly agree on what each partner is trying to achieve. A win-win situation is needed.
- Agree on roles. Each party must play the agreed role on all counts.
- Good planning, with details
- Dedicated involvement of both parties
- Well planned financing
- Monitoring and evaluation

To make full use of public private partnerships the following mechanisms are necessary:

- Build an inventory/ database of qualified seed experts in the country. This will enable examination of available expertise within Uganda's seed sector; thus, the database will serve as an informative decision support tool in designing the requisite capacity building programme;
- Formulate a multi-disciplinary platform to facilitate harmonisation of various activities within the seed sector;
- Documenting good practice (e.g. how to build the supply chain with shared value for farmers, how to develop mutual respect, essential aspects to partnering, communication strategies);
- Transparent networking and knowledge management efforts to keep up the community informed;
- Building a seed alliance that can nurture PPPs in different sectors to give support and provide advice on matters such as due diligence processes, revenue planning, IP, resource mobilisation, etc.; and
- Develop a joint research agenda which can contribute to furthering the cause of PPPs.

In a system that depends largely on public plant breeding and private seed production, foundation seed represents the hand-off from the public to the private side. It is not only a key stage in the seed chain but decisions about who takes responsibility for its production can make a significant difference to the structure of the industry. To transform the 68% of the faming household from subsistence to commercial agriculture will require optima high quality seed volumes to reach all farmers.

7. Recommendations

Adopt innovative approaches to solve persistent shortages of foundation seed:

The public sector dominates EGS production and delivery. Therefore shortages of foundation seed will remain a bottleneck as long as breeders are not facilitated and motivated to generate adequate quantities of breeder seed to meet seasonal foundation seed needs by seed producers. Adoption of innovative approaches are urgently needed to overcome this. Institutional changes and mind-set are crucial.

Develop a methodology and tools to better assess demand for seed and specific varieties

The characteristics of seed demand are difficult to establish accurately. This is caused by several factors: the diversity of producers' sources of seed, including low or non-market channels; the use of seed produced on the farm; free handouts from government and relief programmes; inefficient agricultural statistical system; and lack of accurate market studies. There is a need to develop appropriate tools and methods for a more reliable assessment of demand in the different links of the seed value chain. Seed companies should be encouraged to conduct reliable market studies and keep accounts in order to plan volumes of their sales / productions over the years.

Stimulate incentives through appropriate licensing of use of publicly developed varieties by seed companies

The implementation of licensing contracts with a payment of royalties between the public sector breeders and seed producers and distributors from the private sector would add value to the work of public research. This will provide an incentive to streamline EGS production and allow third parties to multiply foundation seed. This will generate funds to support breeding of new varieties and maintaining existing ones.

Reduce use of farm-saved seed through an intermediate see system producing quality declared seed

With a diversity of crops (cereals, small grains, legumes, oilseed crops, and root and tubers) produced and consumed by majority of Ugandans, it is often not easy for seed companies to focus on which crops will be profitable to produce and market. Maize, (hybrids and OPVs) dominate the seed industry, while other crops are relegated to the informal seed system. It is, therefore, high time that NSCS consciously and carefully determine within a specified timeframe which crops must follow formal seed systems and those that can should still be accommodated in the intermediate seed systems. This can be agreed upon at the national level. In this way, potential investors can easily identify which areas; 'crops in the formal system or 'crops in the intermediate system requires their investment. A relatively efficient seed system to supply quality seed to farmers is dependent on (a) public institutions'

commitment to supply EGS at affordable prices, (b) a relatively larger distribution network through the agri-input outlets (c) empowering small-scale seed entrepreneurs such as the LSBs to produce of foundation and certified and/or QDS; and (d) farmers' access to credit to invest in high yield enhancing technologies. Identifiable market can be well structured to meet the needs of all stakeholders in the seed subsector.

Establish and nurture meaningful public-private partnerships for an efficient seed sector

Partnership among the various actors is a vital instrument in attaining the objectives of supplying the best quality seeds to farmers. Full support from government agencies, civil society organisations, donor agencies, academia, researchers, non -governmental organizations, seed companies, private seed entrepreneurs, seed producers, co-operatives, and entire stakeholders will ensure sustainable development of agriculture sector, food security, and improved livelihoods of smallholder farmers in Uganda. An array of approaches with variable interests at the various nodes of the seed value is used (e.g. PVS and demonstrations, innovation platforms for knowledge and information sharing etc.). However, it is necessary to strengthen consultations and make them evolve into formal partnerships around common objectives. For example the relationship between seed companies and cooperatives and LSBs can be developed and lead to contracts in which the companies agree to buy, process, and package seeds produced by these entities. Such an arrangement would benefit both players and help to better organise the supply of quality seed.

Increase marginal economic returns to producing seed of all classes by reducing transaction costs and pricing of seed to represent real costs

Publicly-funded institutions operate with high transaction costs because of many reasons including institutional challenges and limited market outlets. A large share of EGS costs was borne by salaries, coupled with handling and storage costs, especially for voluminous crops like the legumes. This indicates that options that favour production at the local level should be emphasised for such crops. The opportunity for this is the presence of farmer groups with the necessary skills to produce quality seed at the village level in proximity with the buyers.

To ensure a steady supply of breeder seed, NARIs should be allocated a special fund to sustain subsequent stages of EGS and revenue from the sale of seed should be retained by the institute. This can be extended to produce and sell breeder seed on a cost- recovery basis with a small profit. The latter can be used to improve facilities such as irrigation, and land management of the seed farm. This will require a policy change to allow public entities to keep NTR to enable them to re-invest in their EGS enterprises.

Breeder seed production involves several generations of multiplication and is the earliest generation, which has been the responsibility of the NARIs that released the variety. This requires significant resources. There are significant requirements for capacity building in the seed subsector that development partners can help address. The scale of current development partner interest in developing the private seed sector is growing rapidly and may mean that potential entrepreneurs will be able to take advantage of various

programmes, loans and grants without necessarily facing the immediate realities of the seed market. Some rationalisation and coordination of future donor seed efforts is necessary.

Stimulate farmers' adoption of improved varieties and quality seed

The seed system is based mostly on public varieties. The deployment of varieties should be one of the primary measures for assessing an institute's performance. To achieve such uptake, the NARIs need to rethink their breeder seed production system and to devote more attention to ensuring that adequate information about varieties is available for seed growers and farmers.

For the seed sector to grow, some unpopular decisions that break established privileges and complacency, resisting easy answers such as seed subsidies, and providing adequate incentives to the public and private actors in the seed system cannot be overemphasised.

Building horizontal linkages between the informal and formal seed systems at different functional levels (e.g. research and development, seed production etc.) can facilitate transformation of traditional to more advanced systems, and that farmers need to be better integrated in every aspect. . However, the transformation process from an informal to a formal system should not be viewed as a linear process as different levels of development will evolve and co-exist depending on several factors including the types of crops, the level of input and output market development, and the prevailing policy environment.

In the short-term public investments are required to increase availability of breeder and foundation seed, but the way in which such investments are made must not hinder increased private investment in seed production.

Actions for government

- Develop an EGS multiplication plan per crop and guidelines for seed companies to make orders for EGS supply
- Empower communities at county/sub county and village levels to be engaged in quality seed production and demand forecasting.
- Strengthen the Department of Crop Inspection and Certification to guarantee seed quality
- Develop regulations and guidelines for private sector and DAOs accreditation for seed inspection and certification
- Develop and operationalise an effective intellectual property rights system
- Set up a professionally managed foundation seed unit, recruit a seasoned business manager and develop a realistic business plan for EGS Unit
- Revisit the NTR policy and provide for exceptions where institutes can show proper business plans for breeder seed production and cost recovery.
- Implement a smart subsidy programme to provide incentives for seed companies to invest in production and distribution of seed of non-hybrid crops
- Reactivate the national seed forum to articulate on the seed subsector development and growth

- Support an efficient extension and advisory services program to educate farmers on how to enhance their crop productivity

Actions for Development partners

- Support transitioning of intermediate seed system to facilitate transforming subsistence to commercial agriculture
- Support EGS production models adapted for crops characteristics, profit margins and demand
- Support capacity building of seed producers through a public-private partnership with clear roles and responsibilities for each entity
- Support efforts that provide an evidence- base on which of the archetypes is working well and which don't as well as methods that are efficient in demand prediction
- Support efforts that make new technologies available and affordable to curb poor quality seed

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ANNEXES

Annex 1: Current seed systems in Uganda

The seed sector at a glace

The seed sector in Uganda is characterized by the formal and informal systems that are co-existing. The formal system is responsible for the production of improved and certified seeds through a structured system of variety development and release, multiplication, quality control distribution, marketing, and use. The major players in the formal system are public institutions including the government (e.g., Ministry of Agriculture Animal Resources and Fisheries (MAAIF), National Agricultural Research Organisation (NARO), National Agricultural Research Institutes (NARIs), National Variety Release Committee (NVRC), National Seed Certification Services (NSCS), and National Seed Board (NSB). International Agricultural Research Centres (IARCs) and Makerere University are also public institutions investing in research and development and dissemination of new varieties. The private sector consists of local (25 registered seed companies) and multinational seed companies; member association including Uganda Seed Trade Association (USTA), Uganda national Agro-Input Dealers' Association (UNADA) as well as Non-Governmental Organisations (NGOs); development agencies, community based organisations and farmer cooperatives. All are linked together through MAAIF and NARO. The formal system is estimated to contribute 15% of the seed use (Draft National Seed Strategy, 2015). On the other hand, the informal system dominates making up 85% of the seed planted. Seed is sourced mainly from farm-saved seed of previous season's crops and local markets. The informal system is unregulated.

Seed system assessment

Seed systems can be characterised on the basis of the domains in which they operate (public, private, informal, formal, mixed); the types of crops produced; (food and cash crops); the type of variety used (land races, improved, exotic, and hybrids); the type of quality assurance mechanisms operational (informal, quality declared, truthfully labelled and certified); and the seed supply mechanisms (local exchange, agro-input dealers, and subsidized distribution).

In Uganda, the seed sector is characterized by the formal, intermediate and informal seed systems. Each seed system is further characterized by who is producing the seed, which crops and varieties, types of quality assurance and the way the seed is distributed. These systems are summarised in Table 2.1.

Formal seed systems

In the public sector, NARO is the leading public organisation for research and development. Within NARO, the National Crops Resources Research Institute (NaCRRI) is responsible for breeding programmes for maize, rice, common beans, soybean, sweet potato and cassava. The National Savana Agricultural Resources Research Institute (NaSARRI) is responsible for breeding programmes for sorghum, sesame, finger millet, cowpea and groundnut. Kachwekano Zonal Agricultural Research and Development Institute (KaZARDI) breeds Irish

potato. Makerere University contributes to crop breeding and variety release for soybean and cowpea. IARCs such's CYMMT, IITA, ICRISAT, CIP, Africa Rice and multinational seed companies are also sources of new improved varieties. Currently, NARO is the only source of pre-basic (breeder) and basic (foundation) seed for released varieties. The private seed companies and other seed multipliers obtain their foundation seed from breeders at NARO. However some of the seed companies in Uganda (e.g., NASECO, FICA Seeds, East African Seed Ltd and Victoria Seeds) obtain breeder seed of mainly maize, beans, sunflower and soybean; from research and multiply them it into foundation seed, and then sell it to other seed companies (The African Seed Access index (TASAI) Uganda Brief, March 2015).

Seed companies and other seed multipliers face challenges while accessing foundation seed. ISSD Uganda has identified limited availability of foundation seed for certain crop varieties and inadequate volumes of breeder seed among the major constraints hampering the development of the seed sector in Uganda. This is largely due to funding challenges beyond the control of breeding institutions that are mandated to produce and deliver early generation seed (i.e. breeder and basic). The national seed strategy proposes devolution of foundation seed production to seed companies or NARO produce foundation seed as a business.

Seed companies (formal)

The formal seed system comprises registered seed merchants (a company, an individual, a cooperative or a farmer association) producing, conditioning, distributing and marketing improved seed from released varieties. These companies produced "certified seed". This system currently focuses mainly on hybrids and open pollinated crops like maize, sunflower, sorghum and a few self-pollinated crops like beans and soybean. There are 26 registered seed companies producing an estimated 18,000 MT of seed, contributing about 15% of planted seed. Seed distribution in the local market is carried out through agro-inputs dealers' network. The formal system also covers seed trade, including imported vegetable seed for the domestic seed market, and exports to regional markets. The NSCS regulates the formal seed system from variety listing through to final seed certification; but systemic weaknesses result in ineffective monitoring of field production and seed conditioning for quality control. For instance, only 35% of the formal seed system is certified

Closed value chains (formal)

Semi-autonomous government bodies- the Uganda Coffee Development Authority (UCDA) and Cotton Development Organization (CDO) operate a closed value chain for cash crops and facilitate the production and sale of seed of these crops to smallholder farmers. Both NARO and UCDA have their own internal quality controls independent of NSCS. CDO gets pre-basic cotton seed from NARO, bulks it with selected farmers and seed companies, and arranges for seed to be de-linted and dressed. CDO delivers seed to farmers with quality control done internally. For other cash and export crops such as oil palm, sugarcane, and tobacco, companies in the sector manage seed propagation and sale along with other aspects of the value chain. This vertical integration has well-established voluntary regulatory mechanisms. Uganda's tea sub-sector has both smallholders (for which government is involved in research and seed supply) and large producers who manage their own seed supply. The formal system also covers international seed trade including importation of vegetable seed for the domestic seed market, and seed exports to regional markets.

