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Assessment of Grain Legumes and Dryland Cereals Seed Value Chains in Uganda

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Cover photo: Women farmers from a seed producer's group in northern Uganda

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Abstract

A well-functioning seed system is key to timely access to low-cost and quality seed by farmers. Improved varieties are critical to increase grain production in terms of both quality and quantity. Hence, decision-makers in agriculture face the challenge of developing an integrated and cost-effective seed system that can generate and deliver improved seed varieties to farmers, thereby ensuring seed security and enhancing livelihoods, particularly of the dryland farmers.

This paper analyses the current state of Uganda's seed value chain for grain legumes and dryland cereals (GLDC), the challenges as well as the opportunities in it. It also identifies critical areas that can drive sustainability in seed value chains.

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EXECUTIVE SUMMARY

Crop yields have either remained stagnant or risen marginally in Africa compared to other parts of the world with similar agro-ecologies (Tittonell and Giller 2013). While their area has been increasing, production volumes of grain have seen a relative decline. The same trend has been observed in yields of grain legumes and dryland cereals (GLDC), except for millet, which has remained relatively stable (Annexure 1, Figures 1, 2 and 3).

While GLDC crops play a crucial role in the food, nutrition and income security of households in Uganda, their production has been hampered by limited access to quality seed of improved varieties, knowledge disparity among value chain players and unfavourable output markets. Farmers depend more on their own saved seed and markets as sources of the seed of these crops. The formal seed system is not well developed, especially in moving certified seeds through their distribution networks.

This study sought to review models currently deployed in seed delivery of GLDC crops in East Africa, compare them with those used in similar geographies globally and analyze the current situation, including challenges and opportunities. The study also identified critical areas that can drive sustainability in the GLDC seed value chains. Data were collected from prominent actors in Uganda's GLDC seed value chain using specific questionnaires (Annexure 2). A combination of content analysis and descriptive statistics was used to analyze the interviews on common themes across open-ended and yes/no questions. A total of 109 key informant interviews were conducted between 2 September and 1 October 2018 with 12 public sector officials (regulators, breeders), 38 private sector representatives (seed companies, traders, processors, agro-dealers), two subject matter experts, 11 development partner officials, 33 lead farmers and 13 focus group discussions (FGDs).

The results show that the seed value chain for GLDC crops has potential for lateral[1] and vertical[2] growth. Further, it has tremendous potential to improve Uganda's economy and households' food, income and nutrition security. However, several challenges continue to impede the growth of these value chains. Seed access by farmers and local seed businesses is poor, especially improved varieties from seed companies and national breeding programs. The difficulty in accessing markets and stable prices for GLDC grain continues to be a disincentive for farmers' adoption of high-yielding modern varieties. Farmers cited drought, pests and diseases as the main reasons for low productivity. These factors also endeared them to their own saved seed.

Similarly, access to capital was a problem among seed companies, local seed businesses, grain traders and farmers. Grain (and seed) traders operating within local markets felt that the research system was not pushing out varieties their customers sought. Most of the respondents appreciated the importance of up-to-date farming and market information. They proposed better synchrony between stakeholders directly involved in production and market systems development training.

The following steps are recommended to address these challenges and revamp GLDC seed value chains in Uganda:

a. More strategic demand-led breeding supported by CRP-GLDC which ensures farmers (and other consumers) access the suitable varieties;

[1] Lateral growth will aim at the expansion of business operations through entry to new markets, i.e., new geographical locations and/or business sectors.

[2] This value chain could benefit greatly if it increased its market share compared to maize; this implies scaling the diverse products in grain legumes and dryland cereals. By venturing deeper into the current market, there is a chance to increase the demand for GLDC crops and their adoption.

b. Cost-effective capacity building applicable to multiple actors along the value chains (specifically on how to improve seed quality, utilization and access to credit);
c. A critical review of subsidy programs by government or development partners that seem to create artificial seed demand that cannot be sustained in the long run;
d. Policies to support additional clauses on easy-to-access seed classes like quality declared seed (QDS) or standard seed and
e. Provide holistic extension services that embrace models of inclusion.

1. Background

1.1. INTRODUCTION

Grain Legumes and Dryland Cereals (GLDC) are essential crops that support the livelihoods of poor farming households in rural areas of sub-Saharan Africa (SSA) and South Asia (SA). These crops are critical in improving smallholder farmers' income, food and nutritional security and that of other value chain actors (Ojiewo et al. 2015, 2018; Orr 2018; Das et al. 2018). Therefore, increased productivity and marketability of these crops (Table 1) hold great promise of eradicating poverty within the agro-ecologies they are grown, i.e., semi-arid and sub-humid drylands (Das et al. 2018). These are agro-ecologies where acute poverty, malnutrition, soil degradation and climate change impacts have been reported (Mirza 2011; Gill et al. 2013; Das et al. 2018). Therefore, rural development and poverty reduction in these agro-ecologies depend heavily on sustainable seed flows of these crops (Almekinders et al. 1994; Almekinders and Louwaars 2002; Orr 2018).

The productivity of these crops has been hampered over time mainly due to the limited adoption of improved varieties due to poorly functioning seed systems. Therefore, it is important to document and understand success stories, challenges and opportunities in the seed value chains of these crops to address the bottlenecks, revamp them and make them more responsive to the ever-changing needs of farmers and other value chains actors/stakeholders.

Table 1. Priority crops of the CGIAR Research Program on Grain Legumes and Dryland Cereals.

Grain Legumes	Dryland Cereals
Chickpea	Sorghum
Groundnut	Pearl millet
Cowpea	Finger millet
Pigeonpea	
Lentil	
Soybean	

Globally, seed remains an essential element in crop production and represents a valuable resource for sustaining food and feed supplies (Chauhan et al. 2016; Das et al. 2018). This underlines the need to address the bottlenecks that inhibit smallholder farmers' seed quality, availability and access.

