# Business models for early generation seed production and marketing

**Working Paper**
**September 2022**

ISSD Africa

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## **ISSD Africa Working Paper:** September 2022

The action research presented in this working paper was completed under ISSD Africa Action Research Topic 6: Business models for Early Generation Seed. The topic is led by ICRISAT.

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Version 1, Sept 2022
ISSD Africa No. 2022-02

This working paper can be accessed at:

**DOI:** https://doi.org/10.18174/579986

**ISBN:** ISBN 978-94-6447-475-6


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# Contents

## Acronyms

| | |
|---|---|
| AATF | African Agricultural Technology Foundation |
| AGRA | Alliance for a Green Revolution in Africa |
| CGIAR | Consultative Group on International Agricultural Research |
| CIAT | International Center for Tropical Agriculture |
| CIMMYT | International Maize and Wheat Improvement Center |
| EGS | Early Generation Seed |
| EIAR | Ethiopian Institute of Agricultural Research |
| ESE | Ethiopia Seed Enterprise |
| EUCORD | European Cooperative for Rural Development |
| GLDC | Grain Legumes and dryland Cereals |
| ICAR | India Center for Agricultural Research |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IER | Institut *d'*Economie Rurale |
| IITA | International Institute of Tropical Agriculture |
| INRAN | "*Institut National de la Recherche Agronomique du Niger*" (National Institute of Agronomic Research of Niger) |
| ISABU | "*Institut des Sciences Agronomiques du Burundi*" (Institute of Agronomic Sciences of Burundi) |
| ISSD | Integrated Seed Sector Development |
| KALRO | Kenya Agricultural Research and Livestock Organization |
| KEPHIS | Kenya Plant Health Inspectorate Service |
| KSU | KALRO Seed Unit |
| LCIC | Legacy Crop Improvement Center |
| LSB | Local Seed Business |
| MAAIF | Ministry of Agriculture Animal Industry and Fisheries |
| MASA | Malawi Seed Alliance |
| NSAI | National Seed Association of India |
| NARO | National Agricultural Research Organization |
| NARS | National Agricultural Research Systems |
| NSC | National Seed Corporation |
| OPV | Open Pollinated Variety |
| SAU | State Agricultural University |
| S4S | Seed for Seed |
| SRF | Seed Revolving Fund |
| SSU | Seed Services Unit |
| USAID | United States Agency for International Development |
| ZARDI | Zonal Agricultural Research Institute |

## Executive Summary

Sustainable access to early generation seed (EGS) is important for efficient supply of quality certified, standard and/or quality declared seed of improved high-performing crop varieties. Some studies have been conducted from a global perspective on the delivery of EGS with a major focus on the economic analysis and identification of effective pathways for sustainable supply. This study was designed to establish the best practices and critical factors for the delivery of EGS for grain legume and dryland cereal crops in selected countries in sub-Saharan Africa (SSA) and parts of South Asia.

A literature review of specific business models applied in SSA and India was conducted. More information was gathered through in-depth interviews with specific key informants drawn from the respective institutions or agencies that were studied. The models include public-sector or research-led models, private -sector models, and public-private partnership models.

This working paper presents a synthesis of best practices and approaches through which the specific business models ensure the production and supply of breeder and foundation seeds. The paper identifies practices involving mechanisms for planning, financing, infrastructural facilities required for EGS production, incentives to promote pure line crop EGS production by the private sector, and the methods of production.

The study reveals critical constraints for EGS production and supply, including seed market vagaries; the short shelf life of some crop seeds like groundnut; limited maintenance breeding efforts; low quality of breeder seed; lack of infrastructure to produce EGS; breeder seed production does not match the demand for production of foundation seed while foundation seed production does not match the demand for production of certified seed; and high costs of supervising and managing various groups of seed outgrowers.

Interventions that build the capacity of seed producers to effectively plan EGS production requirements, guided by a seed roadmap, and product cycle management are needed. The public research institutions need to be strengthened with facilities that enhance their capacity to produce sufficient quantities of breeder seed at the required time. Besides, the proceeds from the sales should “revolve” to enable the unit to make further investments and carry out all the necessary operations in a timely manner. This requires consultation with Governments to set up financial management structures that provide an easier accountability process. Incentive schemes should be developed to encourage investment in the production of pure-line grain legumes and dryland cereals by the private sector as well as enhance their role in popularizing new varieties.

Improvement and enforcement of quality assurance and control systems by breeding programmes, including modern technological methods should be considered. Importantly, a handover system that includes lisencing and pre-orders would help to bridge the supply and demand disparity.

## 1.0 Introduction and background

Agriculture in sub-Saharan Africa (SSA) is dominated by smallholder farming characterized by low crop productivity attributed to many factors including underperforming crop varieties. Breeding efforts have resulted in the development and release of improved varieties that address production constraints including the biotic and abiotic stresses. The estimated contribution of seed quality to a crop's total production is about 15-20% and largely influences the response of other efficiently managed inputs (FAO, 2018). The importance of seed as basic input for sustainable agriculture cannot, therefore, be overlooked. Access and availability of quality seed require an integrated and effective seed supply system that is capable of generating and delivering seed of improved varieties to farmers at affordable prices. The uptake of these improved varieties is however constrained by limited availability of quality seeds caused in part by disfunctional early generation seed (EGS) value chains. The delivery of EGS in SSA is a major bottleneck affecting the performance of the seed value chains for key staple crops (Context Network, 2016).

Sustainable access to EGS (breeder and foundation seed) is important for efficient supply of quality certified and/or quality declared seed of improved high performing crop varieties (Ojiewo *et al*., 2018). Numerous studies have been carried out to analyze EGS business models from a global perspective with a major focus on conducting financial analysis and identifying effective pathways for sustainable supply of EGS (Lion *et al*., 2015). However, there is limited understanding of country-specific experiences of how they ensure production and supply of EGS in the various production environments. This study was therefore designed to fill this information gap to analyze past and current experiences and identify the best context-specific practices and the critical factors constraining access to EGS for non-hybrid grain legume and dryland cereal crops in SSA given the various business models. The study focused on the following questions; a) How is the production of early generation seed organized? b) What practices are enabling sustainable production of EGS? c) What are the critical challenges for the delivery of EGS?

## 1.1 Objectives

The general objective of this study was to examine EGS business models used by various public and private institutions. The specific objectives were to;

- Describe how the production of EGS is organized
- Establish best practices for EGS production within specific business models
- Examine the critical challenges to EGS production across business models.

## 1.2 Methodology

This study adopted a qualitative research approach and involved a review of secondary information on selected EGS business models in SSA as well the single case of India in South Asia, complemented with key informant interviews. The business models investigated can be grouped into three categories, i.e., public-sector led models, private-sector driven models and public-private partnership models. The public-sector models include; the Kenya Agricultural and Livestock Research Organization (KALRO) Seed unit of Kenya, the Institut National de la Recherché Agronomique du Niger (INRAN) Seed unit of Niger, the Ethiopia Institute of Agricultural Research (EIAR) model for common bean and chickpea, India Rice EGS system, Institut des Sciences Agronomiques du Burundi (ISABU) of Burundi seed unit; while the private institution models included the Legacy Crop Improvement Center (LCIC) of Ghana, Premier Seed Nigeria and Soprosa-Sarl of Mali. The third category comprised of models that involve public-private partnerships; and included the "Seed for Seeds" foundation seed enterprise of National Agricultural Research Organization (NARO) Holdings Limited in Uganda, Egerton University business approach for promoting Highland Bean Varieties, the malt barley case in Ethiopia, the CGIAR/NARS driven models comprising of the Seed Revolving Fund (SRF) designed by ICRISAT in Malawi, and the Seed Revolving Fund Youth Engagement and Gender Inclusion (SRF-YEGI) initiated by ICRISAT in Tanzania as well as Qualibasic Seeds Limited based in Kenya and the IITA GOseed in Nigeria.

More information was gathered by conducting in-depth interviews with specific key informants drawn from the respective institutions, agencies and companies that were studied. Given the prevailing circumstances with the COVID-19 pandemic, the interviews were conducted using an interview guide administered by phone and in some cases through email.

# 2.0 Presentation of Findings

## 2.1 Characterizing the business models

This section provides an overall categorization of the business models studied (Table 1). Aspects of; the type of crop seeds produced, the type of EGS produced, the geographical coverage of the produced EGS, where the model is financially independent or subsidized, seed production approach, whether a pre-ordering system is in place, cash flow strategy and the legal status of the business model are considered.

Generally, the business models legally fall under; public, private and public-private depending on the type of institution that's is applying the model. Most the models are subsidized especially during the initial stages of establishment especially in setting up buildings, seed handling facilities and production infrastructure in some cases. Some private companies including; Premer Seeds Ltd, in Nigeria, Soprosa-Sarl in Mali, and NARO Holdings Ltd S4S also continue to subsidize their operations by entering into public-private arrangements with national and international research centers as a strategy to subsize itheir business operations especially in acquiring seed production and handling infrastructure.

The public-sector led models operate in a semi-autonomus manner, however they often remain subsidized through payment of staff salaries by the establishing organizations, including use of resources such as land and transport facilities. Most public-sector led and public-private models such as the ICRISAT SRF in Malawi and Tanzania, NARO Holdings Ltd S4S model in Uganda; KALRO; use the seed revolving fund approach as a cash flow strategy to ensure EGS production. All the business models heavily rely on seed production through out-grower schemes. The geographical coverage for most of public sector led seed units is largely for national consumption except for the private seed companies  such as QBS, Premier seeds Ltd, Nigeria and LCIC that have explored wider regional markets in their business strategy. However, the regional markets are mainly for marketing and distribution of hibrid maize and hybrid soybean varieties. More details are illustrated in the Table 1.