Informal seed systems

This system makes up 85% of the seed planted (MAAIF 2015). It is supplied by home-saved seed achieved through selection and preservation of previous harvests of crops that mainly meet communities' food requirements. These are mostly self-pollinated crops like rice, finger millet, legumes (cowpeas, groundnuts, soybean and green grams) for which it is easy to maintain genetic purity through successive generations. Vegetatively propagated crops include Irish potato, sweet potatoes, cassava, bananas and various fruit trees. Access to these seeds and planting materials is through community exchange and to limited extent local markets. Women play a pivotal role in this system, including in variety selection, multiplication, seed condition and seed marketing. This contributes significantly to food security. This system is usually unregulated, but quality assurance is based on mutual trust.

Intermediate seed systems

There is growing awareness that the formal system as such (the legally prescribed adherence to defined quality standards) may not be able to solve the problem of availability of quality seed. In a broad effort to modernise agriculture, the Government of Uganda (GoU) realises that the formal system depends on the potential of the traditional, informal seed systems. These are well adapted to the local seed requirements for annual food crops produced under variable cropping systems and agro-ecologies. The seed supply relies on simple technology and low costs and can provide seed at a low price, with a low entrepreneurial risk. The informal systems need to be strengthened and linked with centralised seed certification in order to function optimally. The development of such integrated seed systems requires adaptation of technology, a flexible seed legislation and regulation, wise enforcement, and institutional capacity.

MAAIF, through NARO institutes provides improved varieties for food and nutrition security crops through NGOs, farmers' associations and donor funded seed projects to farmers' groups for further multiplication. Skilled and enterprising farmers involved in intermediate seed systems are progressively being empowered to become specialised seed producers. This is being achieved through a Local Seed Business (LSB) model to produce and market Quality Declared Seed (QDS) as a way of intermediating between informal and formal seed systems. This is expected to create a vibrant, market-oriented and pluralistic seed sector in Uganda. The National Seed Strategy 2015, projects that the LSB model will contribute an additional 25% share of certified seed (QDS seed class) by 2020.

Seed demand

Seed demand data is useful for decision making and planning purposes. It is required by a cross section of stakeholders (farmers, researchers, investors, government, policy makers, donors, etc.). Uganda currently lacks data on seed demand, seed production, seed import and export. There is limited capacity and resources to collect the required information. Seed companies are routinely requested to provide information on quantities of seed produced, imported and exported. However, some companies are not responsive, sighting sensitivity and confidentiality of the information required. As a result, the available data is scanty and unreliable.

It is estimated, and broadly accepted that counterfeit seed accounts for 30-40 % of the seed offered for sale in Uganda (Proceedings National Stakeholders meeting 2014). The NSCS,

which is mandated to enforce regulations against counterfeiting seed, lacks the necessary means to do so. Moreover, the fines for seed counterfeiting are too low to serve as a deterrent to the offenders. Farmers' seed demand is not delivered in time, due to the high cost of distribution to widely dispersed smallholder farmers and a weak network of seed dealers. Seed price is often not competitive as the returns for seed use (outputs) are low and this is compounded by the inadequate availability and high cost of other complementary inputs such as fertilizers and pesticides. Further, the demand for early generation seed is uncertain and inconsistent, making estimation of effective demand for certified or quality declared seed impossible. This hampers planning and forecasting for an effective seed production programme.

Policy and regulatory environment

Uganda has made strides in developing an institutional and policy framework for the seed sector, although implementation remains a challenge. MAAIF, NSB formulates seed policies and implements them. The NSCS in the Department of Crop Inspection and Certification (DCIC) is responsible for implementing seed policies, all matters relating to seed quality control and certification. Some of the seed policies and laws that have been developed include: the Seed and Plant Act 2006, Plant Variety Protection Act 2014, Plant Protection and Health Act 2015; draft Seed and Plant Regulations 2015, draft National Seed Policy 2014, the draft Plant Genetic Resources Policy 2015 and the Bio-safety and Biotechnology Bill, 2012 among others.

The Seed and Plant Act 2006 is a legal framework that provides for the promotion, regulation and control of plant breeding and variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and other planting materials. The draft Seed and Plant Regulations provides guidelines for enforcement of the Act. The objective of National Seed Policy is to ensure the availability of adequate, high quality and safe seed on the market in order to increase agricultural production and productivity for improved standards of living and food security. The policy recognises both the formal and informal seed systems. It puts emphasis on public-private-partnerships (PPP) towards the development of a vibrant seed industry. The policy also recognises the addition of a Quality Declared Seed (QDS) class to bridge the gap between formal and informal systems. A National Seed Strategy (NSS) has been drafted to operationalize the seed policy.

The current regulations on seed quality control and certification (SQCC) require official inspection of almost all the operations of seed production. In addition to field inspections and seed testing, permission to transport the seed to the seed company, official order to process the seed and supervision of seed processing and conditioning are also imposed. This increases transaction costs to seed companies who have to pay for these services.

The Plant Variety Protection Act 2014 provides for the promotion and development of new plant varieties and their protection as a means of enhancing breeders' innovations and rewards through granting of plant breeders' rights and other related matters. The objective is to enable Uganda accede to the International Union for the Protection of New Varieties of Plants (UPOV). The implementation of this law is being challenged in courts of law.

The Agriculture Sector Strategic Plan (ASSP) 2015 - like the National Agriculture policy, looks at the performance of the agricultural sector and its contribution to the national economy in terms of poverty reduction, food and nutrition security as well as employment.

The strategy also looks at the challenges to agricultural performance as well as the institutions concerned with development of the agricultural sector. It then lays down the investment plans and development strategies for the agricultural sector. The plans and strategies are broad and inclusive of all aspects of the agricultural sector. The seed subsector emphasises a dynamic and pluralistic seed system that is inclusive of all actors in the seed value chain. It provides for activities for strengthening the NSCS and integrate formal and informal seed systems.

Plant Protection and Health Act 2015 consolidates and reforms the law relating to protection of plants against destructive diseases, pests and weeds, to prevent the introduction and spread of harmful organisms that may adversely affect Uganda's agriculture. It provides for the regulation of export and import of plant and plant products so as to protect and enhance international reputation of Uganda's agricultural products.

The national policy on Plant Genetic Resources for Food and Agriculture (PGRFA) 2015; applies to plant genetic resources for food and agriculture whether naturally occurring or naturalised including those bred or intended for commercial purposes within Uganda or for export, whether under *in-situ* or *ex-situ* conditions. It also applies to imports, regional and international exchange of germplasm. It provides for policy interventions for the collection, and conservation, sustainable use and equitable sharing of benefits arising from the use of these resources.

Seed related programmes

The GoU and direct aid programmes/projects fund most of the seed activities in the country. These programmes focus mainly on strategic crops, such as maize, beans, rice and cassava, but also smallholder cash crops like cotton and coffee. They support the private sector, intermediary and more informal seed systems. NARO runs public breeding programmes for these crops, and is responsible for the production of breeders' seed and early generation seed. Through the Agricultural Technology and Agribusiness Advisory Services (ATAAS) project, NARO produces pre-basic and foundation seed , train seed companies, and promote seed production in the informal sector. The National Agricultural Advisory Services (NAADS) trains farmers and farmers' groups in seed production, and links private seed companies and farmer seed producers to seed users. Institutions like UCDA and CDO play a similar role to NAADs in facilitating access to seed and planting materials for smallholder producers. The DCIC of MAAIF is in charge of seed company licensing, variety release and variety cataloguing; import and export regulations; and seed quality assurance.

The International Centre for Tropical Agriculture (CIAT), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Japan International Cooperation Agency (JICA); provide examples of international organizations that run programmes directly supporting the public sector, facilitating breeding, variety selection and community based seed production activities.

The East African Agricultural Productivity Program (EAAPP) supports NARO in pre-basic and foundation seed production for cassava, pastures, rice, and wheat; and strengthening phytosanitary protection and also certified/QDS seed.

Sasakawa Global 200 (SG 2000) is an NGO that intervenes in seed production and supply through its technology transfer mechanisms, including establishing Farmer Learning Platforms and promoting value addition activities.

USAID Feed the Future/Enabling Environment for Agriculture (USAID FtF/ EEA) supports MAAIF to improve policy environment for seed related interventions, (policies, and regulations). It has also supported the harmonisation of the National Seed and Plant Regulations to the Common Market for East and Southern Africa (COMESA) harmonised seed trade regulations.

USAID's Ag Inputs supports seed companies and agro-inputs dealers and agents to sell quality seed. The project also supports development of seed production and sales data bases as well as a see quality management system (e-verification) that will enhance uptake of quality seed and minimize counterfeit seeds in the country.

Agribusiness Initiative Trust assists private seed companies to expand their operations and to build their capacity.

The Program for Seed Systems (PASS) of the Alliance for a Green Revolution in Africa (AGRA) focuses on training of scientists at MSc and PhD levels in plant breeding and seed systems at Makerere University; provides start-up capital for seed companies; provides short-term training and trips for seed company staff and supports NARO in developing new varieties.

VECO mainly works with groundnut and in a new programme (2014-2019) includes common bean as well. The program works on availability of inputs (community based seed multiplication, input revolving schemes) and organisation of business meetings with partners along the value chain.

World Vision is an NGO building capacity of legumes, seed production to access quality seed beans whole of Uganda); soybean (Norther/eastern Uganda((Lira, Gulu Kitgum); and groundnut (northern and eastern Uganda) The approaches are giving seed loans, with payback through community leaders (not to NGO) and strong focus on community schemes; linking of farmers and input dealers; bulking of harvest at community level, for sale to middlemen/ warehouses/ factories. that supports informal seed production, especially for poor communities and refugees.

The Embassy of the Kingdom of the Netherlands (EKN) supports Wageningen UR – Centre for Development Innovation to implement the Integrated Seed Sector Development (ISSD) programme in Uganda. This programme focuses on greater entrepreneurship at the local level by creating Local Seed Businesses (LSBs) to promote seed sales for crops and varieties adapted to specific locations that are not easily addressed by the more national-oriented companies. The programme operates in three geographical areas based on agro ecological zones; namely West Nile, Northern Uganda and Western Uganda. At the start of the programme in 2012, 30 LSBs (10 in each zone) with a total of 900 farmers were created and coached in QDS seed production and marketing. After 3 years, additional 70 new LSBs have been created through out-scaling partners in the same zones. This is expected to be rolled out to enable a better coverage of food and cash crops in all regions of the country. The programme also address issues related to quality assurance, foundation seed availability and access and policy environment.

Challenges and opportunities

The GoU aims to support a competitive, profitable, sustainable, market-led, regulated and coordinated seed sector. However, national seed companies face many challenges. They have to compete with each other, producing seed of the same varieties resulting from public breeding programmes, and with international companies marketing seed of their own varieties. NARO is currently involved in exclusivity arrangements with national seed companies for maize hybrids, providing a space for them to compete in the seed market. The absence of regulations to operationalise the Plant Variety Protection law limits the interest of foreign companies to become active in Uganda for marketing the seed of non-hybrid varieties. Where the market for maize seed is sufficiently profitable (more than 70% of the volume of formal seed is maize), other seed crops are more difficult to commercialise. The companies still largely depend on NGO and government seed buyers for crops like beans and groundnut. This hinders the direct buyer-seller relationship, and compromises the integrity of the seed industry. The sustainability and robustness of the overall seed sector is therefore questionable. Free seed distribution through the government Operation Wealth Creation programme also constrains seed business development; since farmers have no incentive to but seed when it can be freely distributed. Despite the efforts put into the development of the seed sector in Uganda, the sector continues to face many challenges along the entire seed value chain as summarised in Table A.1.