In Uganda, smallholder farmers barely have access to seed of improved varieties because of the poor network of agro-dealers that sell quality seed and their inability to buy seed, forcing them to make do with sub-optimal quantity and unreliable quality of seed from other distributors and informal seed systems (local communities, weekly markets and social networks). Unfortunately, informal seed systems are less monitored/controlled by government policies and regulations; this is likely to compromise the quality of seed flowing through these sources.

Other challenges affecting the seed system include weather variations, low adoption rates of high-yielding improved varieties, poor seed quality, limited funding for breeding efforts, continuous cropping without crop rotation or external inputs resulting in soil fertility decline; high dependence on rainfall with limited to no irrigation capacity and a poor extension network to guide good agronomic practices and technology adoption, among others. Variations in weather patterns, i.e., drought and excessive rains, have played a significant role in yield losses (GOU 2007).

These challenges have consequently undermined productivity. While seed statistics are not readily available, Uganda has recorded a decline in grain production of GLDC crops in the past two decades (Figure 1).

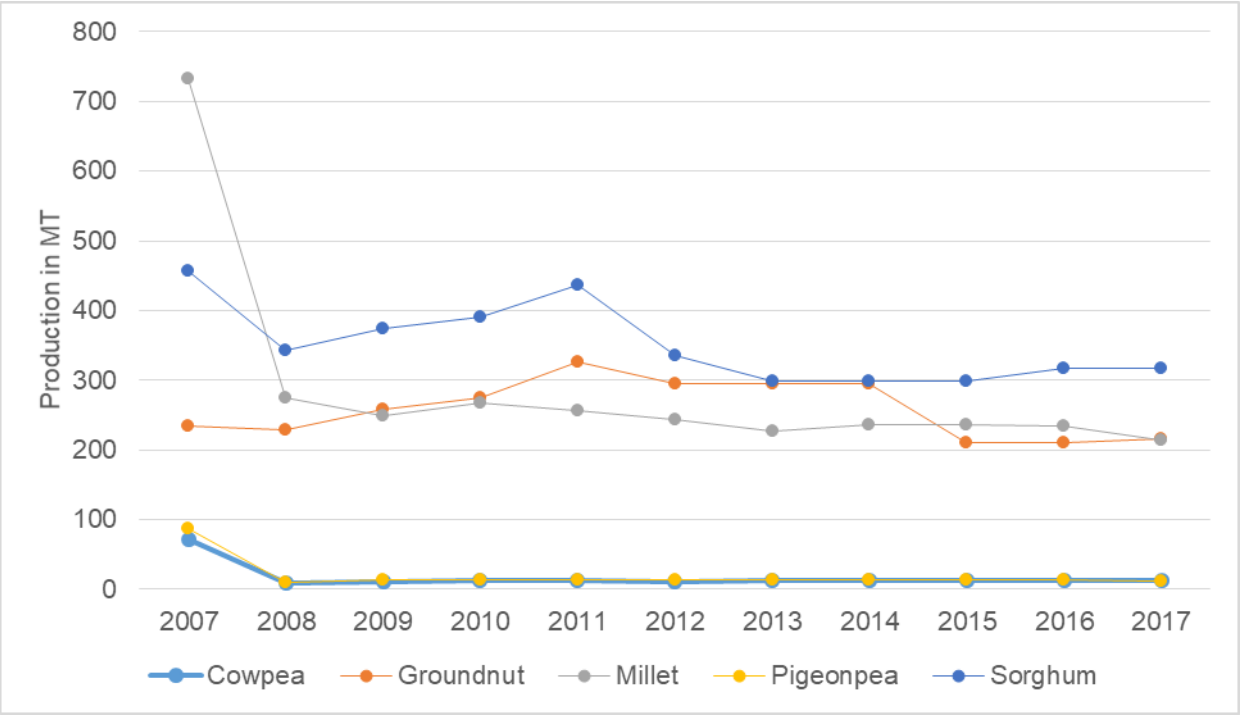

Figure 1. Overall trends in grain production ('000 MT) of GLDC crops in Uganda, 2007-2017.

Source: FAOSTAT (2019), accessed on 11 Jul 2019.

Research has identified many instances of dysfunctionality in agri-food systems. Some of these include (i) inability to meet the annual seeds demand (CTA 2014); (ii) limitations of the regulatory frameworks governing agriculture (Almekinders and Louwaars 2002; MAAIF 2012); (iii) high prices and inappropriateness of hybrid varieties in aligning with farmer conditions, such as how to link fertilizer complementarity with hybrids (Prasad et al. 2017); (iv) level of inputs (and their cost) needed to drive greater adoption of improved varieties (Almekinders et al. 1994; Das et al. 2018) and (v) release of only a few varieties that in turn fail to meet small farmers' needs (Prasad et al. 2017).

1.2 Study objectives

The study's overall goal was to review the status of seed value chains of GLDC target crops in Uganda. This in-depth review focused on the current status of the structure, conduct and performance of the seed systems to provide insights into and practical recommendations on the critical bottlenecks along the value chains, as well as answer the question: ''what would make GLDC seed value chains sustainable?".

The specific objectives of the assessment were to:

- Review models currently deployed in seed delivery of GLDC crops in East Africa and compare them with those used in similar geographies in the rest of the world;
- Review the grain market outlook for GLDC grain in East Africa, focusing on what happens to the grain once it leaves the farm;

- Review the Early Generation Seed (EGS), breeder, foundation sub-sectors for GLDC crops in East Africa, including its financing;
- Review the certified and quality declared seed (QDS) sub-sector for GLDC crops in East Africa;
- Review the improved GLDC seed delivery mechanism in East Africa, highlighting the governing policies, structure and conduct and
- Review opportunities in the regional integration of GLDC seed value chains, focusing on unique opportunities targeted to youth and women.