**Table 1: Characteristics of the EGS Business Models from selected countries in ESA, WCA and South Asia**

| Organization / Company | Crops handled | Seed type | Country/ Coverage | Production approach | Pre-order system | Cash flow strategy | Financial status | Legal status of institutions involved |
|---|---|---|---|---|---|---|---|---|
| The INRAN Seed Unit | Pearl millet, sorghum, cowpea, groundnut | Breeder seed, Foundation seed | Niger | Own production | Yes | Own resources | Subsidized | Public institution |
| Ethiopia Institute of Agricultural Research | Chickpeas, common bean | Breeder and Foundation seed | Ethiopia | Own production, | Yes | Own resources | Subsidized | Public institution |
| | Malt-barley | Breeder and Foundation seed | Ethiopia | Seed Enterprise farms | Yes | Grant received from private partner | Subsidized | Public-Private |
| KALRO Seed Unit | Common bean, mungbean, soy bean, OPV maize, wheat, sorghum, finger millet | Breeder and Foundation seed | Kenya | Own production, Out-growers | Partly Yes | Own resources/ revolving fund | Partially Subsidized | Public institution |
| Pre-Order Seed model, ISABU | Common bean, rice, maize, wheat | Breeder and Foundation seed | Burundi | Own production | Yes | Advances from buyers | Partially Subsidized | Public institution |
| ICAR India | Rice | Breeder, Foundation | India | Own production, | Yes | Own resources | Subsidized | Public institution |
| Legacy Crop Improvement Centre (LCIC) | Maize, cowpea | Breeder and Foundation seed | Ghana, COMESA region | Own production, | Not always | Own resources/ grants | Partially Subsidized | Private company |
| SOPROSA-Sarl | Sorghum, Pearl millet, Groundnut | Foundation seed | Mali | Own production, Out-growers | Not clearly defined | Own resources | Independent | Private company |
| Premier Seed Ltd | Maize, cowpea, sorghum | Foundation seed | Nigeria, COMESA region | Own production, Out-growers | Not clearly defined | Own resources | Independent | Private company |
| ICRISAT- Seed Revolving Fund | Groundnut | Foundation seed | Malawi | Out-growers | Not clearly defined | Revolving fund | subsidized | Public-Private |
| ICRISAT SRF Youth Engagement and Gender Inclusion | Groundnut, sorghum | Foundation seed | Tanzania | Out-growers | Yes | Revolving fund | subsidized | Public-Private |
| IITA GOSeed | Banana, rice, cassava, cowpea, maize, plantain, soybean and yam | Foundation seed | Nigeria, COMESA | Own production, Out-growers | Yes | Own resources | subsidized | Public-Private |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Seed for Seeds Ltd-NARO Holdings | Common beans, groundnut, rice | Foundation seed | Uganda | Own production, Out-growers | Yes | Revolving fund | Subsidized | Public-Private |
| Highland beans-Egerton University | common bean | Breeder and Foundation seed | Kenya | Own production, License agreements | Yes | Royalties | Subsidized | Public-Private |
| QualiBasic Seeds Ltd | Maize, common bean | Foundation seed | East and Southern Africa | Out-growers | No | Own resources | Subsidized | Public-Private |

## 2.2 Public-Sector Led Business Models

### 2.2.1 The KALRO Seed Unit, Kenya

The KALRO Seed Unit (KSU) was established in 1997 with the primary objective of promoting the uptake and commercialization of crop varieties that were not picked up by private seed companies. The crops of focus were mostly legumes such as common bean, mungbean, soybean, and the open-pollinated cereal crops such as OPV maize, wheat, sorghum, finger millet as well as horticultural crops (Omanga, 1998). The unit started its operations with a focus to produce EGS but along the way started to produce certified seeds too. KSU works together with breeders and contracted farmers to produce EGS as well as certified seeds. The KALRO Seed Unit (KSU) works with about 2,500 farmers per season with support by the umbrella organization KALRO itself. The key partners include the CGIAR centers CIAT, ICRISAT, CYMMIT as well as WorldVeg Center. These research centers support the unit with the breeder seed. The unit also partners with some private seed companies that it licenses to produce foundation seed of some crop varieties. KALRO Seed Unit operates smaller units at the organization's semi-autonomous research centers located at various parts of the country where they implement specific research mandates. For instance, the seed unit at KALRO Kakamega produces OPV maize, common bean, soybean, groundnuts, sorghum and finger millet. Common bean and maize are the leading crops constituting more than 75% of the total seed production with sorghum, finger millet and other legumes constituting less than 25% of seed production at the unit.

**KALRO approach to EGS supply**

KALRO provides the initial seed grant that the Seed Unit uses to initiate EGS production activities. KSU then engages breeders to produce seed that includes breeder and pre-basic seed classes. Basic seed production is contracted to selected and willing farmers who operate as individuals or are grouped into units called Seed Industry Development Units (SIDUs). KSU operates between 25-30 SIDUs per season. These farmers and groups are based in one locality and are required to plant the same variety to provide acceptable field isolation. This strategy is similar to the seed village community seed production approach used in India to maintain varietal purity. KSU, seed merchants, extension and KEPHIS provide technical and quality control support services throughout the crop cycle. The seed merchants specifically ensure compliance of seed out-growers directly under them to strict seed production rules and regulations. The produced seed is processed by outgrowers and collected by KSU staff at between 13-15% moisture content for further conditioning to 12%-13% moisture content. KSU trains farmers on how to clean, treat and package the seed to ensure proper post-harvest handling. The produced EGS is sold to private seed firms and development projects. The foundation seed price is set in a way that ensures self-sustenance in the long term.

The sale of foundation seed is accompanied by a document from KSU which authenticates the EGS material being supplied. This document must be produced before the Kenya Plant Health Inspectorate Service undertakes seed certification. Once the seed is sold, KSU retains 80% of the proceeds from sales for further seed production and 20% is remitted to the organization KALRO. Apart from working with contracted farmers, KSU also licenses private seed companies to produce foundation seed. The licensed seed companies pay some royalties to KALRO to sustain this.

**How KSU sustains EGS production**

***Joint planning:*** KSU conducts national annual meetings to plan and make strategies to improve its performance. Projections of seed demand are made during these meetings and are based on the number of clients demanding seed. Seed pricing is also agreed upon during these meetings.

***Revolving fund:*** An initial one time grant is provided to the Seed Unit by the KALRO to initiate seed production activities and thereafter, 80% of the proceeds is injected back into seed production and development of relevant infrastructures such as seed processing and storage facilities.

***Licensing private seed companies:*** Large companies with the capacity to produce EGS are licensed to produce seeds of certain crops through payment of royalties to the mother organization KALRO. By receiving royalties, the KALRO generates funds that are occasionally injected into the various Seed Units to facilitate seed production activities.

***Incentives for farmer seed producers:*** Seed production being a restrictive and costly enterprise, KSU has put in place mechanisms that incentivize farmers to take up contracts to produce seed and build on their trust and integrity to work together. Contract farmers are given seed loans which are recovered when they deliver the produced seed to KSU. KSU also offers a premium price of about 20-30% for the EGS produced by outgrowers compared to the price offered by other buyers of seed and grains in order to ensure the produced seed is sold to KSU. These incentives have built trust between KSU and its contract farmers and also ensured farmers' commitment to produce seed.

***Irrigation system:*** KSU has invested in the establishment of irrigation systems to enable offseason production and also cope with the frequent dry spells caused by climate change effects.

***Partnerships:*** For breeder seed supply, KALRO does not only rely on its breeding programmes but works closely with the CGIAR centers CIAT, CIMMYT and ICRISAT among others.

**Challenges**

- Capaity for customized planning
- Limited land at the research centers to allow for seed production

- Supervision of outgrowers is very costly

**Coping with challenges**

- Contract more outgrowers
- Concentrate outgrowers within specific communities growing seed for a common crop

### 2.2.2 Chickpea and common bean EGS model of the Ethiopia Institute of Agricultural Research (EIAR)

According to Jonnes *et al.*, (2006), the Ethiopia Institute of Agricultural Research (EIAR) developed and released new Kabuli type varieties in response to the high demand in export markets for large seeded Kabuli type chickpeas which fetch significantly higher prices compared to the existing Desi types. This required investing in better seed supply systems and institutional arrangements that would improve access to high quality seeds of improved varieties by chickpea producers to enhance commercialization. The formal seed system is the major channel for dissemination of EGS of new improved varieties released by EIAR and other Research Centers (Jonnes *et al.,* 2006, Kassie *et al.*, 2009). Improved varieties are channeled through the Ethiopia Seed Enterprise (ESE) through the Regional Seed Enterprises (RSEs) which produce, process, distribute and market pre-basic and foundation seeds for legumes such as chickpeas, beans as well as cereal crops such as sorghum, maize, and malt barley among others (Ojiewo, *et al.*, 2018).

**Production and supply of EGS by EIAR and ESEs**

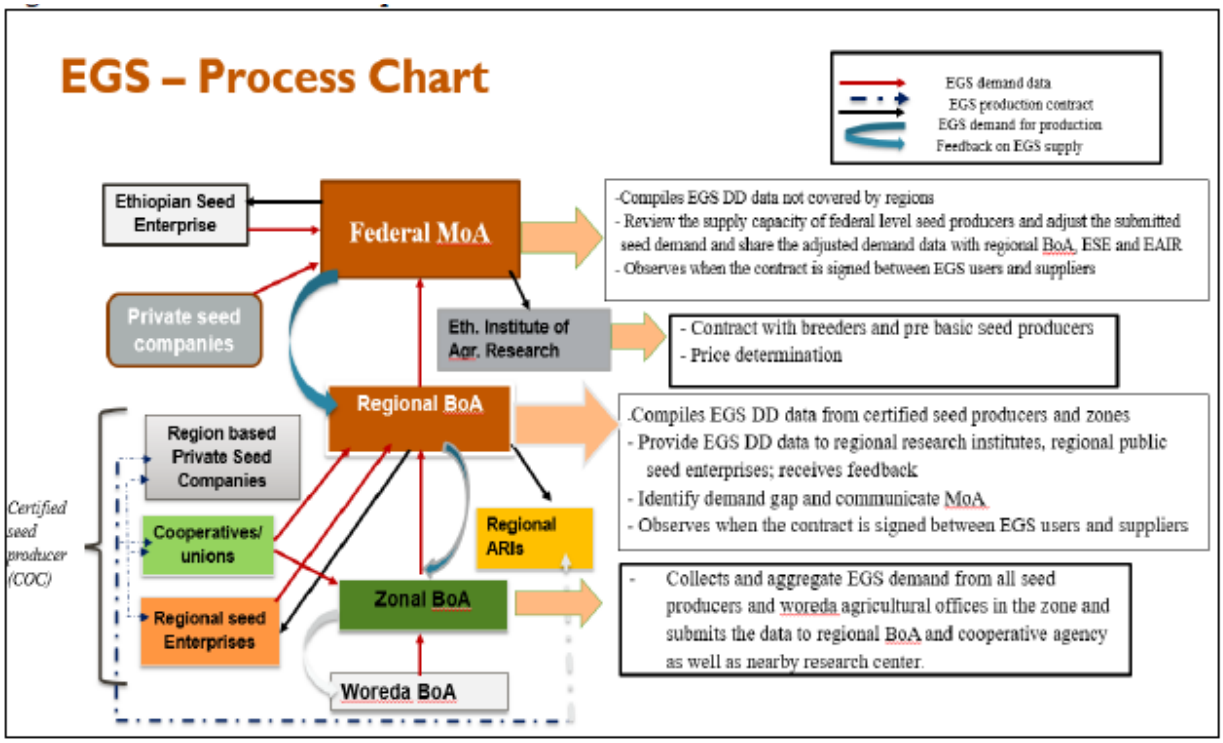
Breeder seeds are produced by the EIAR's National Agricultural Research centers and supplied to ESE. The ESE produces pre-basic and foundation seeds of various crops at its four farms that are located in different agro-ecological zones of the country based on the official demand projections from the regional Bureaus of Agriculture. Both cereals and legumes EGS is produced; however, the ESE produces more cereal crops seeds (maize, wheat, and teff) compared to the legume crops beans, chickpeas, and lentils as indicated in Table 2 (Atilaw *et al.*, 2016). The ESE may also contract other public and private farms, seed producer cooperatives, and smallholder farmers to produce foundation seeds (Ojiewo *et al.*, 2018, Akpo *et al.*, 2020). The seed production trend is present in Table 3.