Table A.1. Challenges and opportunities in the seed sector in Uganda

Value chain component	Challenges	Opportunities
Variety development and maintenance breeding	• Lack of appropriate facilities to accelerate breeding of new varieties and production of breeder seed • Limited technical capacity to produce breeder seed and government funding to carry out trials • Lack of participation of local seed companies in plant breeding • Low investment on food security crops • Few released varieties know by farmers	• Increased government funding to crop improvement research and availability of donor funding for strategic crop commodities • The Seed and Plant Act provides for Public Private partnerships in variety development • ZARDIs conducting adaptive research in the various agroecologies • Availability of other sources of germplasm from international Agricultural Research Centers • farmers and farmer groups participation in PVS
Breeder and breeder seed production	• Public sector dominance in producing source seed with limited technical and financial capacity	• Planning volume of breeder seed required to meet the demand of certified seeds through seed roadmaps • Availability of low cost irrigation facilities to accelerate bulking of breeder seed • ZARDIs closer to seed users in the various agroecological zones. • Seed companies willing to produce breeder seed • Experienced famer groups or individuals willing to participate in seed production
Certified seed production	• Insufficient breeder and foundation seed • Seed companies, Small and Medium scale Entrepreneurs (SMEs) have limited capital to invest in seed production and hence capacity to produce seed • Lack of a seed demand forecasting and monitoring	• QDS being produced where certified seed is not competitive. • Farmers motivated in learning and in establishing seed business • Periodic effective seed demand determination • seed companies desire to have qualified seed technologists on their staff • Community based seed production system progressively being improved to integrate into the formal seed system.
Seed processing and conditioning	• Seed companies lack capacity to increase seed processing capacity • Available storage facilities not fully utilised	• Financial institutions availing credit to finance processing and conditioning infrastructure • Availability of unused storage facilities
Marketing and promotion	• Weak promotion and distribution systems with high transaction costs • Inadequate seed dealers, channels and networks • Unaffordable pricing of seed packets • Weak and underdeveloped agro-dealer networks (most have limited technical, commercial and financial knowledge and capabilities)	• Availability of smart seed marketing strategies such as sales of small seed packs, and labelling • Village agents to collect seed demand • Business linkages with LSBs • Farmer led demand
Distribution	• Prevalence of counterfeit/fake seeds	• Expanding agro-dealer networks to more remote

Value chain component	Challenges	Opportunities
	• A weak contractual arrangement system characterized by high social risks	areas • Tougher laws and regulations to make sale of counterfeit /fake seed a highly risky business
Quality control	NSCS under resourced limiting its effectiveness and efficiency in carrying out its responsibilities.	• MAAIF police to fight sale of fake seeds. • Availability of tamper proof labels • Government Operation Wealth creation programme • Quality assurance system through accreditation of field inspectors, samplers and laboratories for testing at district/regional levels
Policy	• An effective policy and regulatory framework not yet in place • Royalty payments from seed companies to NARO not enforced as they are based on informal arrangements and licensing of public varieties remain problematic • Limited capacity of the Uganda Seed trade Association (USTA) to advocate for effective implementation of national policies and regulations favouring seed industry development and expansion of seed sales and use	• Final drafts of the necessary instruments (seed policy and regulations available and only require approval by the competent authorities) • Regulations to operationalize PVP act • Advocacy tools including web-based stakeholder platform, communication strategy, policy briefs, brochure and posters to USTA members • Inclusive seed system • A new extension policy
Seed users	• Farmers' perception of seed being expansive • Insufficient promotion and demonstration • long distances to input supply centres (mainly located in urban canters) • Lack of knowledge about quality seed • Lack of awareness about new varieties • Low quality seeds	• Many development partners, NGOs, Government programs, farmers' organisations that support farmers to produce and access quality seed of improved varieties

Source: Mini-stakeholder roundtable consultation to formulate the national seed strategy (February 2015); Draft National Seed strategy, 2015., Uganda development Investment Strategic (DSIP 2010'-2015).

Annex 2: Crop Value chains

The information on the various crop value chains was derived from secondary information particularly from the MAAIF analytical reports for maize, rice, and beans (MAAIF 2010) and analytical report for the seed and planting materials all prepared in 2012. Other sources of information were from AGRA-PASS review documents

Maize

Production*:* Maize production in Uganda is driven by the maize grain and flour value chains. The maize grain value chain is dominated by a number of key players which include farmers, rural traders, urban traders, large-scale traders/exporters and millers. Since it handles between 50-75% of the domestically traded maize and 100% of exported maize, it is hence the most reliable one for farmers. Throughout this value chain, maize is sold as grain even if quality and value addition is much appreciated and emphasized by key players as one moves downstream. Only primary processing is done and includes: shelling, drying, cleaning, and grading of maize grain. However, due to the large capital needs, the number of key players decreases as one moves downstream.

Inputs: Maize inputs critical to modern maize production include: seeds, agro chemicals, and extension. Seeds and chemicals are provided by seed companies and input stockists. There are various seed companies engaged in maize seed production and marketing. They distribute their seeds through their retail outlets or agents, and agricultural input stockists who also deal in other inputs, such as chemicals and hoes. The National Agricultural Advisory Services (NAADS) as well as NGO's such as Sasakawa Global 2000 provide extension services to farmers.

Actors: Maize is produced by both small-and medium-scale farmers. Small-scale farmers are usually subsistence in nature with land holdings of between 0.2-0.5ha under maize production. Nearly all of the small-scale farmers do not use improved inputs and lack post-harvest equipment. In contrast, the medium-scale farmers tend to be commercially-oriented in their farming operations and have 0.5-2.0 ha under maize. However, small-scale farmers contribute over 75% of the marketable surplus while the rest (25%) comes from the medium-scale farmers. Because of lack of storage and the limited income generating enterprises, small-scale farmers usually sell off most of their surplus maize as soon as it is harvested. The small-scale farmers sell most of their maize surpluses to rural traders/agents. Conversely, the medium-scale farmers do not sell off their maize surpluses immediately after harvest for it is first stored and then later on sold to mostly urban traders.

Rural traders represent over 90% of the maize traders and handle about 60% of traded maize. The main function of rural traders is to buy and assemble maize from numerous scattered small-scale farmers in inaccessible areas. These rural traders use bicycles and pick-ups for collecting maize from farmers who they pay on a cash basis. Since they live in rural areas, the rural traders also form a reliable linkage between farmers and urban traders and thus, sometimes act as agents or brokers of urban traders.

Urban traders live in urban areas (major trading centres and district towns). They comprise less than 10% of the total number of maize traders and handle about 30% of the traded maize. The main activities of urban traders include networking with rural traders, serve as a market outlet for commercial farmers, assemble, bulk, and pre-clean maize grain before selling it to institutions,

large-scale traders, millers, and export markets. Urban traders also provide market information about price and volumes within their areas of operation.

The large-scale traders live mostly in Kampala where they operate as private companies. Due to the large amounts of capital required to operate at this level, these traders are very few and comprise of only less than 1% of the maize traders. Nonetheless, these traders handle about 30% of the traded maize. Their major roles including networking with urban traders, serving as a market outlet for commercial farmers, pre-cleaning, fumigating and verifying, and re-bagging maize grain before it is exported. Large-scale traders store maize grain between one to two months, depending on the availability of the market and sources of capital. They supply millers in the domestic market as well as international relief agencies and regional markets. Large-scale traders also provide market information to urban traders and commercial farmers and search for markets for surplus maize.

Maize millers are of three types: small-scale, medium-scale, and large-scale. The small-scale millers comprise of about 85% of the maize millers and are scattered in various rural trading centres throughout the country predominantly carrying out customized maize milling. Small-scale millers operate hammer mills of less than 10 tons per day mainly on contract basis and handle 50% of the total volume of milled maize. The mills are locally fabricated and are often poorly maintained, resulting in the low and poor quality flour. Daily production levels vary depending on the consistency of power supply, type of machines and market demand.

The medium-scale millers, who are mainly based in urban centres and handle about 40% of the total volume of milled maize, offer both contract and trade based milling services to institutions and urban traders. They are less than 15% of the total millers in the country. Like the small-scale millers, the medium scale millers operate mills using outdated technology with capacities of up to 50 tons per day. Although they are involved in grain storage, the volumes handled are limited by storage space and working capital. Their level of profit margins depends on their stocking strategies as well as control of overheads and operational expenses.

Large-scale millers are mainly found in Kampala, constitute less than 2% of the total number of millers and handle 25% of the total volume of milled maize. They have modern machinery with large milling capacity, large warehouses and bulk handling systems. They restrict themselves to trade-based milling, and normally supply the flour to institutions and relief agencies. The stocking of maize grain, especially off-season forms the basis for their profitability.

The main product from maize is flour. Various grades of flour exist and can be sold either as branded or unbranded flour. Flour can be used to make local bread (posho), porridge and local brew. Maize by-products include bran and germ that are used in the making of animal feeds. Millers usually sell unbranded flour to consumers (individual, institutions) via wholesalers and retailers. Branded flour on the other hand is distributed to individual consumers through wholesalers and supermarkets. Local brewers use specialized flour for making local brew, such as "kwete". Animal feed blenders who are mainly found in urban centres are the major buyers of maize by-products. Animal producers are then the final consumers of animal feed.

Indirect actors supporting the maize value chain in Uganda include both private and public institutions, namely: Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), National Crops Resources Research Institute (NaCRRI), NAADS, Ministry of Trade, Industry, and Cooperatives (MTIC), Uganda Commodity Exchange (UCE), Uganda National Bureau of Standards (UNBS), and financial institutions. MAAIF through NaCRRI at Namulonge develops new maize technologies. MAAIF and NAADS provide extension services to maize farmers. UCE and UNBS are

parastatals under the MTIC. UNBS together with UCE and other partners in the private sector are responsible for the development of grades and quality standards in the maize sector. UCE and FIT Uganda Ltd, a private company provide market information services. UCE oversees the recently introduced warehouse receipt system (WRS) of marketing maize. Financial institutions so far participating in the WRS are Housing Finance Bank and Opportunity Uganda. The above actors along the maize value chain are critical to drive demand for improved quality seed.

***Maize breeding and seed production**:* NARO's Cereals Research Programme at NaCRRI, Namulonge focuses on development of maize and to address critical agronomic constraints faced by farmers and their taste preferences. Priorities are defined through participatory research and the involvement of other seed sector stakeholders.

Maize breeding efforts have included addressing declining yields as a result of low soil fertility, low fertilizer use and poor agronomic practices, high disease susceptibility and major diseases such as (1) maize streak virus; (2) leaf blight; and (3) grey leaf spot. Three maize varieties (Longe 6H, 7H and 8H) were released way back in 2002, and have dominated the seed market.. In 2009, Yara 41, Yara 42 and Longe 9H, 10H and 11H were also released. Current efforts include breeding maize for resistance to disease and pest, drought tolerance and striga including shorter season varieties suited to Uganda. Hybrid production requires investment which government cannot meet. More than 20 companies would like access to the varieties but the slow pace and exclusive licensing arrangements make it difficult for breeders to satisfy company needs. Breeding is also heavily reliant on rain-fed agriculture and breeder seed very inadequate to meet the demand by companies. NARO's recent charge of USD150 per kilogram of breeder's seed, whilst positive is not likely to generate significant revenue. NARO is in the process of drafting a new agreement with seed companies to introduce the payment of royalties equivalent to 3% of turnover. However, how these royalties will benefit breeders is unclear.

Production of foundation and quality seed: NARO uses exclusive distributorship licensing arrangements to ensure that the seed is traceable on the market. An open bid system is used for maize hybrids to transparently choose seed companies that are best suited to distribute the varieties in question. Exclusivity is meant to give the licensed company the incentive to invest in bulking and multiplication of the seed, as well as aggressively promoting the variety among farmers in a commercially viable manner. While the benefits are clearly articulated, the disadvantages of exclusive licensing are also obvious. Exclusive licensing did not work very well for Longe 7H and 8H hybrid varieties. Harvest Farm stopped operating while having been given the exclusive license to bulk and multiply Longe 7H, and the passing on of the breeder who was helping the East African Seed Company to bulk breeder seed for Longe 8H negatively affected the bulking and distribution of these two maize varieties in Uganda. Given these developments, there is a strong view in the maize industry that non-exclusive may be more favourable. Companies should have been allowed to purchase breeder seed from NARO and then allowed to compete on the quality of certified seed made available onto the market. NARO is considering for the future to issue distributorship licenses to two companies per variety as opposed to one company.

***Seed production, multiplication and distribution**:* There is lack of a proper seed distribution system, fake and non-certified seed on the market, limited facilities and funds for maize research, and inadequate capacity by the private sector to multiply and disseminate seed. Although NaCRRI has constantly been generating new maize varieties, there is need to put in place a proper, efficient, and regulated seed distribution system to enhance their uptake by farmers. Maize seed production is done by a Cooperative Society on contract from private seed companies under

irrigation in Mubuku irrigation scheme, Kasese; production of quality maize seed by Uganda Prisons Services (e.g. Amita prison farm in Abim and Rwami prison farm in Kabarole). In the second season of 2014, 30 MT of seed was produced. Seed distribution – done by NAADS and Operation Wealth Creation, private seed companies (for hybrids, exclusive licensing is done).

Under the ATAAS project, new high yielding, stress (drought, pests and diseases) tolerant/resistant, and fortified maize varieties have been developed, released and commercialized. Continued research on farmer preferred varieties and strengthening the seed multiplication and distribution system will thus ensure high adoption of these improved seeds by maize farmers. The private sector has inadequate capacity to multiply and distribute maize seed. Consequently, fake and non-certified seed are sometimes found on the market. Hence, there is a need to increase volumes of foundation seed, streamline seed distribution channels, put in place a quality assurance system, and enhance farmer access to certified seed.

Marketing and Distribution: Maize hybrids Longe 6H, 7H, 8H, 9H, 10H and 11H are mainly distributed to farmers through exclusive licensing of seed companies. These companies have been disseminating the varieties to farmers using a combination of strategies, the main ones being: (1) responding to Government, UN and NGO tenders for seed procurement and distribution; (2) direct sales to farmers; and (3) selling seed through agro-input dealers (wholesalers and retailers). All seed companies advertise their products using demonstration plots, unique packaging, and direct extension service provision through their agronomists.

In general, adoption of improved seed among maize farmers is still low. While research generates new maize varieties, seed multiplication and distribution constraints still persist in the seed chain. The private sector has inadequate capacity to multiply and disseminate seed. Consequently, fake and non-certified seed are sometimes found on the market. Therefore, there is a need to increase volumes of foundation seed, streamline seed distribution channels, put in place a quality assurance system, and enhance farmer access to certified seed.