This study focused on understanding the dynamics and finding opportunities for women and youth in seed system development. It involved reviewing seed system literature and collecting data from the field and analyzing them.

A literature matrix was created to organize the notes and information gathered from different literature reviews. Critical elements in GLDC seed systems and value chains were tracked and assessed. Background documents on seed systems, with specific emphasis on GLDC in SSA and Asia, were reviewed. Online searches were conducted for grey literature and peer-reviewed articles using various search terms. Seed production data and statistics gathered from databases were analyzed, and results were presented and discussed in this report. Thus, the literature review precedes the final report and complements the field data collected and reviewed.

2. LITERATURE REVIEW

2.1 Overview of GLDC seed systems in Uganda

The development of a country's agricultural sector is dependent on a vibrant seed sector. In many SSA countries, farmers' access to quality seed and adoption of improved varieties is low (Shiferaw et al. 2008; Louwaars and de Boef 2012; Orr 2018). Only South Africa has had a more sophisticated seed industry. It has been a net exporter of seed to other African countries like Zambia, Mozambique and Uganda (Kuhlmann 2015; TASAI 2018).

Uganda's GLDC sub-sector is characterized by two parallel seed systems, the formal and informal, which cut across most of the crops grown in the country.

2.1.1. Formal seed system

The formal seed system in Uganda is responsible for the production and marketing of improved, certified seed, enabled through a structured system of variety development, release, multiplication, quality control, distribution and marketing. However, this has been mostly true for maize hybrids than GLDC crops – a common scenario in other developing countries (UNSP 2015; ISSD Uganda 2014).

In the case of GLDC, formal seed systems are still small, improved varieties are not effectively commercialized, and farmer access to quality seed is limited. Most GLDC seed is sourced locally within communities, from own harvest (selected and stored), and even from local open-air markets where sometimes grain is sold as seed. The limited formal investment in GLDC seed systems is mainly due to low returns on investment for the private sector. Farmers do not frequently replace their seeds with new ones from agro-dealer outlets, but at markets.

In Uganda, both public and private sectors participate in the seed value chain. Breeding activities are public sector-driven while the private sector complements this with seed multiplication and distribution to farmers. In terms of vibrancy, the participation of private seed companies in the seed value chain is still developing. Out of more than 26 registered seed companies, less than a third regularly deal with GLDC crop seeds. Annual production of seed (all crops) has been estimated at 18,000 MT (MAAIF 2012; CTA 2014), which is less than 50% of the total seed demand in the country. This formal system is estimated to account for about 10-15% of certified seed used for planting (UNSP 2015; ISSD Uganda 2014), of which 80% comprises maize and a paltry 5% are GLDC crops. Overall, the formal seed system has been constrained by policies limiting access to early generation seed (EGS), e.g., a single policy governing EGS of all crops (a one-size-fits-all solution).

2.1.2. Informal seed system

The informal seed system in Uganda has been defined by its flexibility and encompasses a wide range of variations. It is characterized by integrated and locally organized activities that allow farmers to produce, disseminate and access seed. The source could be own harvest, through farmer-farmer exchanges, or bought in local grain markets (Naluwairo 2006; UNSP 2015). It is primarily an unregulated seed production and distribution system.

Of all the seed planted in the country, about 85% comes from informal systems (MAAIF 2012). A similar trend is observed for GLDC crops. In the case of legumes and small grain cereals, studies show an over 75% dependence on farm-saved seed sources (Ayieko and Tschirley 2006). Crop varieties in this system range from local to mixed varieties that have changed over time through breeding and use.

Seed quality has been found to vary in purity and physiological or physical traits. This system embraces varietal choice, testing, introduction and dissemination, albeit embedded in farmers' production systems rather than discreet activities (Almekinders and Louwaars 2002).

There is also a sub-category of community-based seed systems comprising individuals in a group or a cooperative and often supported by Non-Governmental Organizations (NGOs), Community-Based Organizations (CBOs), or state agents. This segment undertakes entrepreneurial forms of seed multiplication and marketing that give them a 'semi-formal' status. In most cases, this system is an outcome of efforts to help farmers recover from stresses (pests, disease, or drought).

In Uganda, QDS production is moving from semi-formal to formal and bridging seed access and availability gaps. This move may be because of a need to strengthen farmer-based systems with improved varieties or seed quality enhancing techniques. Often, they are unregulated (informal) in terms of seed quality assurance and control mechanisms (Munyi and De Jonge 2015). There is a minor distinction between 'seed' and 'grain' in most of this system. Local technical knowledge, standards and social structures/norms offer much-needed guidance in its functioning (Louwaars and de Boef 2012).

2.1.3. Components of the seed systems

The chain includes the development of new varieties and germplasm enhancement, EGS production, quality seed production, quality control, distribution and marketing, representing the different pathways along which newly released varieties are disseminated to farmers (Mastenbroek and Ntare 2016).

Figure 2. Components of the seed value chain.

2.1.3.1. Early Generation Seed sub-sector

A country's agricultural sector is dependent on the vibrancy of its seed sector. In many SSA countries, including Uganda, farmers' access to quality seed and the adoption of improved varieties is low (Shiferaw et al. 2008; Louwaars and De Boef 2012; Orr 2018). In Uganda, financial, technical and institutional factors hinder the timely delivery of varieties to the private sector and smallholder farmers.

Unreliable funding streams pose the most significant risk to National Agricultural Research Institutes (NARIs), especially EGS/pre-basic/breeder/foundation seed production (Mastenbroek and Ntare 2016). Failure to meet their mandate due to financial constraints has driven them towards a 'mission creep', often in the name of business orientation to compensate for the budget shortfalls.

Due to inadequate supply, local private companies have had difficulties accessing EGS of released improved crop varieties crucial to improving food security. However, efforts by multiple partners, including CGIAR centers, have gone a long way in supplying means to continue material scaling (Orr 2018).