**EGS Demand Forecasting process**

Ethiopia has an established system and process of seed demand forecasting (Dey and Bezabih, 2021). EGS forecasting is performed at various administrative levels based on established demand for certified seeds. The process starts at the Woreda agriculture office, where crop, variety, and seed producer data is collected and compiled from the seed producer cooperatives, and submitted to the Zonal agriculture office, the Regional Bureau of Agriculture, and the Cooperative Promotion Agency. The Regional Bureau of Agriculture formats the submitted seed demand data by crop, variety, seed class, seed quantities needed, and seed producers and

accordingly informs the EGS producers and the regional Cooperative agency. The bureau also specifies the demand gap and requests the Ministry of Agriculture to fill any gaps through allocation of EGS.

The Ministry of Agriculture compiles the submitted EGS demand data and analyzes the capacity of EGS suppliers at federal level. It also provides EGS demand data to the Regional Bureaus of Agriculture and the public EGS producers and seed enterprises. The ministry also facilitates contractual arrangements between EGS seed producers and commercial seed producers that had demanded the EGS. The entire process is detailed in Figure 1 and Table 2 below.




*DD=Demand; BoA= Bureau of Agriculture,; MoA = Ministry of Agriculture*

Source: (Dey and Bezabih, 2021)

**Fig.1: EGS estimation process**

**Table 2: Key stakeholders and their roles in EGS demand forecasting in Ethiopia**

| Role | Woreda | Zone | RBOA | MoA | PSE* | PSC* | Coop | ARI* |
|---|---|---|---|---|---|---|---|---|
| Collect data from | Collect EGS demand data from certified seed producer cooperatives | Data collected by woreda BoA; collect data from cooperative union registered and operate at zone level | Collect EGS demand data from zonal BoA, or/and seed producers (private seed companies, public seed enterprises, cooperative unions); EGS demand may also come from other regions | Receives EGS demand data from RBOA, PSE and PSC | EGS demand is collected through RBOA and MoA. PSE plan for EGS supply based the data | Demand data collected from producer cooperatives and clustered farmers (groups) producing certified seed as out growers | Demand collected from its seed producing members; Information on demand is also communicated to coops by BoA/MoA to plan seed production planning | Demand estimated by RBOA and MOA is used by ARI for planning EGS production; Limited cases of collecting data from farmers and coops |
| Compile data | Aggregate the data by crop, variety, and coops | Aggregate data by crop, variety | Aggregate the EGS demand by crop, variety by certified seed producers; Shows the gaps to be filled at the federal level | Compile the EGS data, analyze the capacity of EGS suppliers at federal level and make adjustments. Aggregated by region, crop type and variety | PSE makes no aggregation but bases its plan for EGS supply on demand for certified seed, past years' trend, availability of breeder and pre-basic seed | Data used for own planning based on resources availability | Compiles by crop and variety | Compiles data by crop and variety and considers past trend to adjust the plan based on its capacity |
| Submit data to other stakeholders | Zonal Agr Office and regional BoA and cooperative agency | Regional BoA and cooperative agency | Data reported to seed producers in the region, coop agency, MoA (to fill regional EGS gaps) | Share the revised EGS demand with RBOA, EIAR and ESE/EABC | | Communicate the BoA, inform out-growers about the plan to prepare land for seed production | Zonal or regional BoA | Communicate its EGS production capacity to RBOA, MOA andESE |
| Coordination | | Follow up the actions taken | Coordinate the EGS demand collection in collaboration with ARI | Facilitate contract signing between EGS suppliers and seed producers | | | | |

** PSE= Public Seed Enterprise; PSC= Private Seed Company; ARI= Agricultural Research Institute*

**Factors enabling EGS production**

- Ethiopia has an established "bottom-up" system and process of seed demand forecasting.
- The ESEs and RSEs annually receive a national budget allocation through the Ethiopian ministry of agriculture for carrying out EGS production activities.
- Partnerships with development projects that have seed delivery interventions with the purpose of improving crop productivity and livelihoods.

**Challenges**

- The seed demand forecasting process is not digitized and uses non-rigorous econometric approaches.
- Market information is rarely used in the estimation and forecasting of seed demand resulting in unreliable estimations.
- Lack of digitized data archives to enable panel and trends analysis of seed production. This makes estimation of seed demand shifts difficult.
- Seed data adjustments made at the different administrative levels are not transparent and well documented.

**Table 3: EGS production (pre-basic and basic seed) in tons by EIAR**

| Year | Maize | Bread Wheat | Barley | Sorghum | Tef | Faba Bean | Haricot bean | Chickpea | Lentil |
|---|---|---|---|---|---|---|---|---|---|
| 2011 | 248.5 | 273.7 | 17.9 | 8.2 | 90.7 | 16.5 | 96.4 | 47.5 | 3.2 |
| 2012 | 287.4 | 555.9 | 20.18 | 4.8 | 88.5 | 10.7 | 26.9 | 52.5 | 6.2 |
| 2013 | 63.3 | 603.8 | 13.21 | 0 | 87.3 | 14.9 | 62.8 | 63.9 | 7.4 |
| 2014 | 12.1 | 475.8 | 33.38 | 8.7 | 38.4 | 76.8 | 58.7 | 34.3 | 2.9 |
| 2015 | 215.7 | 203.4 | 10.83 | 12.2 | 58.1 | 20.9 | 16.6 | 0 | 0.8 |

*Source: Atilaw et al., 2016*

### 2.2.3 The INRAN Seed Unit

The unit was created in 1998 with the objective of improving the supply of EGS for major crops and contributing to a sustainable private seed industry in Niger. The unit is overseen by a technical seed committee that comprises breeders and has a coordination office with representatives at the research station level. The role of the technical seed committee is to plan and evaluate the unit's performance. The unit enjoys a semi-autonomy status from INRAN, runs its own separate account, and is given priority access to production fields. The unit has for the last five years been producing an average of 20.5MT of pearl millet, 6.5MT of sorghum, 6.8MT of cowpea, and about 4MT of groundnut EGS annually.

Breeder and foundation seeds are produced by the Seed Unit at research institutes or any other institutions responsible for the release of varieties. However, a private company can produce foundation seeds only under the supervision of the INRAN Seed Unit. It is mostly done through a contract between the seed company and the Seed Unit. In some cases, a seed company having technical capacity can access breeder seeds for the production of foundation seeds without a contract. The supply of breeder and foundation seeds from 2014-2018 is summarized in Table 4.

**Table 4: EGS Production (Metric tons) by INRAN Seed Unit from 2014-2018**

| Crop | 2018 | 2017 | 2016 | 2015 | 2014 | Total |
|---|---|---|---|---|---|---|
| Pearl millet | 16.07 | 15.87 | 12.10 | 32.53 | 26.25 | 102.82 |
| Sorghum | 6.22 | 4.62 | 3.63 | 10.35 | 7.87 | 32.69 |
| Rice | 1.01 | 0.90 | 0.78 | 1.75 | 1.69 | 6.13 |
| Maize | 0.53 | 1.57 | 1.46 | 0.36 | 3.17 | 7.09 |
| Cowpea | 8.91 | 5.27 | 4.58 | 5.74 | 9.58 | 34.08 |
| Groundnut | 3.13 | 2.30 | 2.00 | 8.11 | 4.34 | 19.88 |
| Total | 35.87 | 30.53 | 24.55 | 58.84 | 52.90 | 202.69 |

***Source**: INRAN Seed Unit, 2019*

### 2.2.4 The Rice EGS System in India

In India, EGS production is organized and streamlined in such a way that seed producers place orders and receive seed allocations through a systematic demand planning process involving State Agricultural Universities (SAUs), Indian Council of Agricultural Research (ICAR) institutions, State Seed Corporations (SSCs), the National Seed Corporations (NSC) and licensed private seed companies through National Seed Association of India (NSAI) with the supervision of the Government of India (GOI) (Context Network, 2016; Kalyanrao, 2011).

**Rice EGS supply approach**

Research institutions (SAUs and ICAR) are responsible for producing and supplying breeder seed to both the public and private seed companies (i.e SSC, NSC and licensed Private sector-led companies). The SSC, NSC and licensed Private sector-led companies produce the foundation seed. Indents from the various seed producing agencies are collected by State Departments of Agriculture (SDAs) and submitted to the Department of Agriculture, Cooperation and Farmers Welfare (DACFW) in the Ministry of Agriculture

The DACFW compiles all submitted information and sends it to the crop project coordinator at ICAR, who then allocates production responsibility to the appropriate SAU/ICAR institutions. The compiled indents must be forwarded to ICAR at least 18 months in advance. The ICAR-DAC annually holds a seed review meeting in which the actual production of foundation seed by different research centers is planned and allocated. Figure 2 illustrates the planning process.