Rice

Actors*:* The rice value chain comprises of numerous key actors including: input distributors, producers, traders, millers, animal feed blenders, and consumers. These key players vary by nature and contribution to the rice trade and, are systematically characterized below:

Inputs: NARO contributes to the development of high yielding varieties, which are linked to input distributors (seed companies and input stockists), for multiplication and sale to farmers. NARO also supports on-farm research demonstrations, which assists farmers in accessing new technologies. Seed companies involved in rice related inputs in Uganda include FICA, NASECO and Victoria Seeds. Extension services are also provided to farmers by the public sector through NAADS. Other support organizations in the distribution of rice inputs include nongovernmental organisations and development partners, such as JICA, USAID, DANIDA, UNADA, and AT Uganda have provided certified seed and/or trained farmers and input dealers in agronomy and application of agricultural chemicals

Farmers: According to MAAIF (2012), rice farmers are categorized into three groups according to acreage planted with rice, namely: small scale, medium scale, and large scale. About 80% of rice farmers in Uganda are small scale farmers with rice acreage of less than 2 hectares using simple technologies including rudimentary tools, little or no fertilizer use, poor quality seed, little or no irrigation and poor water management practices among others. About 15 % of them are medium

scale farmers with acreage of 2-6 hectares producing rice most of which using practices similar to small scale farmers and a few using non-motorized tools such as jab planters. And, a small proportion (about 5%) of rice farmers are large scale with land under rice cultivation over 6 hectares.

Traders: There are two types of traders involved in rice trade: rural and urban. Rural traders buy threshed rice from farmers and sell it to the millers or urban traders after milling. Milled rice is sold by farmers, rural traders, or millers to the urban traders. Farmers and rural traders often absorb transport costs of paddy to milling centres and pay for milling charges prior to selling the rice. Urban traders are primarily wholesalers and importers who either purchase milled rice from the millers and farmers or import it from other countries. Urban traders are mainly based in Kampala with a few of them living in other towns. Actual purchase of rice may also be accompanied by cleaning, consolidation and bulking. Through retailers such as grocery stores and supermarkets, milled rice is sold to end users constituting of individual consumers and institutions (schools, hospitals, prisons etc.).

Millers: There are three (3) types of millers. A majority (77.5%) of the rice millers are small (Engel-bergs), 20.8% of them are small (Mill-tops), and only 1.7% of them are medium to large (MAAIF, 2012). While most of these mills were bought by private owners, some of them were provided under NAADS, NUSAF 2, and by Ministry of Local Government, and Food and Agriculture Organization (FAO). As mentioned earlier, small rice mills use rudimentary technologies (engel-bergs and mill-tops) as opposed to medium and large mills that are installed with ultra-modern technology. However, 95% of the total paddy produced in the country is processed by small mills while only 5% is done by medium and large mills.

***Products*:** By-products from rice milling include husks and bran. In the past, the usage of these by products was lacking or limited and they used to be disposed off as waste. With the growth of peri-urban agriculture, there is increasing demand for rice bran by animal feed mixers for making feeds for livestock such as poultry and pigs. Rice husks are also used to make briskettes that are used as fuel thereby substituting traditional sources of fuel such as wood and charcoal that are associated with environmental degradation.

Any weakness in the above points of the value chain will significantly affect the demand for quality seed.

***Rice breeding and seed production**:* Rice breeding in Uganda has focused predominantly on selection of suitable NERICA series of upland rice. In 2002, WARDA in collaboration with IITA released ITA 257 and ITA 325 rice varieties (familiarly named NARIC 1 and NARIC 2, respectively). NARIC 3 (popularly known as NERICA 4) was also released in 2002. However, due to resource constraints, two other varieties, NERICA 1 and NERICA 10 were only released in 2007 Future work on rice research in Uganda will require training breeders at PhD level focusing on improving current varieties with new traits, for example, improving NERICA 4 with aroma whilst preserving attributes of this variety. Some of the new rice materials developed by the breeders are now at F5 generation stage and ready for testing and selection together with farmers. The funding of rice breeding is dependent on donors such as the Japanese government. Weak institutional capacity of the National Seed Certification Services (NSCS) is hindering the pace at which new varieties are being produced. The NSCS has an acute shortage of seed inspectors with only 3 inspectors to support a network of about 26 registered seed companies. Farmers are planting retained seed rather than certified seed purchased from seed companies. Once a new variety is released and introduced on the market, active participation of farmers in the market to buy new seed is confined to a period of the first two seasons, allowing subsequent purchase from

neighbours. This pattern for rice is a major disincentive to the private sector in terms of investing in seed multiplication, certification, promotion and distribution.

***Production of foundation and quality Seed**:* Multiplication and distribution of rice varieties are through two main channels: (1) through registered seed companies; and (2) through the NARO outstations. Like maize, the bulking of rice to produce foundation seed and multiplication to produce certified seed has been driven largely by demand which has been strengthened by government, FAO and NGO tenders. Programmes such as those of AGRA have supported NARO-Zonal Agricultural Research and Development Institute (ZARDI) in the West Nile region to support the adaptation, multiplication and distribution of open pollinated seed varieties of rice and beans. The ZARDI conducts adaptation trials, production of foundation seed, raising awareness among farmers, transferring the technology, supporting the farmers to produce Quality Declared Seed, and then linking the farmers to markets.

***Seed production, multiplication and distribution**:* There is high demand for rice seed both locally and in other African countries. It is projected that the total demand for certified seed stands at 475 MT per year (This report,). To produce these certified seed, the private sector (seed companies) needs foundation seed amounting to 27 MT. For NERICA, NARO/NaCRRI usually obtains 1 MT of breeder seed (10 -50 kg for each variety) from Africa Rice, and other sources and undergoes variety trials and multiplication to produce a foundation seed. These together with other varieties are further multiplied by NaCRRI and ZARDIs to produce seed that is distributed to seed companies. Distribution of certified seed to farmers is done by the seed companies, government, and NGOs. However, there is lack of a proper seed distribution system, fake and non-certified seed on the market, limited facilities and funds for rice research, and inadequate capacity by the private sector to multiply and disseminate seed. While research generates new seed varieties, there is need to put in place a proper, efficient, and regulated seed distribution system to enhance seed uptake by farmers.

***Marketing and Distribution of Certified/ Quality-declared Seed**:* Donor funded programs have been a significant vehicle by which new rice varieties have been reaching farmers. For example in 2010, NERICA 1 and NERICA 10 and NERICA 4 were the preferred varieties under the World Bank funded agricultural input procurement and distribution programme through NAADS, which tendered for 850 MT of seed for the second season. FAO's rice promotion programme has also been a significant vehicle. NGOs have been active in Uganda distributing rice seed in areas affected by natural disasters. Other programmes such as AGRA-PASS have also facilitated varieties reaching farmers through (1) licensed seed companies; (2) farmer-to-farmer sales; (3) government and (4) NGO handouts.

Beans

***Actors**:* The bean value chain consists of various actors: input providers, producers, traders, and relief agencies. There is generally lack of use of improved inputs among bean farmers. However, there are a few farmers who procure improved seed from seed companies or stockists, governmental and nongovernmental organizations. Under the NAADS program, both food security and commercially-oriented farmers especially those in northern Uganda are provided with improved seed. NGOs, such as AVSI and VEDCO, have also been involved in giving improved seed to farmers. Moreover, NAADS and NGOs such as VEDCO, are involved in provision of extension services to bean farmers on various aspects: seed production, agronomy, marketing, and value addition.

Bean production is done by smallholder farmers with 0.5 ha or less. These farmers tend to be women and youth. They are scattered and in most cases disorganized. In a few cases, where they are organized into farmers' groups, such as in Kibaale and Kamuli, they are involved in own or contractual seed production and marketing, bulk grain production and marketing, and processing/value addition.

Traders: There are two types of bean traders: rural and urban traders. Rural traders buy beans from farmers at the farm gate and local markets and sell to urban traders comprising of wholesalers and retailers. The urban wholesalers sell beans to mostly urban and rural retailers, who in turn sell to urban and rural consumers, respectively. Some of the urban wholesalers also sell to the World Food Programme (WFP). Other buyers of bean grains are institutions (schools, hospitals, police, prisons, restaurants, etc.), mainly from village stores or large urban traders. Volumes purchased differ according to the size of the institution. Purchases are mainly done on credit basing on the ruling price in the market.

***Bean breeding and seed production**:* The bean breeding programme in Uganda is focused on producing varieties that are disease resistant (especially root rot and anthracnose which can cause complete yield loss), yield, colour, bean shape and size, taste, and early maturity. A wide range of new varieties have been released. The most recent are the NABE series bred from the local landrace lines from CIAT which are resistant to athracnose fungal disease. Other important traits being bred into new varieties are drought tolerant, faster cooking time. In recent years the process of releasing varieties has also been simplified, with two variety release meetings now being held every year. Breeders have to present 2 year on-farm data, on-station data, results of stability tests done, and DUS tests done for at least two seasons. Whilst the above analysis shows many opportunities that exist in bean breeding, the challenges facing these programmes are many. Yet, in order to effectively address all/most concerns of farmers, breeders need to incorporate many improved genes to one background gene. Hence the usual mismatch between the duration of funding and that of the breeding programme. Breeders are in need of cold room facilities to safely store and maintain the germplasm which they collect locally and internationally and which once in a while they have to regenerate in the field.

***Production of foundation and quality seed**:* Commercial bean seed production is an unattractive area of investment by many seed companies because farmers rely on the informal market. According to breeders interviewed, the private companies are only guaranteed getting viable turnover in the first season of introducing the improved bean variety, or when NGOs and NAADS float tenders for the purchase of certified seed for humanitarian interventions. As a result, breeders promote bean seed production mostly through farmer groups.

***Seed production, multiplication and distribution**:* There is lack of a proper seed distribution system, fake and non-certified seed on the market, limited facilities and funds for maize research, and inadequate capacity by the private sector to multiply and disseminate seed. Although NaCRRI has constantly been generating new bean varieties, there is need to put in place a proper, efficient, and regulated seed distribution system to enhance their uptake by farmers. Local seed businesses are filling up the gap.

***Marketing of foundation, certified and quality declared seed**:* Distribution of improved bean varieties is mainly done through farmer groups who are given free foundation seed by NARO to produce and market Quality Declared Seed. Since 2012, ISSD Uganda has enabled 30 local seed businesses to access foundation seed from NARO at a cost to produce QDS. Efforts are under way to extend this model country wised to cove a wider range of food crops.

Sesame

This section is based on sesame value chain in Uganda report by Munyua etal 2013.

Production and actors: Sesame is produced predominantly by small-scale farmers. The farming methods employed in sesame production are simple and have not changed over many generations. Farmers use animal draught for land preparation, broadcasting for planting and manual weeding, harvesting, drying and threshing. As such, sesame farming is characterized by low resource use with little mechanization or use of inorganic fertilizer and chemical pesticides. Farmers have been producing sesame for subsistence consumption and increasingly for income through the marketing of surplus production.

Due to the fragmented and small-scale nature of production, considerable effort is required to assemble sesame into economically viable volumes for trade. Sesame marketing is therefore characterized by numerous transactions involving small volumes, and equally as many traders with variable capacity. These traders can be categorized into categories based on the location, volumes handled and hierarchy along the sesame marketing value chain. The categories include the following:

Various actors are involved in moving sesame from the farm gate to the market. They include: traders on foot; bicycle traders, rural open-air market traders, rural wholesalers, and rural shopkeepers.

Bicycle traders and traders on foot move from farm to farm during the marketing season buying from farmers. These traders are mostly active on non-market days and then sell the accumulated stocks to rural open-air traders. Rural open-air traders are traders operating mainly on designated market days. They move from market to market on designated market days as well as buying directly from farmers and other smaller traders who move sesame from farm gate to market. These traders are seasonal and operate for a short period after sesame is harvested when volumes are high. During the off-season for sesame they move to other commodities.

Other traders to be found at the assembly stage include rural wholesale and retail traders. These are stationary traders operating from permanent premises such as shops and grain stores. They buy sesame continuously throughout the sesame marketing season from farmers directly, and from foot traders, bicycle traders and open-air traders. The bulked sesame is then transported to larger market centres in sub-county, county, district and regional levels and sold to urban wholesale produce dealers. After locally produced sesame is exhausted, these traders are involved in the sourcing of sesame from larger markets and then retail sesame seed to farmers and rural consumers at the grassroots.

Regional urban wholesale traders: These actors are found at regional market centres such as Soroti, Lira, Jinja and Gulu. They are commodity traders with well established businesses and the capacity to handle large volumes of sesame. They not only handle sesame but other grains and legumes produced in the area. These traders are well capitalized and have investments in storage and transport facilities. They also have adequate access to formal credit. They buy sesame mainly from rural wholesalers and sell to exporters and processors in the regional buying centres or transport bulked sesame to exporters based in Kampala.

Most exporters and processors are found in the capital city Kampala. However, some exporters have buying centres in the production regions, mainly West Nile Gulu and Lira. In Kampala, exporters screen, clean and bag sesame into 50 kilo bags. The bagged sesame is then packed into

20 and 40 metric ton containers which are transported to the shipping lines for onward shipment to the export destinations through Mombasa. Domestic processors are smaller in scale. They handle limited quantities of sesame which they process into snacks for confectionary industries and into sesame paste for distribution to retail shops and supermarkets. Other small scale processors operate in urban markets in lockups that mill and blend sesame with groundnuts into sesame paste for application on bread.

These are associations of farmers who are brought together by common interests such as collective marketing, learning activities in Farmer Field Schools, or participatory testing of improved sesame varieties with research organizations. Membership of the association is from the local community. Farmers were also found to engage in collective activities involving other crops besides sesame.