Five seed classes characterize the seed system in Uganda: breeder, pre-basic, introductory, certified and standard. This follows Uganda's adoption of the Organisation for Economic Co-operation and Development (OECD)[3] seed scheme (Mubangizi 2012; Joughin 2014). Typically, breeder seed is the original nucleus seed that comes from the breeder, who may be part of NARI or a private seed company. The breeder or agent under supervision then multiplies this into pre-basic seed. The National Seed Certification Service (NSCS) plays a regulatory role in the multiplication of pre-basic to basic seeds. This seed is finally multiplied into certified seed, which can be of two or more generations, still under regulation by NSCS.

Reviewed literature has shown that understanding a country's value chain and market segments for seed is the first step towards unlocking business models of the NARIs in EGS (van den Broek et al. 2015; Mastenbroek and Ntare 2016; Jelliffe et al. 2018). Similarly, solid public research and enabling government policies like in India could become the primary drivers of the growth of the dynamic and diversified seed industry in Uganda (Manjunatha et al. 2013). Working down the chain with private sector players could guarantee a sound judgment of present and future seed demand and accurate projections.

2.13.2. Certified and Quality Declared Seed sub-sector

Seed value chains begin with seed development and distribution. Both certified and QDS are outputs of EGS from breeding programs of seed companies and research institutions. These two seed classes often attract different farmer segments, especially given their varied cost and geographical spread. Quality Declared Seed costs less than certified seed; while certified seed can be sold across the country, QDS is limited to the production district.

In Uganda's case, literature points to a consistent lack of reliability in the local seed market. The liberalization of the Seed Act is a mixed basket of fortunes for the future market (Vernooy 2017). Through the Seed Trade Association of Kenya, the crop seed sector in Kenya is undertaking its first study on the seed market, including seed sales and different dissemination channels. This critical exercise will add a new parameter to the data, i.e., how much of the certified seed is sold and through what channels. Such an analysis could assist researchers and seed producers in developing market projections. In Bhutan, for example, access to good seed by smallholder farmers is ensured through a network of government extension agents supplying seed, along with agronomic information in demonstrations (Kobayashi et al. 2017).

Farmer cooperatives and groups producing QDS have been a success in Uganda, showing that a business model around them is possible (Kansiime and Mastenbroek 2016; Otieno et al. 2017). Additionally, this seems to offer NARIs the required product differentiation within the chain. This observation denotes practicality, following a financial analysis that helps find the breakeven selling price for GLDC seed and guiding a differential pricing to encourage advance orders.

The seed supply deficit of over 20,000 MT should be bridged to meet national demand and end the widespread sale of fake seeds (Vernooy 2017).

[3] The OECD Seed Schemes provide an international framework for seed certification with the aim of facilitating seed trade by reducing technical barriers. It also includes the assurance of varietal purity and identity for international seed trade, and is normally used in conjunction with ISTA seed lot certificates, which also carry the results of other quality tests.

More recently, there has been a drive to adopt a new class of seed called QDS, which offers farmers higher quality at a slightly lower cost and ease of access (TASAI Uganda 2018). Primarily driven through local seed businesses in a district, farmers benefit through farmer-to-farmer extension and access to demonstration farms.

2.1.3.3. Grain market outlook

Rural communities worldwide rely on smallholder farming as a primary source of food and fiber (World Bank 2007). Higher yields often result from ready access to high quality seed and good agronomic advice. However, the natural diffusion process is unsettled by barriers that deter seed adoption even when the agroecology is right. Without creating an increased demand for seed at the farmer level, the sustainability of local grain markets remains a dream (Shiferaw et al. 2008).

Literature consistently shows that new and available technologies must be complemented by sufficient outreach and education for adoption to occur. Adoption depends on pre-existing social networks (Conley and Udry 2010; Cunguara and Darnhofer 2011; Thuo et al. 2014), implying that seed demand will often follow a robust output market system for grain (Shiferaw et al. 2008; de Boef et al. 2010; Orr 2018). With enhanced entrepreneur interest in agro-processing and value addition in these value chains, grain productivity (and GLDC seed adoption) is envisaged. It should be complemented with proper storage facilities, especially during surplus seasons.

2.2. Structure, stakeholder roles, and linkages

2.2.1. Seed systems structure

The challenge of producing adequate and nutritious food for populations in SSA and SA can be dealt with through sustainable and well-functioning seed delivery systems. In Uganda, seed delivery has been the responsibility of national agricultural research systems and public/private seed companies (Fisher et al. 2015). Small to medium scale and privately owned companies and a few multinationals make up the diverse landscape of Uganda's seed industry. Other actors include NGOs, farmer organizations, cooperatives, input dealers, processors, financial institutions and government agencies/officials (Louwaars and De Boef 2012). An agro-input dealers' network enables seed distribution in local markets. The formal system also includes the import of seeds for the domestic market and export to regional markets. The integration of central seed delivery systems -- formal and informal (including semi-formal/intermediate) -- offers hope (ISSD Uganda 2014). According to the OECD seed scheme, the seed system is characterized by five seed classes: breeder, pre-basic, basic, certified and standard (Mubangizi 2012; Joughin 2014).

2.2.2. Stakeholder roles and linkages

In developing and promoting a functional seed delivery system, attention to vertical and horizontal integration will help improve effectiveness, together with dedicated monitoring and evaluation (M&E), coordination of actors and allocation of responsibility. A typical flow of roles based on the nature of Uganda's seed system is described in Table 2.

Table 2. Actors in the seed value chain in Uganda.