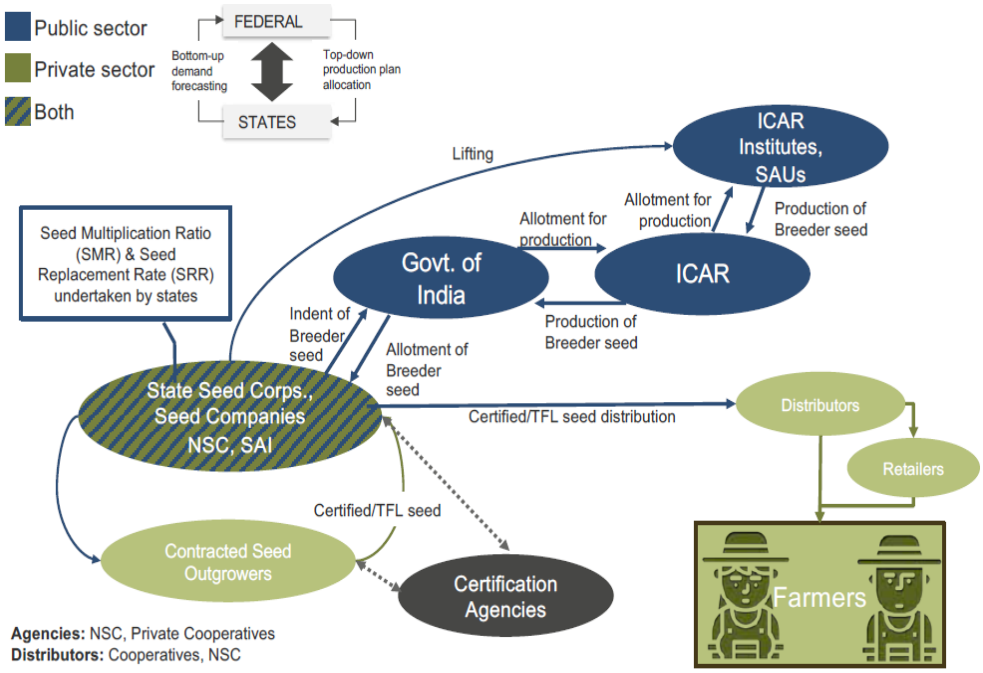



**Figure 2: The Rice EGS Production Planning Process**

*Source: [https://seednet.gov.in/](https://seednet.gov.in/)*

**Key success features in the rice EGS system in India**

The following features characterize and have contributed to the success of the India rice EGS system according to the previous EGS study (Context Network, 2016)

- Bottom-Up demand forecasting and production planning process
- Strict adherence to calendar of operations
- Breeder seed supply often exceeds demand
- Financial sustainability is assured through dedicated and reliable public sector funding for commercially valued research and seed production.
- Institutionalized process, resourcing and organizational-level accountability exist to meet annual breeder seed demand requirement.
- Private seed producers depend on out-growers for foundation seed production and commonly maintain breeder-quality seed on their farms.
- Agro-dealers support seed company decision-making with information on demand and farmer preferences thereby encouraging the formation of feedback loops
- Government and political authorities consider rice to be critical to the nation and, therefore, it enjoys government support through grants, schemes in addition to the budgetary allocations.
- Conducive policy environment and government support for the role of the private sector, combined with effective advocacy from the National Seed Association

- The role of private actors in providing agricultural extension and popularizing new varieties is enhanced.

**Challenges**

Infrastructural deficiencies in terms of cold storage, seed processing and seed quality assurance testing equipment which affect the maintenance of seed production efficiency and quality.

Poor quality assurance systems from public institutions seed which sometimes fail genetic purity. This results in loss of trust from private seed companies that are forced to carry out purification of lines.

### 2.2.5 The Pre-Order Seed model, ISABU- Burundi

The breeder and foundation seeds in Burundi are produced and supplied by the specific research centers of *Institut des Sciences Agronomiques du Burundi* (ISABU). Additionally, the CGIAR centers IITA, CIAT, ICRISAT, and IRRI also supplement supply of EGS through ISABU (Mabaya et al., 2021).

ISABU's approach requires the commercial seed producers to apply to the respective research centers for foundation seed with an advance 10% payment of the total cost of seed (Mabaya et al., 2021). The pre-order system has greatly improved the availability of EGS in Burundi. The pre-order approach allows EGS producers to estimate the size of their market and the needs of farmers based on the seed bookings made by buyers. The rate of satisfaction with the availability of foundation seed by commercial seed producers in the country is currently considered "excellent" for rice at 83%, and "good" for maize, beans, and wheat at an average rating of 71.3% (Mabaya et al., 2021; https://www.kit.nl/project/private-seed-sector-development-burundi/).

## 2.3 Private-Sector Led Business Models

### 2.3.1 Premier Seed Nigeria Limited

Premier Seed Nigeria was founded in 1984, initially as Agricultural Seed Ltd (AgSeed) owned by the Multinational Leventis Group of Companies. AgSeed was later acquired by Pioneer Hi-Bred Seed International and was renamed Pioneer Hi-Bred Seed Nigeria Ltd. In 1994 it became a limited liability company officially named Premier Seed Nigeria Ltd. The company which is involved in breeding and seed production activities for maize, sorghum and rice as its main crops is one of the largest seed businesses in Nigeria today. Among its activities, it produces and supplies early generation seed for the above mentioned cereal crops as well as vegetables. The company sources its materials through its various collaborations. Premier seed ranked 11$^{th}$ in the 2019 access to seed index for Western and Central Africa. It has demonstrated strengths in research and development, marketing crop varieties from its breeding program throughout Nigeria and its governance and strategy such as setting targets for improving smallholder farmers' access to quality seeds.

**Organization of EGS production at Premier Seed Ltd**

The company has built strong partnerships with international and public research institutions, non-government organizations as well as farmers. Premier seeds partnered with CGIAR centers, national research centers and NGO's like Sasakawa Africa Association.

The Company has a 70 hectare research farm with irrigation facilities which is used for the multiplication of foundation seeds for different crops and the breeding of new maize inbred lines for the development of new hybrids. The farm is also used for conducting nationally coordinated trials involving the NARS and CGIAR centers. The company also operates a highly developed out-growers scheme comprising of highly trained and motivated farmers to produce high quality foundation seeds for certified seed production.

Key players in this initiative include the NARS and CGIAR centers such as the International Institute of Tropical Agriculture (IITA), ICRISAT, and AfricaRice center. Other collaborating Research Institutes include Institute for Agricultural Research (IAR), Zaria, Nigeria, National Cereal Research Institute (NCRI), Badeggi, Nigeria and National Institutes for Horticultural Research (NIHORT), Ibadan, Nigeria.

**Key success factors for premier seed ltd**

The company has a well-established research and development department that is led by highly trained and experienced plant breeders to produce its own early generation seed rather than rely on mainstream research institutions.

The company operates a highly developed outgrowers scheme which comprises highly trained and motivated farmers to produce high quality foundation seeds for certified seed production. This diversified approach creates a system that reduces potential production risks.

The company has a 70 hectare research farm with established irrigation facilities which is used partly for the multiplication of foundation seeds. This enables the company to ensure a continuous supply of early generation seed all through the year.

Through partnerships, the company receives breeder seed as well as parental lines of improved hybrid varieties developed by other research institutes and also ensures the sustainability of its own research wing as well access to additional resources.

### 2.3.2 The SOPROSA-Sarl EGS model, Mali

The history of producing sorghum seeds comes from the fact that sorghum is a cereal used traditionally by 80% of Malians as food. SOPROSA-Sarl together with ICRISAT and the national research institute partners sought to commercialize high-performing varieties. SOPROSA-Sarl produces sorghum foundation seeds with the support of Institut d'*Economie* Rurale (IER).

**EGS production at SOPROSA-Sarl**

Breeder seed is supplied by the sorghum breeder at the national research institute IER. The company annualy receives 300 to 400kg of sorghum breeder seed from the IER. SOPROSA-Sarl has invested in solar irrigation equipment to ensure reliable all year-round production of foundation seed on its farm.

**Enabling factors for sorghum EGS production and supply by SOPROSA-Sarl**

- Working closely with international organizations such as the Alliance for Green Revolution in Africa (AGRA), ICRISAT, SYNGENTA Foundation to advance the country's core seed policies through strategic research.
- Financial support to the national research institute IER to produce breeder and pre-basic seed
- Irrigation facility enabling the production of foundation seeds throughout the year.

**Challenges and coping mechanisms**

The challenge is the initiation adotption of new varieties by other value chain actors. To address this challenge, SOPROSA liaises with the sorghum breeders at IER to create awareness and promote the new varieties.

### 2.3.3 The Legacy Crop Improvement Centre (LCIC) model

LCIC is a private entity specialized in the production and marketing of foundation seeds of cowpea, soybean, rice, and hybrid maize. Its focus is to ensure the production of good quality foundation seeds as well as building and supporting other seed sector players whose performance depends on seed quality availability. These other seed sector players are seed companies, outgrowers, agro-dealers, farmers, processors, government entities as well as non-government investors and donors in the seed sector. The company thrived with initial support from the West Africa Centre for Crop Improvement (WACCI) in form of breeder seed and startup capital from AGRA. LCIC operates on a crop diversification strategy with a larger proportion of seed products portfolio coming from maize and soybean hybrid seeds. For instance, the company supplies more hybrid maize foundation seed which constitutes more than 60% of its product portfolio when compared to other crops. It produces on average 8 tons of hybrid maize seed and 5 tons of soybean foundation seed.

**LCIC approach to sustainable EGS production**

- Build private-public partnership to scale up the production of hybrid seeds
- Operate a mixed seed enterprise strategy that combines hybrid cereal crops with legume crop seeds
- Establish 20 acres drip irrigation farm for in-house breeding, line maintenance and seed multiplication
- Invest in cold storage facilities for seed maintenance.

**Enabling factors for sustainable supply of foundation seeds by LCIC**

***Investing in relevant infrastructure***

*Irrigation system:* LCIC has 20 acres drip irrigation system for in-house breeding and line maintenance which enables all year-round seed production.

*Cold storage facility:* This has enabled storage of EGS in large quantities for a longer period thereby avoiding seed deterioration and enabling maintenance of seed quality.

***Supportive Seed Policy and market***

The ECOWAS has a seed regulation that allows for regional marketing of seed released in two member countries. LCIC markets seed varieties in several countries beyond Ghana (Mabaya *et al.*, 2021).

## 2.4 Public-Private Partnership Business Models

### 2.4.1 The ICRISAT Seed Revolving Fund (SRF) in Malawi

This was initiated by ICRISAT in Malawi in the year 1999 to address the problem of limited access to quality legume seeds that the private seed sector is often reluctant to invest in, but also to reverse the situation of smallholder farmers relying on informal seed channels. The initiative was a public-private partnership involving ICRISAT working together with the Malawi Seed Alliance (MASA), Seed Traders Association of Malawi(STAM) and some commercial entities such as Kakuyu Farm. It was established initially to provide high quality foundation seeds of improved varieties in a sustainable manner and at a reasonable cost, starting with groundnut with the eventual inclusion of other crops including pigeonpea (ICRISAT, 2017).

The SRF activities started with production and supply of groundnut foundation seed through a one-time financial grant from USAID, and continued to run with further support from Irish Aid and other partners with well defined roles as indicated in Table 5 (Bossuet, 2017). The seed revolving fund model has nurtured a solid private seed industry that has resulted in a boost in groundnut production. It does this by providing high quality seed of improved varieties at a reasonable cost (Monyo and Varshney, 2017).