The Ministry of Agriculture is involved in framing agricultural policy and regulations while the National Agricultural Research Organisation (NARO) is involved in research. Sesame research is carried out by NaSSARI, based at Serere in Eastern Uganda. Several improved varieties of sesame have been released to farmers. SESAME II is the most popular as established through participatory varietal selection with sesame farmers in the mandated regions.

The Uganda Oil Seed Producers and Processors Association (UOSPA) was formed in 1995 as an organization of producers, processors and other stakeholders, including traders of oilseed products. UOSPA's strategy has been to work through clusters of farmers in oil seeds production and processing and to develop an integrated enterprise farming system through the adoption of improved technologies, such as improved agronomic practices, use of improved seed, proper post-harvest handling, and establishing savings and loan schemes. UOSPA has been dedicated to fostering development of the Uganda's oil seed processors and producers and the edible oil sub-sector as a whole.

Several NGOs operate in northern and eastern Uganda, working with clusters of farmers to promote improved livelihoods through promotion of improved technologies, linking farmers to markets through formation of groups and dissemination of market information, promotion of organic agricultural practices through farmer training and facilitation of certification of organic produce. The NGOs included NGETA and Concern International (CU) that work on improving rural livelihoods, Lango organic farming, and National Organic Agricultural Movement of Uganda (NOGAMU), two NGOs that promote certification of organic products in Uganda.

Finger millet

Finger millet is among those crops that do not receive priority research and extension funding from government and donor communities. However, in the last 5 years (NaSARRI, 2015), the National NaSARI) has focused on the promotion of pre-and released millet varieties in partnership with the ZARDIs, NAADS and Non-Governmental Organisations (NGOs). ZARDIs multiply seed for on farm trials of pre-release varieties, while some seed companies were contracted to produce seed of released varieties and promoted through demonstrations and publicity campaigns and availing small seed packs for sale. Four varieties (PESE 1, Seremi 1, Seremi 2 and Seremi 3) were used in the demonstrations. Despite these efforts, most farmers still save and use seed from previous harvest except in circumstances such as lack of own-saved seed caused by localised drought, poverty or insecurity; or an incentive to acquire fresh seed e.g. a new variety. The main sources of off-farm seed include local markets, relatives, and other farmers. Seed shortage due to environmental factors usually necessitate replanting in a season particularly when rains start and

stop unexpectedly causing non germination. Farmers must, therefore, plan for these repeat plantings by having access to larger quantities of seed than would otherwise be necessary. There is demand for off-farm seed as indicated by cases of rapid spread of new varieties with desirable traits. An overview of institutions involved in the finger millet seed value chain, and challenges are presented in the following tables

***Breeding finger millet**:* Breeding activities are carries out at NaSARRI mainly involving screening of germplasm from ICRISAT (NaSARRI 2015). Scientist also provide technical services to farmers, agro-based industries and maintain strong links with Agro-based industries, Agricultural Development Projects (ADPs) and other end-users of research results in the country. NGOs carry out technology dissemination activities especially in rural areas.

***Seed production**:* NaSARRI is responsible for the production of breeder and foundation seed. Some companies are contacted to produce certified seed that is sold for grain production. However the bulk of seed is processed as QDS by local seed businesses (LSBs) and cooperative societies.

Source : Harnessing Opportunities for Productivity Enhancement (HOPE) Phase 2: Stakeholders planning workshop Uganda, 31 March-1 April 2015, Soroti Uganda.

Conclusion

From the crop value chains indicates that seed production should be vertically linked to product markets. Often there are no readily available markets for products of crops being grown by the farmers. This reduces their incentives to invest in yield-enhancing technologies (e.g. fertilizers and quality seed). Even when markets are available like for maize and rice, farmers often receive low price for their products. Building coalitions between seed producers, grain/root and tuber producers, traders, agro-input dealers, and processors in the different areas can enhance demand for seed.

Annex 3: National seed demand calculations

Calculations of potential seed demand for quality seed include: national acreage, seed rates, seed/variety replacement rates, estimated discount for non-adoption (use of home saved seed and implicit (grain) seed bought at village markets). The calculations of potential seed demand is based on agronomic practices which are currently prevailing in Uganda**.** Results from these estimates will aid in the analysis of seed production costs at various stages in the value chain and to determine ideal pathways for pre-basic and basic-seed of the target crops.

Table1 provides an overview of the potential seed demand in Uganda and certified/ QDS seed targets for 2020 using UBOS data and figures from the draft National Seed Strategy. The area cultivated is based on UBOS statistics (2015) and serves as basis for calculating potential seed demand. The figures are based on Uganda census of Agriculture (2008/2009). Figures are per annum. Multiplying the acreage by the seed rate gives the estimated seed use per annum. Dividing the estimated seed use by the seed replacement ratio, gives the potential seed demand per annum. The seed replacement ratio indicates the frequency that farmers should replace their old seed stock with fresh seed to maintain vigour, plant health and purity. It is assumed that although most crops can be grown in both season in Uganda, individual farmers grow a particular crop and variety only once a year; either in season one or in season two. For example an individual farmer grows bean variety A, which is high yielding, in season one, while s/he grows variety B, which has a short maturity period, in season 2. As such the seed replacement ratio is taken per annum. Research recommends that a farmer replaces his/her hybrids each season and beans every four seasons. The seed replacement rate for hybrid maize is 1 and for beans is 4. The quantity bean seed potentially demanded in a particular year is only $1/4^{th}$ of the total seed use.

The last two columns in table 5.2.1 shows the estimated quantity of certified seed produced by the formal system in 2014 as provided in the National Seed Strategy (NSS Draft 2015) and the target for 2020, combining both certified seed and QDS. The targets take into consideration the seed market in 2015 and project potential growth of seed companies and QDS producers. It should be noted that the certified seed figures for 2014 are volumes of seed supplied to NAADS - the government's free hand out programme - and may not represent realistic figures. Free handout volumes are not a good indicator for potential seed demand as it does not include willingness/ability to pay for certified seed and QDS.

Table1 Overview of potential seed demand for maize (hybrid and OPV), rice, beans, sesame, finger millet and cassava

Seed	Area (%)	Area (ha)	Area harvested (ha)	Seed rate (kg/ha)	Estimated seed use per annum (MT)	Seed replace-ment ratio	Potential seed demand for 2015 (MT per annum)	Certified seed produced in 2014 (MT)	Annual seed targets 2020 (MT)
Maize Hybrid	10%	1,103,000	110,300	25	2,758	1	2,758	8,000	10,000
Maize OPV	90%		992,700	25	24,818	3	8,273	6,000	6,262
Rice (upland)	100%	95,000	95,000	50	4,750	3	1,583	2,000	4,000
Beans	100%	674,000	674,000	80	53,920	4	13,480	4,000	22,952
Sesame	100%	207,000	207,000	8	1,656	4	414	50	1,914
Millet	100%	175,000	175,000	5	875	3	292	200	439
Cassava (cutting)	100%	852,000	852,000						
Cassava				900	766,800	3	255,600	2,115,148	317,272

Annex 4 Cost of seed production at different stages of the value chain

The costs were initially calculated by the consultant based on available data and interviews and validated by Breeders, seed companies and other stakeholders during a roundtable meeting.

The cost of seed production varies according to the entity that is producing the seed. Currently, all breeder seed is produced by NARO with the exception of some hybrid maize varieties. The costs were initially calculated based on available data and validated by breeders, seed companies and other stakeholders during a roundtable meeting.

Seed produced by seed companies is assumed to follow all required standards and procedures for production. Seed companies spend relatively large amounts on processing, packaging and marketing. As these costs are not available, they are assumed to be between 25% and 30% of the seed production cost. For both foundation seed and certified seed companies rely on out-growers and buy seed at a per unit cost from out-growers. Farmer groups produce QDS of self-pollinated varieties using low input low output schemes. They do not spend the same amount on seed processing, packaging and transport as seed is sold in the vicinity of the farmer groups. Therefore, QDS seed is sold at a lower price than certified seed. For all crops except millet, the cost of production is calculated for certified seed. Millet seed would make a loss, if produced as certified seed; however producing it as QDS, it has a positive result. Unit costs per hectare are used to calculate cost of production of quality seed (both certified and QDS). Casual labour was standardized and slightly higher for crops that require more labour intensive activities and slightly lower for less labour intensive crops. It was assumed that all crops use a standard rate of 120 kg mineral fertilizer and 10litres of chemicals per hectare. Cost of seed production was standardised per hectare for maize, rice and beans, while the actual potential demand was used for millet and sesame. Fixed costs included salaries, benefits and allowances as well as staff training. For maize, rice, sesame and millet, the annual salary and training costs were taken as the per hectare costs. For beans the annual fixed costs were converted to per hectare costs based on the actual area under production for breeder seed. This is because of its low multiplication rate. For details refer to the tables for each crop in this annex.

The cost of quality seed production is based on the following assumptions:

- Application of fertilizer and labour cost. In case of out-growers, the high per acre cost (opportunity cost for family labour and most out-growers are not applying fertilizers) is traded off against a higher percentage harvest and post-harvest losses. A seed company may pay a lower price per kg, but will need a higher volume to sort and select the quality seed.
- Cost of interest from bank loans are not taken into consideration. Most seed companies operate their business on large bank loans against 23% per annum. This loan is needed to maintain the cash flow to make the necessary production investment during the season, while income comes 4- 6 months after the costs are incurred.
- Fixed costs are most difficult to estimate. For most crops, it was assumed that seed companies employ 2 – 3 technical staff to supervise out-growers. The remainder of the fixed costs were taken as a percentage of the variable costs. This varies between 25 and

50%. 50% was taken for most crops. As the volume of seed production is low for foundation seed , the total fixed costs, except for staff costs are relatively low.

- Production of seed, except for pre-foundation seed does not use irrigation. This because the out-growers do not have irrigation facilities. Most breeding stations do not have sufficiently large functional irrigation systems to produce the required quantities of foundation seed .
- To calculate the unit cost of production, the yield per hectare is based on the seed multiplication ratio and seed rate. The estimated yields are not always reached in 2015 because the agronomic practices, fertilizer application and weather is not favourable. This results in a lower cost of production, however this is compensated by the larger acreages needed to produce the required quantities. Since labour is the highest cost for seed production, this averages out.
- Cost of seed inspection is taken at UGX 100/kg. This includes the government's tamperproof label. This is considered the rate for commercial seed inspection which is within reach for seed companies. Currently, the official rates for field inspection and lab testing are extremely low (as per the regulations), however additional indirect costs include travel costs of inspectors. On the other hand, the cost of seed inspection for an accredited private company is estimated at UGX 170 per kg, without the label.

The calculations are based on a number of assumptions. Currently, foundation seed is produced by breeders, using farmer groups. Hardly any foundation seed is produced on farm, both breeders and seed companies use farmer groups as out-growers. The cost of EGS production records are not kept systematically at the research institutes. Most seed, whether basic or quality seed is produced using out-growers. As a result, no records are kept on casual labour which makes up the largest part of seed production. However, the calculation model used, includes the casual labour costs per ha. The casual labour costs range between UGX 700,000 per ha to 1,250,000 per ha, depending on how labour intensive the crop is. Unless mentioned differently, the unit cost for seed production is based on 1,000 MT quality seed. It is important to standardize the cost of seed production, because the proportionate share of fixed costs, depends on the quantity of seed produced. As shown in the individual crop calculations; the staff costs determine for a large part the unit cost for pre-foundation seed. Cost for millet seed is relatively high because of the small quantity needed (20 kg). This is based on the assumption that breeder and technician salaries, allowances and training compose the largest part of the production costs. Except for hybrid maize, irrigation costs and other infrastructure is small as the volume of pre-foundation seed produced is low.

Hybrid Maize

Cost of pre-foundation seed production is based on calculations from the EGS Deloite study. The Zambia data is taken as a starting point and the cost per unit were adapted to the Ugandan cost base and validated during the roundtable. The unit cost depends very much on the quantity of breeder seed produced. In the Zambia case, 100 kg breeder seed was taken, while in Uganda only 10 kg was taken, as a small quantity is needed as starting material. This difference alters the seed production costs with a factor 10. Calculating the cost of production of pre-basic and foundation seed is complex. Most hybrids in Uganda are 3-way crosses involving maintenance of parental materials and stocks. As per 2015, 10% of the planted area is hybrid maize, while the other 90% is OPV maize. In 2014, the volume of seed production was 8,000 MT. The target market in 2020 is 10,000 MT. Considering that a small seed processing infrastructure of US$ 400,000 processes 200 MT, this would be a minimum size of seed company to work at economies of scale. The maize

market is therefore large enough to accommodate the 26 seed companies. 3,300 hectare is needed to produce 10,000 MT seed. 63 hybrid varieties are released in Uganda (USTA seed variety database), of which around 50 are marketed.

Farmers that use hybrid maize, generally use fertilizer and yields are around 2.4 MT per hectare. The output market does not differentiate for quality of maize grain. Therefor farmers do not get a premium for quality grain. A Harvard study found that 40% of maize varieties are not true to type (Bold et al , 2015). Seed companies and public breeding face challenges to maintain purity of parental lines. 23 companies produce maize seed. International companies active in the market are: Pannar, Monsanto and Kenya seed. Until recently, maize was sold in 5 kg and 10 kg packs. Only 10% of the maize seed is inspected by NSCS (Draft NSS, 2015).