Point in the value chain	Description	Type of actors
Research & Development (R&D)	R&D of varieties with farmer and market preferred traits	Breeders in NARIs[4] and International Agricultural Research Centers[5] (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 generations of breeder seed from nucleus seed and variety maintenance	NARIs and IARCs (public) Some multinational and national seed companies that have exclusive rights of crops (mainly maize hybrids) and varieties, such as SeedCo, Equator, Otis, Victoria, Pearl, FICA, EA Seed (private)
Foundation 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 QDS[6] production	Production from foundation seed	Seed companies (private) Farmer cooperatives and local seed businesses (public-private) Individual farmers and groups (private)
Marketing and distribution	Distribution through agro-dealers networks, farmer groups and local markets	Sale in open markets, agro-input dealers, seed/grain traders, seed exchange through local seed systems (seed fairs, social networks, etc.) (private)
Seed quality control and certification	Variety registration, official inspection and certification	NSCS of Ministry of Agriculture Animal Industry and Fisheries (MAAIF) (public)
Seed trade	Facilitate regional and domestic seed trade	Uganda Seed Trade Association (USTA) which is 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 program, e.g., operation wealth creation (public)
Education, training, and extension	Multiple players who ensure farmers know what to do with seed to post-harvest procedures	Seed companies, extension agents, farmers' organizations, NGOs, agro-dealers, USTA

[4] NaSARRI, NaCRRI.

[5] ICRISAT – groundnut, sorghum, millet and pigeonpea; International Maize and Wheat Improvement Center (CIMMYT) – maize and wheat); International Center for Tropical Agriculture (CIAT) – beans and Bioversity International – millet.

[6] QDS is a seed class recognized in Uganda's draft National Seed Policy of 2016. It needs minimum field inspection and certification standards for variety, purity and germination. It can only be sold in the area where it is produced.

Efforts that address extension, market, and policy remain critical to facilitate seed adoption; so is the link of research and development (R&D) with seed producers through a continuous loop of information among stakeholders (Orr 2018; Jelliffe et al. 2018).

A clear appreciation of the roles played by all genders in seed delivery will go a long way in streamlining efforts by all stakeholders (CTA 2014).

2.3. Seed policy and regulatory frameworks

In Uganda, the Seed and Plants Act of 2006 established a regulatory unit, i.e., the NSCS within MAAIF. MAAIF, through NSCS, ensures that seed quality is always standardized and improved through private and public sector stakeholders (MAAIF 2012). The NSCS plays a regulatory role in the multiplication of pre-basic to basic seeds. This seed is finally multiplied into certified seed, which can be two or more generations, still regulated by NSCS.

The Draft National Seed Strategy of 2015 suggests that the formal seed system has contributed up to 15% of seed used in the country. The NSCS regulates the system – from variety listing through to final seed certification. 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 organizations and farmers), as summarized in Table 3.

Table 3. Major players in Uganda's seed system.

Major players	Key examples	Focus (activities + crops)
Government institutions	NSCS, National Agricultural Advisory Services (NAADS)	Certification, extension covering all crops
International Agricultural Research Centers	ICRISAT	Research, breeding in GLDC
	CIAT	Beans, cassava, rice and tropical forages
	IITA	Research, breeding in cowpea, soybean, bananas and plantain + roots and tubers
	Bioversity International	Research, breeding in beans and millets
National research entities	NaCRRI	Root crops, legumes, cereals, horticulture and oil palm
	NaSARRI	GLDC
	Zonal Agricultural Research and Development Institute (ZARDI)	Legumes, cereals, root crops, horticulture and oil palm
Seed companies	Equator Seeds	Oilseed, cereals, vegetables, legumes and seedlings
	NASECO	Cereals
	Farm Inputs Care Centre Ltd (FICA) Seed	Oilseed, cereals, vegetables, legumes and seedlings
	SeedCo	Vegetables and cereals
	Otis Garden Seed	Oilseed, cereals, vegetables, legumes and seedlings
	Victoria Seed	Oilseed, cereals, vegetables, legumes and seedlings
NGOs	ISSD	All crops, extension services
	World Vision	All crops, extension services, links to markets

Major players	Key examples	Focus (activities + crops)
	Lutheran World Relief	All crops, extension services, links to markets
	ZOA	All crops, extension services, links to markets
	World Food Program	All crops, extension services, bulk purchases
	Food and Agriculture Organization	All crops, extension services, bulk purchases
	Action Against Hunger	All crops, extension services, bulk purchases

Source: Author compilation based on literature and interviews.

2.4. Select cases: Sorghum and groundnut

2.4.1. Sorghum

The common types of sorghum grown in Uganda are red, white/cream or brown-seeded based on marketability or subsistence (Apunyo et al. 2016). Being a multipurpose crop, sorghum offers communities the opportunity for a diversified market. More than 35% of it is grown directly for home consumption, with the rest being used as animal feed, by breweries and other industrial products like starch and malt products (Kigozi et al. 2011). Nine open-pollinated varieties (OPVs) of sorghum have been released in Uganda (AIPU 2018). Sorghum yields have been low compared to other countries (FAOSTAT 2018). Zambia and USA had low and high yields, respectively, in 2016 (Fig. 3).