**Table 5: Key players in the ICRISAT SRF and their roles**

| Players | Roles |
|---|---|
| ICRISAT | Develop Varieties, Produce and supply Breeder seed |
| Seed producers/ clubs | Produce and supply pre-basic and basic seed to seed companies |
| Seed companies | Utilize the basic seed from ICRISAT to produce certified seed |
| Seed Services Unit (SSU) | Conducts field inspections and seed certification and relays results to ICRISAT and seed producers |
| Malawi Seed Alliance (MASA) | Make key decisions on varieties to produce based on market needs, required seed quantities, coverage strategy, quality assurance system and seed pricing |
| USAID, IRISH AID | Provided Funds in form of starter grants |

**The SRF approach to EGS production**

- Seed producing clubs of 10 - 15 smallholder farmers are trained in seed production, management and group dynamics.
- These clubs are contracted by the SRF to produce foundation seeds, which are then bought back at agreed prices.
- Small growers are given the pre-basic seeds on credit from ICRISAT, while individual larger farmers, who could also be contracted to multiply seeds for the SRF, have to pay for the EGS in advance.
- The foundation seed is then sold to local seed companies for multiplication into certified seeds.
- Seed companies then sell seed to a larger number of farmers through agro-dealers.
- Proceeds of the seed sales realized are ploughed back to cover operational costs such as staff, inspection and certification, warehouse, seed packaging and transport. The fund is able to engage more smallholder farmers on yearly basis.

The revolving fund enables supply of foundation seed on a cost recovery basis without much emphasis on profits and has been able to include other legume and cereals crops such as pigeonpea and rice (ICRISAT, 2017). Figure 3 illustrates a simplified SRF model.

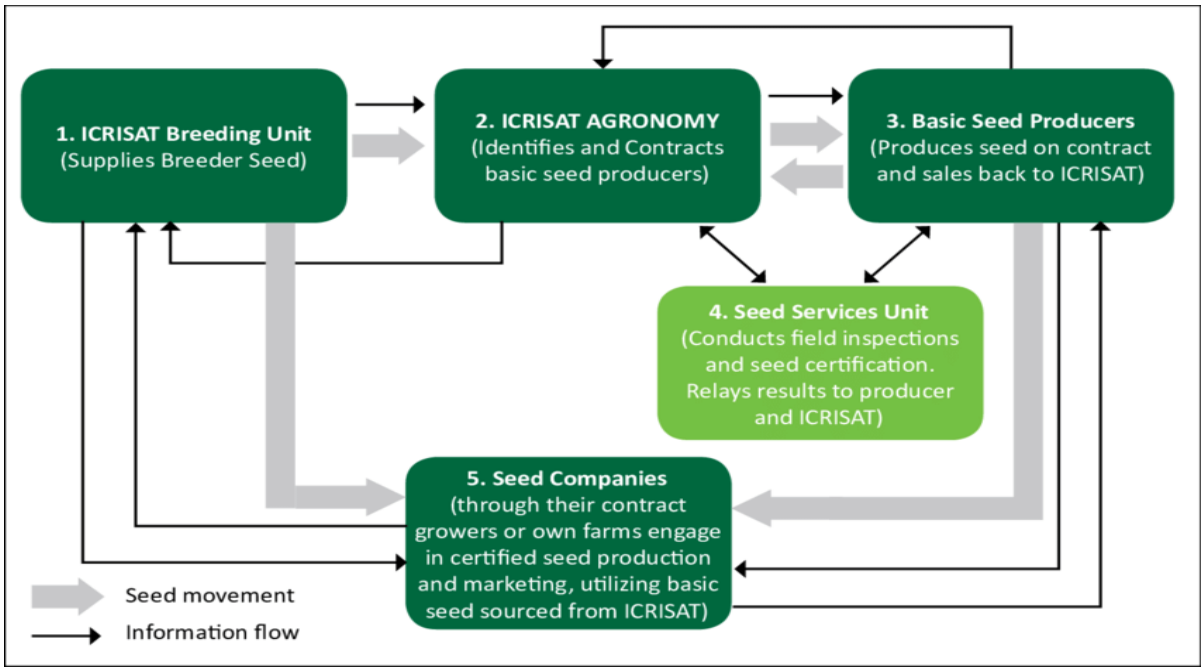



**Figure 3: The Malawi model of the seed revolving fund.**
***Source: ICRISAT***

To date, the scheme has demonstrated growth with the support of an alliance of seed producers in the country that now account for over 54% of legume seed produced in Malawi. By 2010, the scheme had delivered more than 200 tons and 1,200 tons of breeder seed and foundation seed, respectively (Monyo and Varshney, 2017). The model registered a remarkable growth of more than 2,000 MT (Okori *et al.*, 2016) of groundnuts and pigeonpea foundation seed by 2015. Other seeds supplied through the model include rice. However, more than 80% of the foundation seed produced comes from groundnuts with pigeonpea constituting less than 5% (Okori *et al.*, 2016).

To ensure the sustainability of the SRF, the MASA consortium makes key decisions on varieties to produce based on market needs, required seed quantities, coverage strategy, quality assurance system and seed pricing (ICRISAT, 2017). Through the the SRF strategy, the seed system can cover seed production related costs such as warehouse worker wages, seed packaging, transportation as well as engaging more farmers in the seed business every year. The SRF management gradually is being shifted from ICRISAT to MASA as local seed ventures get more involved. The scheme is therefore funded through a revolving fund that grows based on the sale proceeds of the foundation seed to selected local seed companies and NGOs working on food security, who in turn produce and sell certified seed to the government and farmers.

**Success factors for the SRF model**

**Capacity building of Seed producers**: The foundation seed producers are trained on seed production, management and group dynamics. This ensures seed producers have the required skills to produce quality EGS and also creates a sense of trust amongst the seed producers as well as other players in the EGS value chain.

**Availability of breeders Seed**: Research (breeders) ensured breeder seed is readily available on annual basis to seed producers for production of foundation seed to supply seed companies.

**Contract seed production arrangements**: Farmer groups and individual farmers with a proven track record in seed production are given contracts to produce foundation seed. The contract agreement ensures production of the required quantity as well as market for the produced EGS.

**Seed grants:** The seed producers initially receive seed loans and following successful payback they are given more seed to produce on a contractual basis.

**Major challenges encountered with SRF model**

***Seed regulatory services are not adequately financed***

Almost all stakeholders highlighted the lack of capacity by Seed Services Unit (SSU) as one of the major bottlenecks in the Malawi seed value chain. There is limited human and infrastructural capacity in the SSU. This problem is exacerbated by the seed production fields that are small and scattered over wide geographical locations given that the seed producers comprise smallholder farmers working in groups or individually. This geographical dispersion requires substantial human and physical resources to facilitate EGS quality regulatory services.

**Adverse effects of climate change on the rainfall patterns in Malawi**

The production of breeder seed is largely dependent on rainfall and there is minimal and almost insignificant use of irrigation technology and yet the distribution and total amount of rain received in Malawi in recent years has been unfavourable to crop production.

### 2.4.2 The Seed Revolving Fund Youth Engagement and Gender Inclusion (SRF-YEGI) by ICRISAT in Tanzania

The initiative aims to sustain the production and supply of EGS and other seed classes for groundnut and sorghum in Tanzania through a more business-oriented and sustainable seed delivery system. The strategy is to strengthen public-private partnerships that support sustainable production and delivery of various seed classes of sorghum and groundnut with ICRISAT playing mainly a process facilitatory role. The private seed companies are engaged to produce and deliver seeds of improved varieties that fit certain market demand and market quality. Additionally, the initiative is built along the existing markets by working closely with specific off-takers operating across the country. The inclusion of off-takers in the model secures the market for each seed class thereby paving the way for pre-ordering.

### 2.4.3 The IITA GOSeed model

The initiative was started by the International Institute of Tropical Agriculture (IITA) in collaboration with the Ministry of Agriculture after realizing a gap in the supply of EGS of its mandate crops; cassava, banana, yam, and cowpea; and other CGIAR mandate crops. GOSeed is registered as a Limited Liability Company that is housed at the IITA headquarters in Ibadan, Oyo State, Nigeria. It was was established in 2015 as a unit within the IITA Business Incubation Platform (BIP) that seeks to bring various kinds of innovation to the market, including improvement of access to clean seeds. The IITA Business Incubation Platform is the technology delivery arm of IITA. GOSeed is responsible for the commercial production and promotion of the EGS seeds of improved crop varieties generated by IITA and other CGIAR centers across the globe with a particular focus on banana, selected legumes, cereals, root and tuber crops that include; cassava, cowpea, maize, plantain, rice, soybean and yam. The company produces and sells high quality breeder and foundation seeds of different target crop varieties to seed producers in Nigeria and across Africa at affordable prices. It does this through established out-grower schemes. GOSeed works together with seed experts, seed producers and other key stakeholders in the various value chains. However, at the forefront of this EGS model are IITA breeders and the Ministry of Agriculture, National Agricultural Seed Council (NASC).

**GOSeed's approach to EGS production**

They have put in place the necessary infrastructure like an irrigation system and cold storage facilities are in place and also have in terms of the human and financial resources with the capacity to produce seed. However, accurate seed demand forecasting is still a hurdle because

seed off-takers do not provide timely and accurate seed indices. The promotion of new varieties plays a major role in ensuring sustainability.

### 2.4.4 Egerton University model for promoting Highland Bean Varieties

The initiative arose following a threat to household food security caused by severe crop losses due to maize lethal necrosis (MLN) disease that occurred in Kenya in 2011 (FSNWG, 2013). Kenya's agricultural extension service recommended farmers to plant crops other than maize to contain disease spread in the Rift Valley region highlands. Farmers chose to plant common bean given its status a key staple crop in the country. Egerton University in collaboration with the International Center for Tropical Agriculture (CIAT) developed medium- to high-altitude bean varieties with disease resistance. The university partnered with local seed companies to commercialize three new varieties from 2011 to 2014.

**Approach to EGS supply by Egerton University common dissemination bean model**

The university and the seed companies signed contracts through which the university sold breeder seeds to the seed companies who received non-exclusive rights for multiplication, up-scaling and commercialization. The University promoted and marketed the new varieties with financial support from AGRA in 2014.

The spread of disease created an urgent need for action which resulted in the University and seed companies reaching an agreement to provide breeder seeds. The cost of producing one ton of breeder seeds was approximately US$2900. In the agreements, the university did not charge the seed companies licensing fee, but the companies were required to pay a 5% royalty on their gross sales to the university. Development partner AGRA funded marketing efforts which involved promotion activities to create awareness among variety users and stimulate demand once the licensing agreements had been signed.