Although the cost of pre-basic and foundation seed production can be integrated into the cost of certified seed production that would fit the private sector archetype, the current institutional setting is not conducive. Main challenges that affect the market demand are related to the quality of seed in relation to genetic purity and high level of counterfeit seed in the market. The latter is largely attributed to a weak seed quality control and certification of EGS. There is a shortage of breeders and skilled technical personnel in national breeding institutions (on average one breeder per crop). Seed companies do not have capacity to generate their own varieties. Therefore, a public-private partnership, where international and national research centres should invest in maintaining the quality of parental lines is the most appropriate. Cost of EGS maize is presented in the following Tables.

Standardized for 1000MT MAIZE Hybrid exchange rate 1 $ = 3300 UGX

Cost of breeder seed production

					Adjusted for Uganda		
	Hybrid maize production Zambia	$	UGX		**Hybrid maize pro**	**UGX**	**Remarks**
Fixed	Salaries	196,523	648,525,900	Fixed	Salaries	71,000,000	1 breeder , 2 technicians
	Training	78,609	259,410,360		Training	28,400,000	
	Other fixed costs	413,624	1,364,959,200		Other fixed costs	1,267,644	RT - storage
Variable	Irrigation	63	207,075	Variable	Irrigation	120,708	
	labour	209	690,195		Casual labour	241,700	RT
	Equipment - planting/harvesting	61	200,574		Equipment - plantin	82,823	
	Germ plasm	105,000	346,500,000		Germ plasm	10,000,000	In uganda no royalties on germ plasm, but exclusive rights
	Inputs	251	828,234		Inputs	200,574	
	Total variable cost	105,584	348,426,078		Total variable cost	10,645,805	
	Total fixed costs	688,756	2,272,895,460		Total fixed costs	100,667,644	
	Total cost	794,340	2,621,321,538		Total cost	111,313,449	
			-			-	
	Yield	98	98		Yield (kg)	120	
	Cost price	8,102	26,737,266		Cost price	927,612	

Cost of foundation seed production current practice

					Adjusted for Uganda		
	Hybrid maize production Zambia - Foundation seed	$	UGX	cost/ha	**Hybrid maize production Zambia**	**UGX**	**Remarks**
Fixed	Salaries	6,600	21,780,000		Salaries	30,200,00	1 technician, 1 field
	Other fixed costs	413,624	1,364,959,200		Other fixed costs	10,491,54	50% of variable
Variable	Irrigation	1,882	6,211,755	1,584,631	Irrigation	12,000,00	
	labour	7,058	23,291,400	5,941,684	labour	3,600,00	900,000 / ha
	Equipment - harvesting	4,824	15,917,649	4,060,625	Equipment -	800,000	planting, shellers
	Inspection	78	258,819	66,025	Inspection	3,258,81	
	Inputs	7,529	24,847,053	6,338,534	Inputs	14,847,05	

	Transport	44	145,596	37,142	Transport	145,596	
	Total variable cost	21,416	70,672,272	18,028,641	Total variable cost	46,783,09	
	Total fixed costs	422,864	1,395,451,200	355,982,449	Total fixed costs	52,771,54	
	Total cost	444,280	1,466,123,472	374,011,090	Total cost	99,554,64	
			-			-	
	Yield	2,941	2,941		Yield	2,941	
	Cost price per kg	151	498,512		Cost price round 1	33,851	
					cost price round 2	15,907.21	
					total cost price per kg	**49,758**	

Cost of foundation seed production using cost recovery method (paying actual price for breeder seed)

Adjusted for Uganda		
Hybrid maize production Zambia	**UGX**	**Remarks**
Salaries	30,200,000	1 technician, 1 field worker
Training	12,080,000	
Other fixed costs	10,491,547	50% of variable cost
Irrigation	12,000,000	
labour	3,600,000	900,000 / ha
Equipment - planting/harvesting	800,000	planting, shellers
Germ plasm	22,734,225.96	$150 per kg
Inspection	3,258,819	
Inputs	14,847,053	
Transport	-	
Total variable cost	57,240,098	
Total fixed costs	52,771,547	
Total cost	110,011,645	
	-	
Yield	2,941	
Cost price round 1	37,406	
cost price round 2	19,462.80	
total cost price per kg	**56,869**	

Cost of certified seed production

Quality seed production assumptions	
Production (kg)	1,000,000
Production (MT)	1,000
Yield (MT/ha)	2.88
Land (ha)	347
Multiplication rate	120
Seeding rate (kg/ha)	24
Foundation Seed Used (kg)	8,333.3

	Quality seed production economics	**unit**	**unit cost**	**Cost/revenue in UGX**	**Assumptions**
Revenue	Seed sales	1,000,000	5,000	5,000,000,000	
	Total revenue			**5,000,000,000**	

Fixed costs	Staff, store, equipment, etc			384,291,667	
Variable cos	Outgrower seed cost	1,000,000	1,500	1,500,000,000	
	Foundation seed cost	8,333	20,000	166,666,667	
	Agricultural inputs	347		-	
	Field/packaging supplies	347		-	
	External inspection & labelling	1,000,000	25	25,000,000	
	Transport	1,000,000	49,500	49,500,000	$ 0.20 per km per MT @ 75 km
	treatment and packaging mat	1,000,000	55	55,000,000	
	seed marketing	1,000,000	591	591,000,000	50% of seed cost price, incl treatment & packaging
	Total variable cost			*2,387,166,667*	
	Total fixed cost			*384,291,667*	
	Total cost			**2,771,458,334**	
	Profit			2,228,541,666	
	Margin (%)			44.57	
	Production & marketing cost / kg			2,771	

Cost of certified seed production on cost recovery basis

	Quality seed production econom	**unit**	**unit cost**	**Cost/revenue in UGX**	**Assumptions**
Revenue	Seed sales	1,000,000	5,000	5,000,000,000	
	Total revenue			5,000,000,000	
Fixed costs	Staff, store, equipment, etc			384,291,667	
Variable costs	Outgrower seed cost	1,000,000	1,500	1,500,000,000	
	Foundation seed cost	8,333	56,869	473,908,373	
	Agricultural inputs	347		-	
	Field/packaging supplies	347		-	
	External inspection & labelling	1,000,000	25	25,000,000	
	Transport	1,000,000	49,500	49,500,000	$ 0.20 per km per MT @ 75 km
	treatment and packaging mat	1,000,000	55	55,000,000	
	seed marketing	1,000,000	591	591,000,000	50% of seed cost price, incl treatment & packaging
	Total variable cost			*2,694,408,373*	
	Total fixed cost			*384,291,667*	
	Total cost			**3,078,700,040**	
	Profit			1,921,299,960	
	Margin (%)			38.43	
	Production & marketing cost / kg			3,079	

The cost of pre-foundation seed production is based on calculations from the EGS Deloite study. The Zambia data is taken as a starting point and the cost per unit were adapted to the Ugandan cost base. This is due to the complexity in calculating the cost of production of pre-basic and foundation seed. Most hybrids in Uganda are 3-way crosses involving maintenance of parental materials and stocks. As per 2015, 8% of the planted area is hybrid maize, while the other 92% is OPV maize. In 2014, the volume of seed production was 8,000 MT. The target market in 2020 is 10,000 MT. Considering that a small seed processing infrastructure of US$ 400,000 processes 200 MT, this would be a minimum size of seed company to work at economies of scale. The maize market is therefore large enough to accommodate the 26 seed companies. 3,300 hectare is needed to produce 10,000 MT seed. 63 hybrid varieties are released in Uganda (USTA seed variety database), of which around 50 are marketed.

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Rice

For both upland and lowland rice, 20 varieties are released in Uganda, of which 6 are being marketed by 6 National seed companies (USTA variety register). The rice seed market is not well developed. In 2013, 22% of seed farmers used in South Western Uganda, Northern Uganda and West Nile came from agro-dealers (14%), government (2%), and NGOs (6%) (ISSD Uganda, 2014). With the newly released varieties on the market, farmers have a little more choice and there is scope to develop the quality seed market from 3800 MT in 2014 to 4000 MT in 2020.This suggest that partnerships along the rice value chain are critical. Public Private Partnership is ideal for rice EGS production and delivery.

EGS is produced at a loss. Looking at the 5 selected crops (not looking at cassava), rice generates the second smallest value chain turnover and value chain profit; just before millet. The costs of the seed production are presented in the following Tables.

Crop analysis Upland rice

Current scenario Breeder seed	Foundation seed	Commercial seed	
Breeder Seed Cost of Production	**Current practice**	**Cost recovery - current**	
Fixed Costs (UGX/annum)	**Upland Rice**	**Upland Rice**	**Assumption Source**
Salary costs	UGX 35,500,000	UGX 35,500,000	50%1 breeder, 2 SCs, technicians
Training, Testing, and Plot Observation	UGX 14,200,000	UGX 14,200,000	round table meeting Scs, breeders,
Total Fixed Costs	**UGX 49,700,000**	**UGX 49,700,000**	
Variable Costs (UGX/Ha)	**Upland Rice**	**Upland Rice**	**Assumption**
% Fixed costs other - office/lab	UGX 1,000,000	UGX 1,000,000	
equipment/Field lab equipment	UGX 900,000	UGX 900,000	
Casual labour	UGX 1,608,000	UGX 1,608,000	
Field supplies	UGX -	UGX -	
Transport	UGX -	UGX -	
Packaging material and			

marketing			UGX	-	
Storage	UGX	-	UGX	-	
Other Costs	UGX	372,000	UGX	372,000	
Inputs (Fertilizer, Pesticides, etc.)	UGX	500,000	UGX	500,000	
Inspection & Certification					
Total Variable Costs	**UGX**	**4,380,000**	**UGX**	**4,380,000**	
Summary of Breeder Seed	**Upland Rice**		**Upland Rice**		**Assumption**
Fixed Costs (UGX/Ha)	UGX	49,700,000	UGX	49,700,000	
Variable Costs (UGX/Ha)	UGX	4,380,000	UGX	4,380,000	
Total Costs	UGX	54,080,000	UGX	54,080,000	
Production (Kg/Ha)	1,200		1,200		
Cost of Production (UGX/Kg)	UGX	45,067	UGX	45,067	
Potential Margin (10%)	UGX	5,408,000	UGX	5,408,000	
Total Cost + Margin (1 Ha)	UGX	59,488,000	UGX	59,488,000	
Total Cost + Margin (UGX/Kg)	**UGX**	**49,573**	**UGX**	**49,573**	
Foundation Cost of Production					
Fixed Costs (UGX/Annuam)	**Upland Rice**		**Upland Rice**		**Assumption Source**
Salaries	UGX	16,139,500	UGX	16,139,500	
Field/Lab Equipment			UGX	-	
Total Fixed Costs	**UGX**	**16,139,500**	**UGX**	**16,139,500**	
Variable Costs (UGX/Ha)	**Upland Rice**		**Upland Rice**		**Assumption**
Breeder Seed Price (price*seed rate)	UGX	250,000	UGX	2,478,667	
Cost of Land (1 ha) for Production of Foundation Seed	UGX	100,000	UGX	100,000	
% Fixed costs other - office/lab equipment/Field lab equipment	UGX	100,800	UGX	100,800	
Casual labour	UGX	900,000	UGX	900,000	
Field supplies	UGX	105,000	UGX	105,000	
Transport	UGX	12,000	UGX	12,000	
Packaging material and marketing	UGX	-	UGX	-	
Storage	UGX	-	UGX	-	
Other Costs	UGX	44,300	UGX	44,300	
Inputs (Fertilizer, Pesticides, etc.)	UGX	372,000	UGX	372,000	
Inspection & Certification (Valued per ha planted)	UGX	120,000	UGX	120,000	
Total Variable Costs	**UGX**	**2,004,100**	**UGX**	**4,232,767**	

Summary of Foundation cost of production	Upland Rice		Upland Rice		Assumption
Fixed Costs (UGX/Ha)	**UGX**	**8,069,750**	**UGX**	**8,069,750**	
Variable Costs (UGX/Ha)	**UGX**	**2,004,100**	**UGX**	**4,232,767**	
Total Costs	**UGX**	**10,073,850**	**UGX**	**12,302,517**	
Production (Kg/Ha)	1,200		1,200		
Cost of Production (UGX/Kg)	**UGX**	**8,395**	**UGX**	**10,252**	
Potential Margin (10%)	**UGX**	**1,007,385**	**UGX**	**1,230,252**	
Total Cost + Margin (1 Ha)	**UGX**	**11,081,235**	**UGX**	**13,532,768**	
Total Cost + Margin (UGX/Kg)	**UGX**	**9,234**	**UGX**	**11,277**	
Quality Seed Cost of Production					
Fixed Costs (UGX/Ha)					**Assumption Source**
Salaries	UGX	135,000	UGX	135,000	
Cost of Land (1 ha) for Production of Breeder seed	UGX	100,000	UGX	100,000	
Field/Lab Equipment	UGX	100,800	UGX	100,800	
Total Fixed Costs	**UGX**	**335,800**	**UGX**	**335,800**	
Variable Costs (UGX/Ha)					**Assumption**
Foundation Seed Price (kg price * seed rate /ha)	UGX	275,000	UGX	563,865	
Casual labour	UGX	900,000	UGX	900,000	
Field supplies			UGX	-	
Transport	UGX	17,400	UGX	17,400	
Packaging material and marketing	UGX	480,000	UGX	480,000	
Storage	UGX	66,000	UGX	66,000	
Other Costs	UGX	44,300	UGX	44,300	
Inputs (Fertilizer, Pesticides, etc.) Inspection & Certification (Valued per ha planted)	UGX	372,000	UGX	372,000	
Seed treatment	UGX	120,000	UGX	120,000	
	UGX	90,000	UGX	90,000	
	UGX	-	UGX	-	
Total Variable Costs	**UGX**	**2,364,700**	**UGX**	**2,653,565**	
Summary of Quality Seed Cost of					**Assumption**
Fixed Costs (UGX/Ha)	**UGX**	**335,800**	**UGX**	**335,800**	
Variable Costs (UGX/Ha)	**UGX**	**2,364,700**	**UGX**	**2,653,565**	
Total Costs					Margin 15%

Production (Kg/Ha) Cost of Production (UGX/Kg) Potential Margin (15%) Total Cost + Margin (1 Ha)	**UGX**	**2,700,500**	**UGX**	**2,989,365**	
	1,200		1,200		
	UGX	**2,250**	**UGX**	**2,491**	
	UGX	**405,075**	**UGX**	**448,405**	
	UGX	**3,105,575**	**UGX**	**3,437,770**	
Total Cost + Margin (UGX/Kg)	**UGX**	**2,588**	**UGX**	**2,865**	

Beans

According to the variety release database, 21 bean varieties have been released by NARO and 3 seed companies are involved in bean seed production. In 2014, bean seed was the second largest crop in terms of seed production with 4,000 MT. Target for 2020 is 23,000 MT of which largest proportion (75%) is produced as quality declared seed. This huge potential increase in marketed bean varieties, poses a challenge on the EGS system. Considering that currently, foundation seed is hardly bulked, and that it will need 4 rounds of bulking, and it is already done using farmer groups, this should continue. More emphasis will be needed on tracking the number of rounds of bulking, inspection of seed fields and seed testing in the lab. Proper reporting and labelling structure is expected to improve the quality of seed and its vigour, which will enable research, seed companies and farmer groups to bulk foundation seed at least one round before producing seed. The other three rounds of bulking could be done by the private sector for those varieties that they market (these are only 4 companies and about 5 varieties) and by ZARDIs for other varieties.