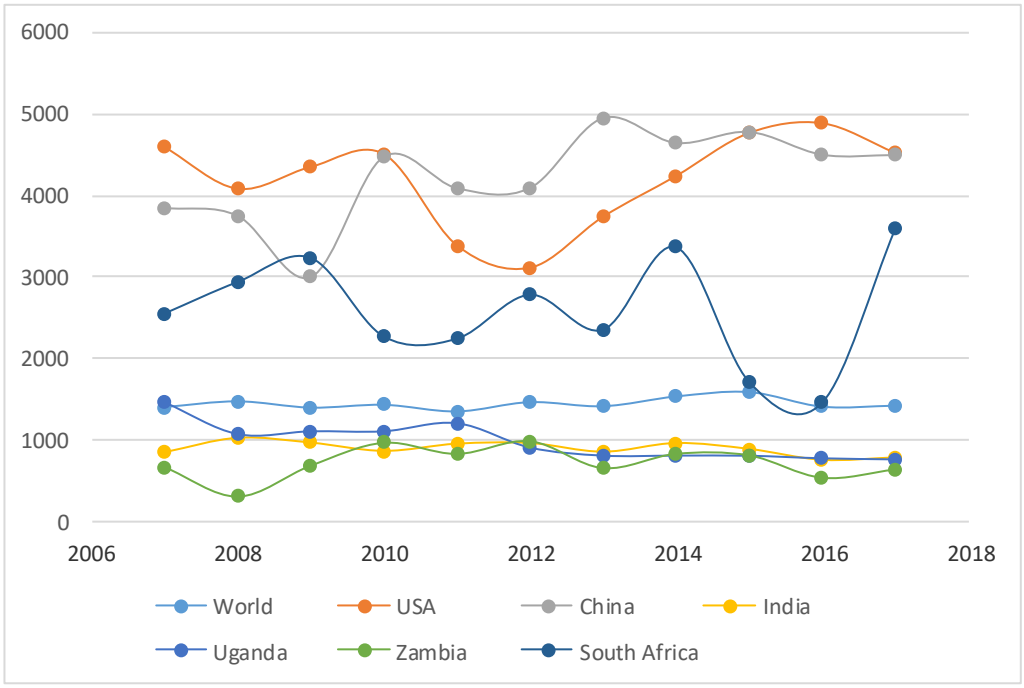

Figure 3. A comparison of sorghum yields (MT/ha) in Uganda, select countries and globally, 2007-2017.

Source: FAOSTAT 2019 (Accessed on 12-Jul-19)

Sorghum grain yields have been low because of low soil fertility coupled with scant fertilizer use (Fig. 3). Other yield-limiting constraints include soil water deficit, stem borer complex, Striga species and N deficiency (Wortmann et al. 2009). These can be rectified with better information flow and partnerships between researchers, farmers and extension personnel. Kraybill et al. (2012)

demonstrated that agro-inputs enabled yield increments per acre, especially when bundled with education and agricultural knowledge among farmers. Structured systems will allow for better market functions and agribusiness demand projections. UBOS (2016) reported that since much sorghum was sold to informal markets, only 14.3% of the product reached the formal market, reducing the targeted amount for Nile Breweries Limited.

Where farmers have practised collective marketing, there has been an excellent impetus for large-scale investments by traders and processors (Nangobi and Mogonola 2018). While sorghum is a staple crop for a large segment of the population, it also serves as a critical base for locally processed traditional foods and brewed beers (Gierend et al. 2014). As shown by the pre-release participatory varietal selection, new cultivars will go a long way in improving productivity (Awori et al. 2015) should there be targeted value chain streamlining to farmers. This could tilt the scales favouring increased production due to yield-enhancing genetics instead of planted areas (Fig. 4).

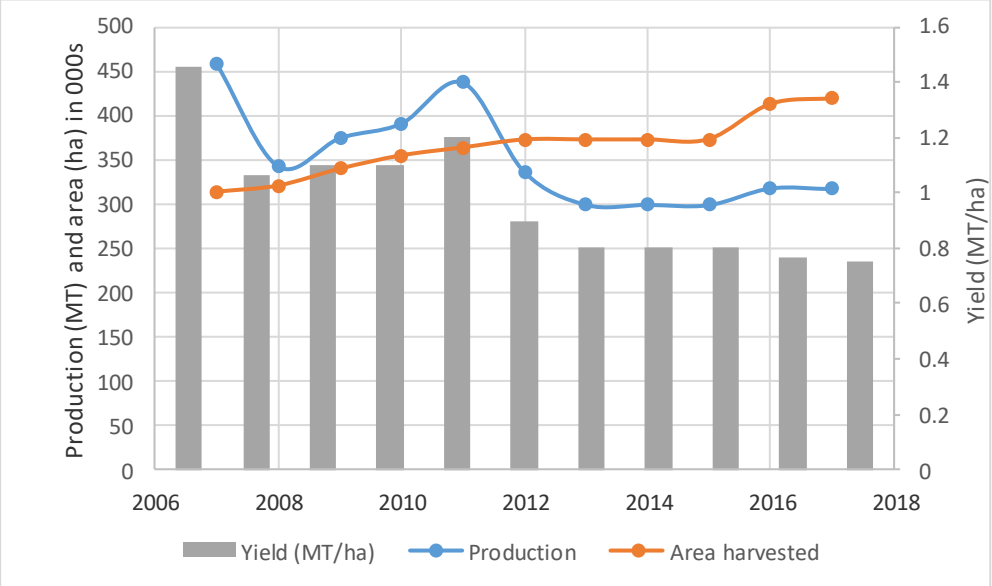

Figure 4. Area, production and yield of sorghum in Uganda, 2007-2017.

Source: FAOSTAT 2019 (Accessed on 12-Jul-19)

2.4.2. Groundnut

Groundnut is the second most important pulse crop in Uganda (Kabeere and Wulff 2008; Okello et al. 2010) and was ranked 11th in production and 6th in area harvested in 2013 and 2014, respectively (FAOSTAT 2018). Smallholder farmers usually grow groundnut for food, cash income and animal feed (Ebanyat 2009; Kassie et al. 2011). Like most legumes in Uganda, most groundnut is grown by women farmers (Okello et al. 2014). Compared to select countries globally, groundnut productivity in Uganda has been low (Fig. 5); the marginal increase could be due to an increase in area planted rather than to productivity improvement (FAOSTAT 2019).