Breeding efforts by the university were driven by climate change models that predicted increased production areas suitable for common bean (Ramirez & Thorntorn, 2015) which in addition to severe maize crop losses attributed to MLN disease resulted in efforts to stock breeder seeds in anticipation of future needs (Cramer, 2018).

The breeders were eager to see the varieties reach farmers and therefore helped to align them with commercial interests through working with seed companies. The university ensured breeder seeds were in stock and quickly shared it through an agreement with local seed companies.

The university worked with seed companies that they had previously worked with and as a result, there was some level of trust between the university breeders and the seed companies that the contracts would be honored and the correct royalties paid. The seed companies were then able to bulk up the breeder seed and obtain the necessary approvals to produce certified seed to market to farmers especially those that needed an alternative to maize (Cramer, 2018).

**Key success factors**

- There was sufficient trust between the actors and smooth coordination for contract establishment and EGS (breeder seed) was readily available
- The contract agreements with seed companies built trust with the university breeders
- The royalties paid by seed companies reinforced this trust and further motivated the breeders to stock sufficient quantities of breeder seeds
- The non-exclusive rights to multiply seed enabled many seed companies to participate in EGS supply
- The anticipated future need and foreseen demand created through climate change modeling also motivated for the breeders and seed companies to avail EGS
- The breeders being able to align the public good (varieties) with commercial interests

- The donor directed financial resources to market and stimulate demand rather than producing the much need foundation seeds.

Despite the achievements and relative success in this model, it was a one-off initiative to address a crisis that required quick intervention and therefore raises some sustainability concerns. However, it offers some insights and lessons for EGS delivery and especially for legumes.

### 2.4.5 Seed for Seeds (S4S) foundation seed enterprise, NARO-Holdings, Uganda

The Uganda EGS system has a multipronged seed delivery approach driven through joint efforts between National Agricultural Research Organization (NARO), the Integrated Seed Sector Development (ISSD) Uganda and the Ministry of Agriculture Animal Industry and Fisheries (MAAIF). EGS of common bean, rice, groundnuts, potato, cassava and sesame is produced through the NARO Holdings Seed for Seeds (S4S) seed enterprise, Zonal Agricultural Research Institutes (ZARDI's) and Lead farmers who are part of the Local Seed Business (LSB) system (Figure 4). In this arrangement, the National Agricultural Research Institutes of NARO maintain the production of the breeder and pre-basic seeds through their respective crop specific breeding programmes; S4S, ZARDI's and LSB Lead Farmers produce the foundation seed; MAAIF provides seed regulation and certification services and ISSD Uganda facilitates the process by building capacity in terms of establishing a centralized seed handling infrastructure system comprising of installing an irrigation system and 60MT cold room seed storage facility at S4S and facilitate inspection services by MAAIF Seeds Certification Unit through the ISSD plus project interventions. Basic seed production is centrally coordinated through S4S by contracting the ZARDI's and Lead Farmers in addition to producing at its own farm and eventually bulks the produced seed for processing and packaging and sales at its facilities located at Kigumba farm.

NARO is the lead player in this initiative. The key partners in this initiative are ISSD, AATF and MAAIF. The partners play the supportive role of building the capacity of outgrowers to produce seed, support quality assurance services by facilitating seed inspection by ministry officials, variety promotion activities and marketing. NARO Holdings role involves monitoring production volumes on site and coordinating processing and packaging activities.

**S4S- NARO-Holdings approach to EGS supply**

NARO Holdings in its approach uses outgrowers to produce EGS in an arrangement where seed producers are given the initial breeders seed without directly paying for it. The cost of the breeder seeds supplied to the outgrowers is factored into the buying price of produced foundation seeds. NARO Holdings buys back the produced seeds where the seed companies then pick it up. In planning the quantities to produce, NARO Holdings directly solicits seed orders from seed companies and Local Seed Businesses and produces as per market demand. NARO Holdings collects all the produced seed to process, pack and brand.

NARO Holdings also works directly with the national research institutes which produce EGS and pass it on to NARO Holdings to market it. This has particularly been the case with rice seeds under the PRIDE project. Both parties agree to a Memorandum of Understanding that ensures efficient distribution and utilization of proceeds from seed sales that in a way allows for continued production of EGS. In the agreement, NARO Holdings remits 80% of the proceed back to the research center for seed production, 15% goes to the producing institute's Non-Tax Revenue account and 5% is retained by NARO Holdings for its operational costs. There is a possibility within this arrangement for the breeders to closely work with farmers to produce the seeds under researcher guidance as a cheaper option for them.

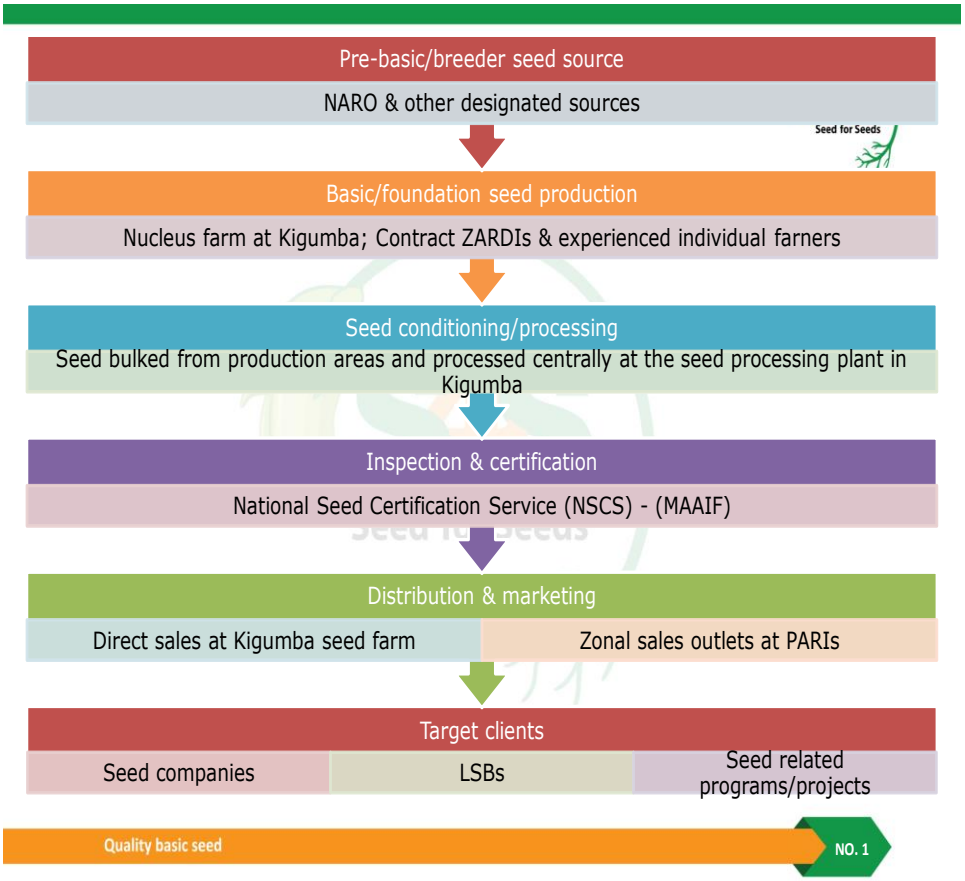



**Figure 4: Seed for Seeds- NARO Holdings business model**

***Source: S4S***

**Challenges encountered by S4S-NARO Holdings**

- The S4S lacks financial autonomy due to institutional bottlenecks such as the non-tax revenue policy and protracted procurement processes. These bottlenecks curtail the timely reinvestment of funds generated from seed sales to sustain EGS production and supply.
- It is expensive to deliver breeder seeds to outgrowers and also pick up the produced seeds for processing as they are widespread over the country
- Some seed companies do not place their seeds requirement orders early enough to allow for seed demand planning.

**How the challenges are being addressed**

- Establish more production units across zonal institutes and charge them with the responsibility to collect seed orders from seed companies and LSBs within the zone before the beginning of the season on behalf of NARO Holdings.
- Decentralizing seed processing rather than the current centralized system.

### 2.4.6 Qualibasic Seeds Limited (QBS) in Kenya

QualiBasic Seeds (QBS) is a foundation seed (FS) company established in 2017 with the headquarter in Nairobi, Kenya and subsidiary operations in Zambia and South Africa with the target to produce for specific regional markets. It was established by the African Agricultural Technology Foundation (AATF) as an EGS (foundation) production entity in SSA to effectively and efficiently supply high quality foundation seed for small and medium enterprise (SME) seed companies on the continent with a start-up grant from the Bill and Melinda Gates Foundation (BMGF). The company was established to address the acute technical, infrastructural and financial challenges the seed companies face in the maintenance, multiplication and timely supply of quality foundation seed, critically essential to improve farm productivity by smallholder farmers.

The company has invested in large production infrastructure in all the three countries of operations comprising of pre-foundation seed production facility for purification through hand pollination, processing and cold storage facilities.

QBS supplies parent seed for hybrid and OPV maize that is predominantly coming from the public research programmes. Due to demand from customers (seed companies and farmers), the company has added common beans as a secondary product to their portfolio in Kenya and are considering other crops too particularly the oil seed crop soybean and hybrid rice. The legume crops are considered secondary products because they are planted for the maintenance of soil health in the hybrid maize fields. The company is currently selling a total of 135 inbred lines and single cross maize hybrids.

**QBS approach to EGS production**

- Qualibasic has invested its resources into contractual partnerships with commercial farmers to produce the basic seeds and environmentally controlled storage facilities as well as seed processing and handling equipment. One of the criteria for selecting outgrowers is possession of an irrigation system on the farm. QBS annually produces 100MT of hybrid maize foundation seed.
- Common bean seed "piggy-backing" hybrid maize seed. The common bean is in this case grown as a secondary crop from the perspective of integrating legumes in the hybrid maize seed production cycle for maintenance of soil fertility in the fields.

**Challenges experienced by QBS**

- Still a young company with a narrow customer base
- Unplanned extra orders from customers. Customers tend to come last minute and increase their order for the seed
- Market vagaries on the side of seed companies. Seed companies are developing their businesses in uncertain market environments. This affects their production planning
- Untimely breeder seed deliveries by breeding programmes.
- Maintaining isolation distance by outgrowers. They however address this by selecting outgrower farmers that are also commercial vegetable producers because they do not grow maize, so isolation distance is attained. Vegetable producers also have irrigation systems installed in their farms and also have a lot of labour at hand.
- Slow seed certification services and acquiring export certificates
- Low quality of breeder seed. Breeding programmes sometimes supply genetically impure breeder seed, especially with the common beans. They developed a protocol for raising the genetic purity of their products through hand pollination but this however increases production costs. QBS also uses the "SEED ASSURE App" to ensure seed purity. The app provides production reports in which it raises flags if there are any issues like pests, diseases and off-types. The app can be used offline in the field and gives reports along with field photographs once connected to the internet
- The legumes like common beans have a shorter shelf life (about 5 years) compared to maize that takes over 18yrs in cold storage with over 90% germination.
- Breeder seeds production does not match demand. This forces the foundation seed companies to wait for the breeder to go through another cycle of production to obtain the required amount of breeder seed.