Costs of EGS and quality seed production for beans are presented in the following Tables.

	Current scenario Breeder seed	Foundation seed	Commercial seed
Input seed (kg)	1.60	359	1,213
round of multiplication	2	3	1
area cultivated,considering rounds of bulking	0.324	4.79	1,011
Quantity seed produced in one year (KG breeder MT) 2 seasons	359	81	81
Multiplication rate	15	15	15
Yield per Ha (kg)	1200	1200	1200
Area cultivated second season	0.30	4.493333333	

Crop Analyzed	Common Bean		Common Bean			
Breeder Seed Cost of Production	**Current practice**		**Cost recovery - current**			
Fixed Costs (UGX/annum)	**Common Bean**		**Common Bean**		**Assumption**	**Source**
Salaries	UGX	35,500,000	UGX	35,500,000		
Training, Testing, and Plot Observation Travel	UGX	14,200,000	UGX	14,200,000		
	UGX	-	UGX	-		
	UGX	-	UGX	-		
	UGX	-	UGX	-		
Total Fixed Costs	**UGX**	**49,700,000**	**UGX**	**49,700,000**		
Variable Costs (UGX/Ha)	**Common Bean**		**Common Bean**		**Assumption**	**Source**
% Fixed costs other - office/lab equipment/Field lab	UGX	396,094	UGX	396,094		
Casual labour	UGX	732,000	UGX	732,000		
Field supplies	UGX	105,000	UGX	105,000		
Transport	UGX	-	UGX	-		
Packaging material and marketing	UGX	-	UGX	-		
Storage	UGX	66,000	UGX	66,000		
Other Costs	UGX	-	UGX	-		

Inputs (Fertilizer, Pesticides, etc.)	UGX	372,000	UGX	372,000		
Inspection & Certification	UGX	500,000	UGX	500,000		
Total Variable Costs	**UGX**	**2,171,094**	**UGX**	**2,171,094**		
Summary of Breeder Seed Cost of Production	**Common Bean**		**Common Bean**		**Assumption**	**Source**
Fixed Costs (UGX/Ha)	UGX	153,622,651	UGX	153,622,651		
Variable Costs (UGX/Ha)	UGX	2,171,094	UGX	2,171,094		
Total Costs	UGX	155,793,745	UGX	155,793,745		
Production (Kg/Ha)		1,200		1,200		
Cost of Production (UGX/Kg)	UGX	129,828	UGX	129,828		
Potential Margin (10%)	UGX	15,579,374	UGX	15,579,374		
Total Cost + Margin (1 Ha)	UGX	171,373,119	UGX	171,373,119		
Total Cost + Margin (UGX/Kg)	**UGX**	**142,811**	**UGX**	**142,811**		
Summary of Foundation / Cost of	**Common Bean**		**Common Bean**		**Assumption**	**Source**
Fixed Costs (UGX/Ha)	UGX	3,703,403	UGX	3,703,403		
Variable Costs (UGX/Ha)	UGX	2,452,100	UGX	13,076,975		
Total Costs	UGX	6,155,503	UGX	16,780,378		
Production (Kg/Ha)		1,200		1,200		
Cost of Production (UGX/Kg)	UGX	5,130	UGX	13,984		
Potential Margin (10%)	UGX	615,550	UGX	1,678,038		
Total Cost + Margin (1 Ha)	UGX	6,771,054	UGX	18,458,416		
Total Cost + Margin (UGX/Kg)	**UGX**	**5,643**	**UGX**	**15,382**		
Summary of Certified Seed / QDS Cost of Production					**Assumption**	**Source**
Fixed Costs (UGX/Ha)	UGX	335,800	UGX	335,800		
Variable Costs (UGX/Ha)	UGX	3,177,700	UGX	4,088,261		
Total Costs	UGX	3,513,500	UGX	4,424,061		
Production (Kg/Ha)		1,200		1,200		
Cost of Production (UGX/Kg)	UGX	2,928	UGX	3,687		
Potential Margin (15%; 10% margin)	UGX	527,025	UGX	442,406		
Total Cost + Margin (1 Ha)	UGX	4,040,525	UGX	4,866,467		
Total Cost + Margin (UGX/Kg)	**UGX**	**3,367**	**UGX**	**4,055**		

Sesame

Three sesame varieties are released in Uganda and two seed companies, both operating in Northern Uganda market these three varieties. Due to the high multiplication rates, small volumes of seed are required and sesame is normally sold in 1 kg – 5 kg packs. In 2014, the seed sector produced 50 MT of seed and it is anticipated that this increases to 1,900 MT, of which the majority is produced under the QDS system. To produce sufficient quantities of sesame seed, only 10 hectare is needed for foundation seed production. Due to the low acreage that is needed for seed production, sesame can be considered as a niche market, in which farmers only buy seed when a new variety is released. Those two seed companies engaged in sesame seed production can produce their own foundation seed rom breeder seed bought from NARO. One ZARDI can fulfil the remainder of the demand for sesame foundation seed. The market should be controlled to avoid too many farmer groups investing in seed production and then not be able to sell seed at a premium. There are no records on production of EGS for Sesame from NaSARRI. The costs of sesame seed production are presented in the following Tables.

	Current scenario		
	Breeder seed	Foundation seed	Commercial seed
Input seed (kg)		0.60	
60	6 round of multiplication		
1	1	1	
area cultivated, considering rounds of bulking		0.075	7.50
1,011			

Quantity seed produced in one year (KG					
breeder MT) 2 seasons 90		60		6	
Multiplication rate 15		100		15	
Yield per Ha (kg) 800		800		800	
Area cultivated second season					
Seed rate 8		8		8	
Crop Analyzed		Sesame		Sesame	
Breeder Seed Cost of Production		**Current practice**		**Cost recovery - current**	
Fixed Costs (UGX/annum)		**Sesame**		**Sesame**	**Assumption Source**
Salaries	UGX	30,600,000	UGX	30,600,000	
Training, Testing, and Plot Observation Travel	UGX	12,240,000	UGX	12,240,000	
	UGX	2,332,500	UGX	2,332,500	
			UGX	-	
Other fixed costs - office/lab equipment	UGX	-	UGX	-	
Total Fixed Costs	**UGX**	**45,172,500**	**UGX**	**45,172,500**	
Variable Costs (UGX/Ha)		**Sesame**		**Sesame**	**Assumption Source**
% Fixed costs other - office/lab			UGX	-	
equipment/Field lab equipment	UGX	625,000	UGX	625,000	
Casual labour Field supplies Transport	UGX	105,000	UGX	105,000	
	UGX	-	UGX	-	
	UGX	-	UGX	-	
Packaging material and marketing	UGX	44,000	UGX	44,000	
Storage	UGX	-	UGX	-	
	UGX	372,000	UGX	372,000	

Other Costs Inputs (Fertilizer, Pesticides, etc.) Inspection & Certification	UGX 500,000	UGX 500,000	
Total Variable Costs	**UGX 1,646,000**	**UGX 1,646,000**	
Summary of Breeder Seed Cost of Production	**Sesame**	**Sesame**	**Assumption Source**
Fixed Costs (UGX/Ha) Variable Costs (UGX/Ha) Total Costs Production (Kg/Ha) Cost of Production (UGX/Kg) Potential Margin (10%) Total Cost + Margin (1 Ha)	**UGX 45,172,500** **UGX 1,646,000** **UGX 46,818,500** 800 **UGX 58,523** **UGX 4,681,850** **UGX 51,500,350**	**UGX 45,172,500** **UGX 1,646,000** **UGX 46,818,500** 800 **UGX 58,523** **UGX 4,681,850** **UGX 51,500,350**	
Total Cost + Margin (UGX/Kg)	**UGX 64,375**	**UGX 64,375**	
Foundation / Cost of Production			
Fixed Costs (UGX/Annum)	**Sesame**	**Sesame**	**Assumption Source**
Salaries	UGX 12,420,000	UGX 12,420,000	
Field/Lab Equipment	UGX 2,332,500	UGX 2,332,500	
Total Fixed Costs	**UGX 14,752,500**	**UGX 14,752,500**	
Variable Costs (UGX/Ha)	**Sesame**	**Sesame**	**Assumption Source**
Breeder Seed Price (price*seed rate) Cost of Land (1 ha) for Production of Foundation Seed % Fixed costs other - office/lab equipment/Field lab equipment Casual labour	UGX 80,000 UGX 100,000 UGX 625,000 UGX 105,000 UGX 10,000	UGX 515,004 UGX 100,000 UGX - UGX 625,000 UGX 105,000 UGX 10,000	

Field supplies Transport	UGX	-	UGX	-	
Packaging material and marketing	UGX	44,000	UGX	44,000	
Storage	UGX	44,300	UGX	44,300	
Other Costs			UGX	-	
Inputs (Fertilizer, Pesticides, etc.) Inspection & Certification (Valued per ha planted)	UGX	80,000	UGX	80,000	
Total Variable Costs	**UGX**	**1,088,300**	**UGX**	**1,523,304**	
Summary of Foundation / Cost of Production	**Sesame**		**Sesame**		**Assumption Source**
Fixed Costs (UGX/Ha)	**UGX**	**1,967,000**	**UGX**	**1,967,000**	
Variable Costs (UGX/Ha)	**UGX**	**1,088,300**	**UGX**	**1,523,304**	
Total Costs	**UGX**	**3,055,300**	**UGX**	**3,490,304**	
Production (Kg/Ha)	800		800		
Cost of Production (UGX/Kg)	**UGX**	**3,819**	**UGX**	**4,363**	
Potential Margin (10%)	**UGX**	**305,530**	**UGX**	**349,030**	
Total Cost + Margin (1 Ha)	**UGX**	**3,360,830**	**UGX**	**3,839,334**	
Total Cost + Margin (UGX/Kg)	**UGX**	**4,201**	**UGX**	**4,799**	
Quality Seed Cost of Production					
Fixed Costs (UGX/Ha)					**Assumption Source**
Salaries	UGX	135,000	UGX	135,000	
Cost of Land (1 ha) for Production of	UGX	100,000	UGX	100,000	
Foundation Seed	UGX	100,800	UGX	100,800	
Field/Lab Equipment					
Total Fixed Costs	**UGX**	**335,800**	**UGX**	**335,800**	
Variable Costs (UGX/Ha)					**Assumption Source**
Foundation Seed Price (kg price *	UGX	80,000	UGX	38,393	

seed rate	UGX	625,000	UGX	625,000	
/ha)	UGX	105,000	UGX	105,000	
Casual labour	UGX	17,400	UGX	17,400	
Field supplies	UGX	400,000	UGX	400,000	
Transport	UGX	44,000	UGX	44,000	
Packaging material and marketing	UGX	60,000	UGX	60,000	
Storage			UGX	-	
Other Seed treatment	UGX	80,000	UGX	80,000	
Inputs (Fertilizer, Pesticides, etc.) Inspection & Certification (Valued per ha planted)	UGX	60,000	UGX	60,000	
Seed treatment	UGX	-	UGX	-	
Total Variable Costs	**UGX**	**1,471,400**	**UGX**	**1,429,793**	
Summary of Quality Seed Cost of Production					**Assumption Source**
Fixed Costs (UGX/Ha)	**UGX**	**335,800**	**UGX**	**335,800**	
Variable Costs (UGX/Ha)	**UGX**	**1,471,400**	**UGX**	**1,429,793**	
Total Costs	**UGX**	**1,807,200**	**UGX**	**1,765,593**	
Production (Kg/Ha)	800		800		
Cost of Production (UGX/Kg)	**UGX**	**2,259**	**UGX**	**2,207**	
Potential Margin (15%)	**UGX**	**271,080**	**UGX**	**264,839**	Margin 15%
Total Cost + Margin (1 Ha)	**UGX**	**2,078,280**	**UGX**	**2,030,432**	
Total Cost + Margin (UGX/Kg)	**UGX**	**2,598**	**UGX**	**2,538**	

Millet

Seven finger millet varieties and three pearl seed varieties are released in Uganda. Most varieties in the 80ies and 90ies with the most resent variety released in 2010. One seed company deals in millet seed. In 2014, 200 MT seed was produced. The target for 2020 is 440 MT. This is still very small. The overall turnover and value chain profit is only 1.5% of hybrid maize and 5% of the rice seed value chains. Costs of millet seed production are presented in the following Tables.