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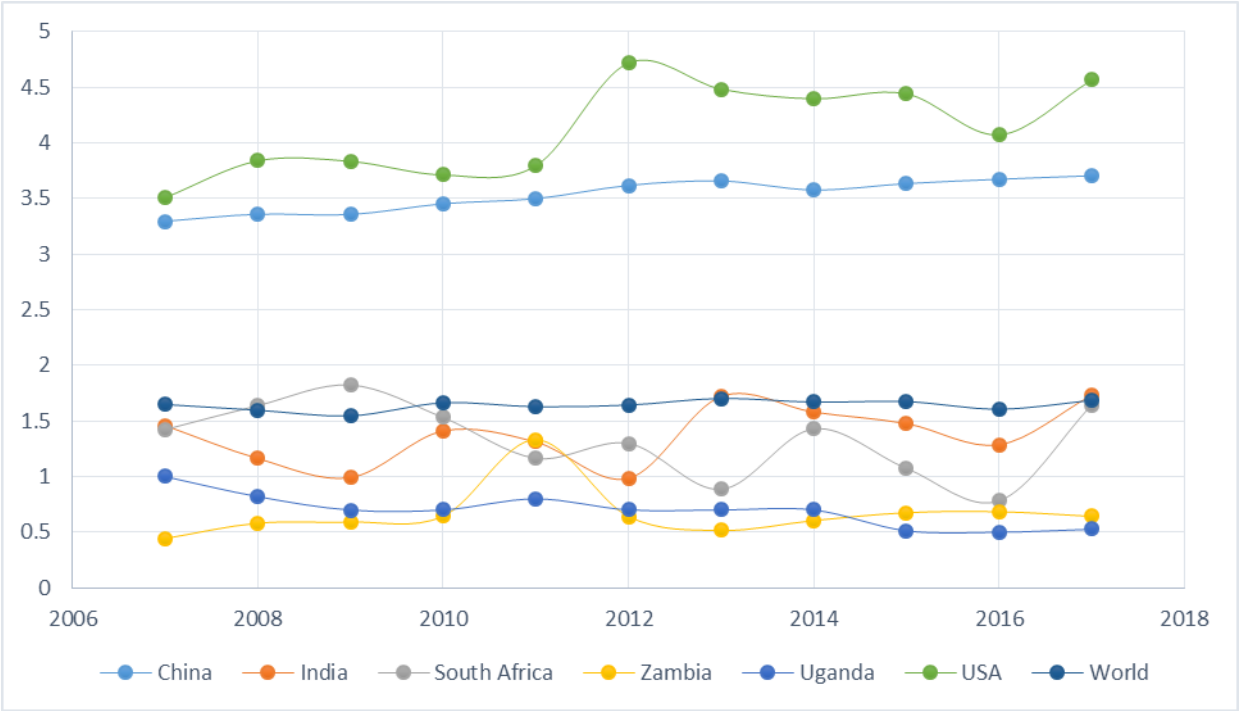

Figure 5. A comparison of trends in groundnut productivity (MT/ha) in Uganda, select countries and globally, 2007-2017.

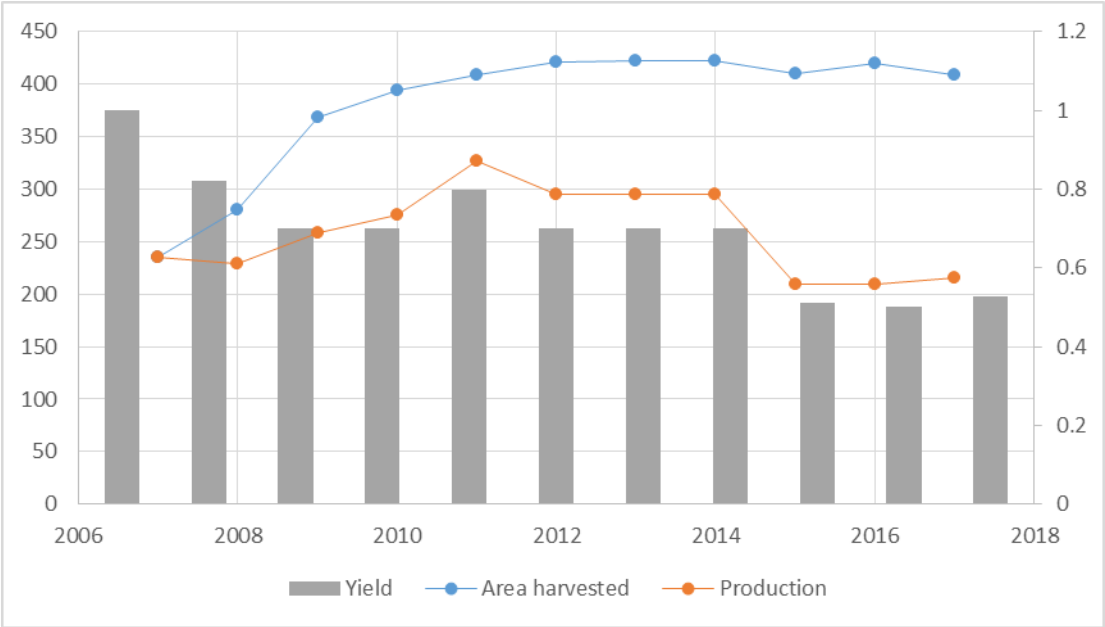

Figure 6. Area, production and yield of groundnut in Uganda, 2007-2017.

Source: FAOSTAT 2019.

In the 2000s, there was a steady growth in area harvested and production accompanied by high yields as the main driver (Fig. 6). This decreased in subsequent years. Significant constraints to groundnut production include pests, diseases, lack of improved varieties, credit and information and droughts (Kassie et al. 2011; Okello et al. 2014). Elevated levels of aflatoxins have impeded the suitability of groundnut for both regional and international markets (Kaaya et al. 2006; NARL 2012). The

establishment of seed banks is crucial in addressing shortfalls in seed supply, especially when community-based seed multiplication groups are linked to markets and research institutes (Vernooy 2017; Orr 2018). Training in post-harvest handling will help improve farmer care of production and obtain better premiums in markets. More information on and access to inoculants could also help drive yields. A yield increase has been reported with the inoculation of groundnut and the use of rock phosphates (Nkwiine and Rwakaikara-Silver 2007; Ebanyat 2009).