### 2.4.7 The Malt Barley EGS System in Ethiopia

The brewing industry in Ethiopia is fast growing with large international brewers such as Heineken and Diageo present in the country considering local sourcing of raw materials for beer production. Local sourcing is a key component of Heineken's strategy of partnering for growth in Africa and seeks to financially empower farmers and their communities. Heineken sought to source malt barley within the country which posed far more benefits to Ethiopian farmer livelihoods and government in terms of savings on foreign exchange rather than importing. Heineken's local sourcing approach was implemented through the CREATE project. In 2013, Heineken signed a Memorandum of Understanding for a 4-year malt barley sourcing programme together with the Dutch Ministry of Foreign Trade and Development Cooperation, the NGO EUCORD and Ethiopian Government institutes, the Agricultural Transformation Agency and the Ethiopian Institute of Agricultural Research with the two government institutions charged with the responsibility to produce and supply EGS (Heineken, 2013). Heineken supported the development of new malt barley cultivars *Grace* and *Traveler.* Based on on-farm trials, *Traveler* emerged best performing with improved productivity levels. To ensure increased easy access and availability of quality certified seed, efforts were made to multiply the variety *Traveler* to guarantee supply of malt barley seed to all contracted smallholder farmers.

**Production of Malt barley EGS**

The maintenance of released varieties and the production of a breeder and basic is done by the agricultural research institutions that have developed the varieties and basic seed production is the responsibility of ESE which has three basic seed farms on which it produces seed for specific crops suitable to the ecological conditions. The Gonde-Ethaya is a farm for highland crops and Shallo and Kunzila farms are fit for mid to lowland crops spanning an area of 2,100 ha with a potential annual seed production capacity of 4,500 tons. The ESE also contracts EIAR research farms to produce basic seeds.

**Factors enabling supply of malt barley EGS**

- *Exclusive rights on varieties:* The beer company Heineken had ownership of the malt barley varieties but provided financial support to EIAR and ESE to respectively produce breeder and foundation seed. The financial support supplement EIAR's and ESE's national annual budget allocation to carry out its mandate of producing breeders seed.
- *Seed contract agreements:* Heineken provided financial resources through contract agreements with EIAR and ESE for the production of breeder and foundation seed.
- *Pre-secured seed and grain markets*: The Seed Producer Cooperatives that are contracted to produce certified seeds for malt barley grain producers provide a ready market for the basic seeds.

## 3.0 Structural organization of EGS production

The business models studied in general demonstrate differences in the structural organization of EGS production in the respective categorization as public sector, private sector and public-private partnership models. The structural organization of the models is assessed in terms of how EGS production is done, seed production facilities and determination or estimation of seed demand (Table 5).

*The actual EGS production*

In general, breeder seed production remains the responsibility of the breeders. Most NARS organizations operate Seed Units that operate as semi-autonomous from the mother organization. The units are provided startup grants which are then maintained as a revolving fund for further investments and maintenance of EGS operations. Outgrowers schemes are also instrumental as a cheaper alternative in terms of acquaisition of land and labour for production of basic seeds as opposed to producing on research station farms. However, some NARS institutions such as KALRO, INRAN, Niger's IER also provide licensing agreements that allow seed companies to produce basic seeds without the obligation to sell back to the NARS Seed Units as the case with the out-growers.

The foundation seed companies such as QBS and LCIC operate in close partnership with the public sector and international research centers. These partnerships have enabled the companies to invest heavily in establishing production, handling and storage infrastructure. The private partner in a PPP arrangement such as the Heineken malt barley case in Ethiopia provides financial support to the NARS to produce and supply the required basic seeds as well as ensuring its off-take by commercial seed producers that are contracted to produce certified seeds. Pre-securing of markets from grain off-takers is another strategy adopted in the Tanzania case. The system allows for the collection of seed orders from clients and the use of the information for subsequent planning of seed production thereby establishing a pre-order system of EGS delivery.

*Seed production facilities*

The private sector-led models such as LCIC, Premier Seeds Nigeria Ltd, Soprosa-Sarl produce seed on their extensive farms with irrigation and cold storage facilities to enable seed production throughout the year without affecting seed quality given the low multiplication rate of most GLDC crops. Some of the public sector-led models such as EIAR, INRAN, ICAR and some centers of KALRO do have the same facilities but are not adequate enough for sustainable EGS production. Business models involving public-private collaborations have invested in irrigation and cold storage facilities which are attributed to cofunding by partners and support from donor agencies. The BMGF supported QBS in Kenya through AATF and LCIC in Ghana through AGRA. Most public sector-led models do not have these facilities in place as a result of the low budget allocation and therefore over-dependence on donor funding.

*Determining seed demand*

This is a very important aspect in planning production that is contributing to the bottlenecks in supplying EGS in sub-Saharan Africa. While most of the models studied did not have a clearly defined system of determining seed demand (Table 5), some business models demonstrated viable approaches for the estimation of seed demand. For instance, the EIAR, ICAR and ISABU business models employ a pre-order system in which certified seed producers place seed orders or indents before the beginning of the season. The advantage in this is that the EGS producers get to know how much to produce and have committed seed buyers before seed production.

**Table 5: Analysis of business models structures**

| Business Model | How EGS is produced | Seed demand forecasting | Innovations to enhance EGS availability/best practices | Challenges |
|---|---|---|---|---|
| Public sector models | | | | |
| INRAN Seed Unit | - Production on own farm<br>- Contracting seed companies<br>- Some Breeder seed from CGIAR | - No clear approach | - Contracting seed companies | - Getting seed companies to embrace new varieties<br>- Demand forecast challenges |
| Ethiopia Institute of Agricultural Research | - EIAR breeding programmes produce breeder seed<br>- ESE produces pre-basic and basic seeds at zonal farms | - Demand projections are done by regional Bureaus of Agriculture | - Annual budget allocation to ESE<br>- Centralized annual demand projections system<br>- Partnering with niche market private comapanies | - Seed production infrastructure |
| KALRO Seed Unit | - KALRO provides an initial seed grant<br>- Breeders produce breeder seed<br>- Foundation seed produced in own farms and through outgrowers<br>- Licensing private seed companies | - Joint planning within KALRO research centers | - Revolving fund (80% retained for seed production, 20% to KALRO)<br>- Issuing non-exclusive license agreements to private seed companies | - Regulation and management of out growers is very costly<br>- Inadequate seed production infrastructure |
| ICAR | - Research institutions (SAUs and ICAR) are responsible for producing and supplying breeder seed (BS) of notified crop varieties to both public and private seed companies | - Seed pre-orders are compiled and forwarded to ICAR at least 18 months in advance | - Seed companies submit indents (seed orders) to ICAR 18 before the beginning of the season<br>- Established a Seed Management Information System that facilitates seed production planning | - Infrastructural deficiencies<br>- Poor breeder seed quality<br>- Seed production in excess may not work with crops with rapid viability decline |
| Pre-Order Seed model, ISABU | - Breeder and foundation seed is produced on station and through outgrowers | - Seed pre-ordering system used to determine seed demand | - Pre-odering system of seed<br>- Advance payement of 10% on seed orders made | - |
| Private-sector models | | | | |
| Legacy Crop Improvement Centre (LCIC) | - Own Production of foundation seed | - No clear approach | - Invested in seed production and handling infrastructure (irrigation and cold storage)<br>- Compliance with regional markets standards | - Forecasting seed demand challenges |
| SOPROSA-Sarl | - IER produces breeder and pre-basic seed<br>- Own production of foundation seed | - No clear approach | - Invested in seed production infrastructure to allow all year round seed production | - Popularizing new varieties<br>- Demand forecast challenges |
| Premier Seed Ltd | - Own Production of hybrid maize<br>- Own production of foundation seed | - No clear approach | - Invested in seed production infrastructure (irrigation system) | - Demand forecast challenges |

| | | | | |
|---|---|---|---|---|
| Public-private partnership models | | | | |
| ICRISAT Seed Revolving Fund | - Own production of breeder seed<br>- Out-growers produce foundation seed | - No clear approach | - Revolving fund to finance seed production operations | - Weak national Seed Services Unit<br>- Cstly management of outgrowers<br>- Demand forecast challenges |
| IITA GOSeed | - Own production of breeder seed<br>- Outgrowers produce foundation seed | - No clear approach | - E-commerce platform<br>- Seed tracker system in place | - Demand fore casting challenges |
| Seed for Seeds Ltd-NARO Holdings, Uganda | - Own production of foundation seed<br>- Foundation seed production by Zonal research institutes<br>- Out-growers produce foundation seed | - Pre-ordering of seed | - Revolving fund<br>- Decentralize production to agro-ecological zones | - Costly management of outgrowers<br>- Demand forecast challenges<br>- Non-tax revenue policy affecting access to seed sales by public institutions<br>- Protracted procurement processes |
| Highland beans-Egerton University, Kenya | - License seed companies to produce foundation seed | - Seed companies set their own production targets | - Issuance of non-exclusive license agreements to seed companies<br>- Payment of royalties to the breeding programme | - Sustaining production after the project failed |
| QualiBasic Seeds Ltd, Kenya | - Out growers produce the seed | - No clear approach | - Work with only outgrowers with irrigation in their farms<br>- Invest in seed production and handling infrastructure<br>- Legumes “piggy-backing” on hybrid maize | - Demand forecasting challenges<br>- Seed market vagaries<br>- Poor breeder seed quality<br>- Breeder seed production does not match demand |
| Malt barley PPP-Ethiopia | - Breeder and pre-basic seed is produced by EIAR<br>- Basic seed is produced by ESE<br>- ESE may also contract EIAR research farms to produce more basic seed | - Pre-determined based on the grain supply needs from the brewing industry | - Partnering with private sector partners for niche markets opportunities<br>- Contracting seed producer Coops for certified seed provided pull for EGS | - |
| ICRISAT Seed Revolving Fund Youth Engagement and Gender Inclusion | - Foundation seed produced by outgrower youth groups in collaboration with TARI and ASA | - Pre-order system | - Linking foundation seed production with seed and grain off-takers | - Grain market uncertainities affecting sustainability of seed production |

## 3.1 Drivers of Sustainable EGS Supply

### 3.1.1 Risk reduction

Some business models have put in place mechanisms through which they ensure reduction of risk in the production EGS. The public-sector models for instance have mechanisms for to protect the seed producer units against production losses, provision of seed grants, seed loans, provision of land for seed production, payment of staff salaries, and provision of breeder seed to ensure consistency in production. The establishment of a private enterprise by Heineken in the case of malt barley in Ethiopia ensured reduction of risk to produce EGS in addition to providing financial support in form of a grant for seed production activities. Pre-securing of markets through advance payments by clients such as the 10% pre-payment in the ISABU-Burundi case; and contract agreements with seed and grain off-takers reduce risk and uncertainities for the seed producers.