	Current scenario	
	Breeder seed	Foundation seed

Input seed (kg)		0.13		20
round of multiplication		1		1
area cultivated, considering rounds of bulking		0.027		4.00
Quantity seed produced in one year (KG breeder MT) 2 seasons		20		3,000
Multiplication rate		150		150
Yield per Ha (kg)		750		750
Area cultivated second season				
Seed rate		5		5
Crop Analyzed	Finger Millet		Finger Millet	
Breeder Seed Cost of Production	**Current practice**		**Cost recovery - current**	
Fixed Costs (UGX/annum)	**Finger Millet**		**Finger Millet**	
Salaries	UGX	35,500,000	UGX	35,500,000
Training, Testing, and Plot Observation Travel	UGX	14,200,000	UGX	14,200,000
Other fixed costs - office/lab equipment	UGX	122,050	UGX	122,050
			UGX	-
	UGX	-	UGX	-
Total Fixed Costs	**UGX**	**49,822,050**	**UGX**	**49,822,050**
Variable Costs (UGX/Ha)	**Finger Millet**		**Finger Millet**	
% Fixed costs other - office/lab equipment/Field lab equipment			UGX	-
Casual labour	UGX	1,280,000	UGX	1,280,000
Field supplies			UGX	-
Transport	UGX	-	UGX	-
Packaging material and marketing	UGX	-	UGX	-
Storage	UGX	41,250	UGX	41,250
Other Costs	UGX	-	UGX	-
Inputs (Fertilizer, Pesticides, etc.)	UGX	372,000	UGX	372,000
Inspection & Certification	UGX	500,000	UGX	500,000
Total Variable Costs	**UGX**	**2,193,250**	**UGX**	**2,193,250**
Summary of Breeder Seed Cost of Production	**Finger Millet**		**Finger Millet**	
Fixed Costs (UGX/Ha)	**UGX**	**49,822,050**	**UGX**	**49,822,050**
Variable Costs (UGX/Ha)	**UGX**	**2,193,250**	**UGX**	**2,193,250**
Total Costs	**UGX**	**52,015,300**	**UGX**	**52,015,300**
Production (Kg/Ha)		750		750
Cost of Production (UGX/Kg)	**UGX**	**69,354**	**UGX**	**69,354**
Potential Margin (10%)	**UGX**	**5,201,530**	**UGX**	**5,201,530**
Total Cost + Margin (1 Ha)	**UGX**	**57,216,830**	**UGX**	**57,216,830**
Total Cost + Margin (UGX/Kg)	**UGX**	**76,289**	**UGX**	**76,289**
Foundation seed Cost of Production				
Fixed Costs (UGX/Annum)	**Finger Millet**		**Finger Millet**	
Salaries	UGX	16,100,000	UGX	16,100,000
Field/Lab Equipment	UGX	4,182,500	UGX	4,182,500
Total Fixed Costs	**UGX**	**20,282,500**	**UGX**	**20,282,500**
Variable Costs (UGX/Ha)	**Finger Millet**		**Finger Millet**	
Breeder Seed Price (price*seed rate)	UGX	60,000	UGX	381,446
Cost of Land (1 ha) for Production of foundation seed	UGX	100,000	UGX	100,000
% Fixed costs other - office/lab equipment/Field lab equipment			UGX	-
Casual labour	UGX	1,280,000	UGX	1,280,000
Field supplies	UGX	5,000	UGX	5,000
Transport	UGX	30,000	UGX	30,000
Packaging material and marketing	UGX	-	UGX	-

Storage	UGX	41,250	UGX	41,250
Other Costs			UGX	-
Inputs (Fertilizer, Pesticides, etc.)	UGX	372,000	UGX	372,000
Inspection & Certification (Valued per ha planted)	UGX	75,000	UGX	75,000
Total Variable Costs	**UGX**	**1,963,250**	**UGX**	**2,284,696**
Summary of Foundation / Cost of Production	**Finger Millet**		**Finger Millet**	
Fixed Costs (UGX/Ha)	**UGX**	**5,070,625**	**UGX**	**5,070,625**
Variable Costs (UGX/Ha)	**UGX**	**1,963,250**	**UGX**	**2,284,696**
Total Costs	**UGX**	**7,033,875**	**UGX**	**7,355,321**
Production (Kg/Ha)		750		750
Cost of Production (UGX/Kg)	**UGX**	**9,379**	**UGX**	**9,807**
Potential Margin (10%)	**UGX**	**703,388**	**UGX**	**735,532**
Total Cost + Margin (1 Ha)	**UGX**	**7,737,263**	**UGX**	**8,090,853**
Total Cost + Margin (UGX/Kg)	**UGX**	**10,316**	**UGX**	**10,788**
Quality Seed Cost of Production				
Fixed Costs (UGX/Ha)				
Salaries	UGX	135,000	UGX	135,000
Cost of Land (1 ha) for Production of Foundation Seed	UGX	100,000	UGX	100,000
Field/Lab Equipment	UGX	100,800	UGX	100,800
Total Fixed Costs	**UGX**	**335,800**	**UGX**	**335,800**
Variable Costs (UGX/Ha)				
Foundation Seed Price (kg price * seed rate /ha)	UGX	20,000	UGX	53,939
Casual labour	UGX	1,280,000	UGX	1,280,000
Field supplies			UGX	-
Transport	UGX	10,000	UGX	10,000
Packaging material and marketing	UGX	206,925	UGX	206,925
Storage	UGX	41,250	UGX	41,250
Other Seed treatment	UGX	56,250	UGX	56,250
Inputs (Fertilizer, Pesticides, etc.)	UGX	375,000	UGX	375,000
Inspection & Certification (Valued per ha planted)	UGX	75,000	UGX	75,000
Seed treatment	UGX	56,250	UGX	56,250
	UGX	-	UGX	-
Total Variable Costs	**UGX**	**2,120,675**	**UGX**	**2,154,614**
Summary of Quality Seed Cost of Production				
Fixed Costs (UGX/Ha)	**UGX**	**335,800**	**UGX**	**335,800**
Variable Costs (UGX/Ha)	**UGX**	**2,120,675**	**UGX**	**2,154,614**
Total Costs	**UGX**	**2,456,475**	**UGX**	**2,490,414**
Production (Kg/Ha)		750		750
Cost of Production (UGX/Kg)	**UGX**	**3,275**	**UGX**	**3,321**
Potential Margin (10%)	**UGX**	**245,648**	**UGX**	**249,041**
Total Cost + Margin (1 Ha)	**UGX**	**2,702,123**	**UGX**	**2,739,455**
Total Cost + Margin (UGX/Kg)	**UGX**	**3,603**	**UGX**	**3,653**

Note: Millet is assumed to be produced by farmers groups and sold as QDS so no fixed costs are considered. If fixed costs is included millet seed production will be at a loss.

Current practice - Total production costs at each stage in the value chain (*1,000 UGX)

	Quantity Breeder seed (kg)	cost of seed production	Total costs (1,000 UGX)	Quantity FS (MT)	Cost of FS production (UGX/kg))	Total costs (1,000 UGX)	Quantity Quality seed (MT)	Cost of QS production (UGX/kg))	Total costs (1,000 UGX)	Total cost (UGX 1,000)
Maize Hybrid	431	927,612	399,670.36	51.70	49,758	2,572,635	6,204	2,771	17,195,167	20,167,472
Rice	27	49,573	1,362.69	19.79	9,234	182,763	475	2,250	1,068,948	1,253,074
Beans	24	142,811	3,422.38	80.88	5,643	456,369	1,213	2,928	3,552,149	4,011,940
Sesame	3	64,375	186.56	0.29	4,201	1,217	29	2,259	65,466	66,870
Millet	0.26	76,289	19.78	0.04	10,316	401	6	3,275	19,106	19,527

Current practice - Total income at each stage in the value chain (*1,000 UGX)

	Quantity Breeder seed	Sales price (UGX/kg)	Total Income (1,000 UGX)	Quantity FS (MT)	Sales price (UGX/kg)	Total Income (1,000 UGX)	Quantity Quality seed (MT)	Sales price (UGX/kg)	Total income (1,000 UGX)	Total Income (1,000 UGX)
Maize Hybrid	431	495,000	213,275	51.70	20,000	1,034,063	6,204	5,000	31,021,875	32,269,213
Rice	27	5,500	151	19.79	5,500	108,854	475	4,000	1,900,000	2,009,005
Beans	24	10,000	240	80.88	4,000	323,520	1,213	4,000	4,852,800	5,176,560
Sesame	3	10,000	29	0.29	10,000	2,898	29	6,000	173,880	176,807
Millet	0.3	12,000	3	0.04	4,000	156	6	3,500	20,417	20,575

Intermediate scenario – Total cost of production at each stage based on cost recovery (*1,000 UGX)

	Quantity Breeder seed (kg)	cost of seed production	Total costs (1,000 UGX)	Quantity FS (MT)	Cost of FS production (UGX/kg))	Total costs (1,000 UGX)	Quantity Quality seed (MT)	Cost of QS production (UGX/kg))	Total costs (1,000 UGX)	Total cost (UGX 1,000)
Maize Hybrid	646	927,612	599,505.54	77.6	56,869	4,410,458	9,307	3,079	28,652,114	33,662,078
Rice	70	49,573	3,452.16	50.1	11,277	565,432	1,203	2,491	2,997,669	3,566,553
Beans	138	142,811	19,773.78	467.3	15,382	7,188,117	7,010	3,687	25,842,415	33,050,306
Sesame	29	64,375	1,838.95	2.9	4,799	13,709	286	2,207	630,449	645,997
Millet	4	76,289	336.24	0.7	10,788	7,132	99	3,321	329,288	336,756

Intermediate scenario – Total income at each stage based on cost recovery (*1,000 UGX)

	Quantity Breeder seed	Sales price (UGX/kg)	Total Income (1,000 UGX)	Quantity FS (MT)	Sales price (UGX/kg)	Total Income (1,000 UGX)	Quantity Quality seed (MT)	Sales price (UGX/kg)	Total income (1,000 UGX)	Total Income (1,000 UGX)
Maize Hybrid	646	927,612	599,506	77.6	56,869	4,410,458	9,307	5,000	46,532,813	51,542,776
Rice	70	49,573	3,452	50.1	11,277	565,432	1,203	4,000	4,813,333	5,382,217
Beans	138	142,811	19,774	467.3	15,382	7,188,117	7,010	4,000	28,038,400	35,246,291
Sesame	29	64,375	1,839	2.9	4,799	13,709	286	6,000	1,713,960	1,729,508
Millet	4	76,289	336	0.7	10,788	7,132	99	3,500	347,083	354,552

Annex 5 List of Participants to the various dialogue meeting on EGS

Table 1 List of participants Breeders meeting 27 October 2015

	Name	Organisation	Email
1	Dr.Alex Barekye	KZARDI	alexbarekye@yahoo.com ; a.barekye@kari.go.ug
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Objectives of the Breeders' Meeting

- To develop consensus on the implementation of a national seed road map for each crop, and an contribution to national seed demand study
- To obtain and compile information on crop descriptors for the most popular varieties

To develop a methodology for collecting data on the costs of early generation seed Table2. Participants at the National Seed Stakeholders meeting

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81	Apango Stephen	West Nile LSB	_
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83	Abiyo Samuel	Koboko District Local Government	_
84	Tumwesigye Patrick	Isingiro District Local Government	_
85	Astrid Mastenbroek	ISSD Uganda	_

86	Patrick Oyee	ISSD Uganda	_
87	Bonny Ntare	ISSD Uganda	_
88	Phionah Ninsiima	ISSD Uganda	_
89	Alice Oriba	ISSD Uganda	_
90	Kawuma Christine	ISSD Uganda	_
91	Charles Kazoba	Africa News Corp	
92	Mark Maiga	Farm media	

This one day meeting orgarnised under the theme "Sustainable access to quality seed" attracted a total of 92 participants representing 29 organisations. The purpose of the meeting was to create an ambiance for sharing updates on new innovative solutions to seed sector bottlenecks and develop new feasible options.

To realise the above purpose, the meeting sought to achieve the following objectives:

1. To gain insight into the status of Uganda's seed regulatory framework;
2. To identify innovations addressing shortage of foundation seed; and,
3. To brainstorm on mechanisms for increasing consumer awareness and confidence.

Table 3. List of participants at the roundtable to validate EGS costs

No	**Name**	**Organisation**	**Designation**	**Email**
1	Anthony Pariyo	NaCRRI/NARO	Cassava breeder	tkakau@yahoo.co.uk
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Table 4: Focus group Interviews

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