### 3.2.2 Seed production infrastructure

***Irrigation facilities***

This is important to enable continuous production through the year, a feature that is impossible with reliance on rain-fed production. Production of EGS is sometimes affected by climate factors in form of dry spells or droughts and seasonal rainfall patterns. Irrigation system-based production mitigates climate change associated production risks. This is well adopted by the private seed companies QBS, LCIC, IITA GOSeed, premier seed Ltd in Nigeria and some NARS agencies like KALRO in Kenya, INRAN in Niger, NARO in Uganda. The level of investment in irrigation facilities is however very poor among the NARS institutions.

***Cold storage warehouse facilities***

EGS production requires effective seed demand planning. This has however proven a challenge and not just for only the pure line grain legume and dryland cereal crops but other crops too due to weak and inconsistent seed demand planning by certified seed, quality declared seed (QDS) and grain producers. Investing in long-term cold storage facilities is important for dealing with effective seed demand forecasting challenges in addition to the risk resulting from over production. Long term cold storage enables the seed producing agency to meet the unexpected demand by allowing them to produce in excess and supply as the need arises without compromising seed viability. This strategy is mainly adopted by the private foundation seed companies like QBS in East Africa and LCIC in the West African country Ghana. In India, the institutions producing EGS are well-established with extensive infrastructure in terms of land, equipment, infrastructure, staffing and most importantly with reliable funding through

government grants. On the other hand, most NARS institutions in SSA are not adequately equipped with these facilities.

### 3.2.3 Decentralizing production to agro-ecological zones

Access to EGS is sometimes limited due to the occurrence of great distances between seed producers and the EGS producers. In Uganda, NARO and ISSD Uganda addressed this problem by engaging the ZARDI's to produce foundation seed so as bring EGS supply services closer to the seed producers within the respective agro-ecological zones. This also has the advantage of minimizing costs for coordination and management of outgrowers besides bringing EGS supply services nearer to off-takers. This approach is employed by KALRO in Kenya, EIAR in Ethiopia and NARO Holdings in Uganda in which seed producing units are established at specific agro-ecological zones.

### 3.2.4 Local Seed Business (LSB) led foundation seed production

Local Seed Businesses (LSBs) are community-based seed producers producing the QDS class of seed. Most community-based seed producers are located far away from research centers that happen to be the source of foundation seed and therefore frequently experience challenges accessing foundation seed due to the great distances involved. In Uganda, the ISSD Plus programme in collaboration with NARO's breeding programmes selected and built the capacities of some LSB's to produce foundation seed to be used for the production of QDS and in Burundi the seed poducers also sell the EGS to other less specialized seed rpoducers, through the pre-ordering system thereby creating a competitive market system.

### 3.2.5 Out-grower schemes

Outgrowers are generally employed to produce foundation seed by both private companies and the NARS breeding programmes. However, with climate change effects and risks, EGS production requires outgrowers that are resilient. It is important to select progressive commercial farmers with irrigation systems installed in the farms to cope with production risks attributed to climate change as well as enable seed production throughout the year. The QBS business model uses this approach by selecting outgrowers' using criteria that ensure conformity to seed production regulations and requirements as well as adaptation to the production risks. The outgrowers are selected based on a criterion that includes the outgrower being a horticulture farmer. This ensured the isolation distance for maize seed production is secured within the production environment and at the same time ensure an irrigation system in place for the management of climate change associated production risks. This enables the company to forego the high cost of investing in the establishment of the much needed irrigation systems themselves.

### 3.2.6 Incentives to produce legume EGS

***Access to breeder seed coupled with support for Market development***

It is vital to ensure breeder seed is readily available when required. It can be an incentive for seed production especially with emphasis on developing market systems. Market development can be done through establishment of a pre-order system along with facilitating creation of networks between seed producers to specific clients

***Legume crop integration with hybrid maize***

The main challenge with the supply of non-hybrid crop EGS is the lack of interest from private seed companies due to the associated low economic gains. However, this study reveals the possibility of interesting private seed actors into producing the non-hybrid legume crop seeds as a secondary crop planted for the primary purpose of crop rotation to maintain soil fertility in outgrower fields. For instance, QBS in East and Southern Africa introduced common bean to its hybrid maize foundation seed outgrowers in Zambia due to the need to manage the declining soil fertility in their fields by crop rotation. This provided a cheaper alternative for maintaining soil fertility in outgrowers fields and at the same time an incentive for the seed company to produce common bean seed as a secondary product in its seed portfolio. This strategy may offer low profitability but renders satisfaction for both seed producer , its clients and partners.

### 3.2.7 Seed demand creation and estimation

***Promotion of new varieties to stimulate demand***

Delivery of improved varieties to uptake pathways goes hand in hand with promotion activities to stimulate demand for the seeds. Some business models address this through facilitating dissemination and access to information to popularize the improved varieties. For example, the IITA' GOSeed uses an e-commerce platform to disseminate information and promote the improved varieties they produce. Stimulating demand is very important as it ensures the off-take of the produced EGS.

***Demand forecasting through seed pre-orders***

Forecasting and determination of seed demand is critical for EGS delivery. This is especially key for a functional EGS system for legume crops given the small volumes of seed produced in a given time coupled with the high risk of not selling which can result in perpetual under-estimation of demand as a mechanism to reduce risk. A pre-order based estimation of demand is useful in determining the amount of seed to produce based on client needs. The system minimizes risks associated with client behavior but can ensure commitment from the clients.

## 3.3 Major Constraints for EGS Supply

***Untimely delivery of EGS to seed producers***

The production of certified seed is sometimes affected by delays in the delivery of foundation seed from research institutions. This stems from the occurrence of systemic challenges that affect the timeliness in the production, processing and delivery of seed to its intended users.

***Demand forecasting challenge due to seed market vagaries***

This is because seed companies are operating a business in uncertain environments characterized by unexpected demand resulting from humanitarian livelihoods emergency response programmes which may sometimes initially be impossible to predict. This affects seed production planning, especially at the EGS level.

***Shorter shelf life of legume seeds***

Legume crops seed like groundnut has a relatively shorter shelf life (about 5 years) compared to maize for example that takes over 18 years in cold storage and still be good with over 90% germination. This is especially a problem when there are no cold storage facilities thereby resulting in severe losses during storage.

***Low quality of breeder seed***

Breeder seed from public institutions sometimes exhibits genetic impurities. The implication is for seed companies to subject the impure breeder seeds through a variety purification process to increase genetic purity. This process takes time eventually affecting the availability of foundation seed and therefore resulting in untimeliness and failure to meet existing demand at a particular point in time.

***Lack of infrastructure to produce EGS***

EGS production requires seed production and processing facilities. This includes irrigation facilities to enable production throughout the year, seed processing and long-term storage facilities. The much shorter shelf life of some GLDC crops seed also necessitates investment in long term storage to enable EGS producers deal with the problem of market vagaries and climate change effects on seed production and viability. The importance of investing in long-term cold storage facilities is demonstrated by the private foundation seed companies like QBS and LCIC whose performance largely depends on producing and storing in excess to meet client needs in addition to irrigation assisted production. Most NARS institutions are however not or inadequately equipped with these infrastructural facilities.

***Breeder seed production does not match foundation seed demand***

Research institutes in both ESA and WCA tend to produce very small quantities of breeder seed that require further multiplication to raise quantities desired by the foundation seed producers. The foundation seed producers, therefore, have to wait for the breeder to go through another cycle of production to obtain the required amount of breeder seed.

***Institutional non-tax revenue policy and protracted procurement processes***

This especially applies in the case of the NARS in Uganda. These curtail timely reinvestment of funds generated from seed sales to sustain production and supply of EGS.

***High costs of supervising and managing outgrower seed producers***

Outgrowers production environments are sometimes distantly located thereby creating challenges in terms of time and financial resources for the execution of seed inspection and regulatory services.

## 4.0 Conclusions and Recommendations

The analysis of the business models in this study emphasizes the need for a systemic approach to address the bottlenecks in the delivery of EGS in sub-Saharan Africa. The study highlights **seed demand forecasting as a critical factor** that is persistently constraining the production of early generation seeds among others. Addressing the problem of seed demand forecasts requires joint efforts by value chain actors and fostering the creation of relevant actor linkages that ensure the functionality of each component of the seed and commodity value chains. It is necessary to put in place a system in which seed production decisions are informed by the actions of other actors in the value chain. This study, therefore, **recommends a pre-order system business model with emphasis on fostering and creating viable linkages with value chain actors including seed system players and grain off-takers**. This approach will enable informed seed production based on market needs.

This study also highlights gaps within the business models that emphasize other bottlenecks in the EGS systems of GLDC crops in sub-Saharan Africa. They include poor breeder seed quality, untimeliness in the delivery of breeder seed, unmatched breeder and foundation seed production and lack of adequate seed production infrastructure. These gaps equally need to be systemically addressed. The following actions are therefore recommended:

- Strengthen breeding programmes with seed production support facilities that enhance their capacity to produce sufficient quantities of quality breeder seed at the required time.
- Develop incentives that motivate investment in the production of the non-hybrid grain legumes and dryland cereals by the private sector as well as enhance their role in popularizing and stimulating demand for new varieties.
- Improve and enforce quality assurance systems for breeding programmes to address the problem of the poor quality breeder seed that necessitates the need for further selection and purification of lines/varieties due to genetic impurities.
- Build the capacity of seed value chain actors on effective seed demand forecasting.
- Securing seed markets in advance by linking seed production with grain off-takers.

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## Annex 1. Participating institutions for the In-depth interviews

- INRAN'SEED UNIT, Niger
- Legacy Crop Improvement Center (LCIC), Ghana
- GOSeed, IITA; Nigeria
- SOPROSA-Sarl, Mali
- Qualibasic Seeds Ltd, Kenya
- NARO, Uganda
- Agriculture Seed Agency, Tanzania
- KALRO, Kenya

ISSD Africa