2.5. Opportunities, constraints and critical gaps in Uganda's seed systems

The success in delivering seeds to Uganda's farmers will depend on complementary opportunities and comparative advantages offered by various seed systems. A well-organized value chain could function optimally and drive innovation (Hellin and Meijer 2006; Kaganzi et al. 2009).

The key bottlenecks that hamper seed sector growth are related to a disconnect between seed demand from farmers and the production of required volumes, the lack of diverse and good quality varieties and limited quality assurance mechanisms (TASAI 2015).

Most of the challenges reported in seed access are partly due to disconnected seed value chains, starting from EGS production and distribution. High yield gaps and crop use in different agro-ecologies could effectively guide the design of interventions. This shift will address limited access to markets, high post-harvest losses and limited sector lending.

All these challenges have denied farmers the tangible benefits of adopting quality seed. Given the yields of the target GLDC crops, steps towards adoption and delivery to help match or surpass world averages are key (Table 4).

Table 4. Production, area and yield of GLDC crops in Uganda compared to the world average (2016).

GLDC crop	Production (MT)	Area harvested (Ha)	Yield (MT/ha)	Potential yield (MT/ha)	World yield average (MT/ha)
Chickpea	5,085	8,313	0.6117	2.5	0.956
Cowpea	12,928	26,354	0.4906	3	0.5676
Groundnut	210,000	420,000	0.5	3	1.5901
Millets (pearl and finger)	234,298	167,261	1.4008	3.5	0.8944
Pigeonpea	13,047	34,173	0.3818	2.2	0.8299
Sorghum	314,553	398,050	0.7902	5	1.4279
Soybean	152,091	121,040	1.2565	2.5	2.7556

Source: FAOSTAT 2018.

Better linkages among actors in the seed value chains, especially in development and distribution, can enhance productivity.

2.6. Regional policies and integration

Harmonization of regional seed policies can improve seed movement across borders so that farmers can gain access to improved varieties for enhanced crop productivity. In creating more opportunities, the low capacity among regulatory agencies, inspectors and other stakeholders (Seed and Plant Variety Regulations 2016) needs to be addressed. This capacity strengthening has a long-term effect

on overseeing regional seed trade, i.e., quality inspection and certification, while also addressing local seed demand.

Also, a National Seed Policy has been developed that offers a more formal framework on which the seed industry could evolve in line with the Government of Uganda's objective of wealth creation; and into an export-oriented seed sector targeting local and regional markets in the East African Community (EAC) and the Common Market for East and Southern Africa (COMESA) (UNSP 2015).

In short, about three key programs/regional economic communities (RECs) can be noted from the literature as active in regional integration issues: COMESA/ Alliance for Commodity Trade in East and Southern Africa (ACTESA), EAC and Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). Apart from dealing with constraints specific to seed systems, these entities collectively address trade concerns. High transport costs, for example, make it challenging to access regional markets, and high fertilizer prices compared to other developing countries drive up the cost of seed production (World Bank 2012). Finally, the development of the QDS market bodes well for the overall demand for certified seed as it increases farmers' appreciation of quality seeds.

2.7. The roles of women and youth in the seed system

Segments in any value chain can be affected by value chain structures (Mayanja et al. 2016). Multiple barriers have been observed that sometimes curtail the active participation of and benefits for specific segments. Women farmers, for example, control less land than men and have limited access to inputs, seeds, credit and extension services. Without a detailed assessment of the value chain, these vulnerable groups can easily be overlooked or neglected (Carr 2008; Haggblade et al. 2012).

Women constitute an average of 43% of the agricultural labour force in developing countries (Doss 2014). They are involved in grain production and storage within households even though most of the training on good agronomic practices is male dominated.

Empowered women farmers can increase their incomes, develop a stable rural livelihood and contribute to ensuring food security. However, their true empowerment should transcend livelihoods to wealth creation and business leadership in agriculture – a call for appropriate technologies for them. Thus, gender inclusion in the seed value chain calls for the proper use of quantitative tools to assess gender-related questions. This process goes hand-in-hand with identifying imbalances and designing proper components and interventions (Carr 2008; Mayanja et al. 2016).

Sixty per cent of those in SSA are under 25 years of age. The majority of youth lack the skills needed to gain employment in the formal sector, with rural youth typically but often fruitlessly emigrating in search of economic opportunities. Increased participation by youth in the agriculture value chain in the region is imperative and vital to facilitating food and nutrition security now and in the future.

The seed business is an emerging opportunity for youth in agriculture in Africa. The seed sector has seen a rise in community-based schemes. There is a market opportunity for the youth to supply farmers with quality seeds of improved varieties. Seed production and multiplication also allow young people to bring their technical skills to bear and produce high quality seeds. Linking farmers to markets through market information is another avenue for youth as they have access to and skills in new technologies and mobile devices.

3. METHODOLOGY

3.1. Study area

This study focused on the four districts of Gulu, Masindi, Hoima and Soroti in Uganda (Figure 7). These districts were selected because they: (i) represent a significant volume of grain trade, seed flow and production of GLDC crops; (ii) embody the potential of GLDC crops and seed to be scaled and (iii) share common agro-ecologies which allowed for interviews with mixed and specialized producers and other actors.

Groundnut, sorghum, millets, soybean, cowpea and pigeonpea were selected as the focus crops for the assessment, based on their high potential to boost food and nutrition security and unique seed dissemination models. Several improved varieties of these crops have been released in Uganda, but farmers still have limited access to them.

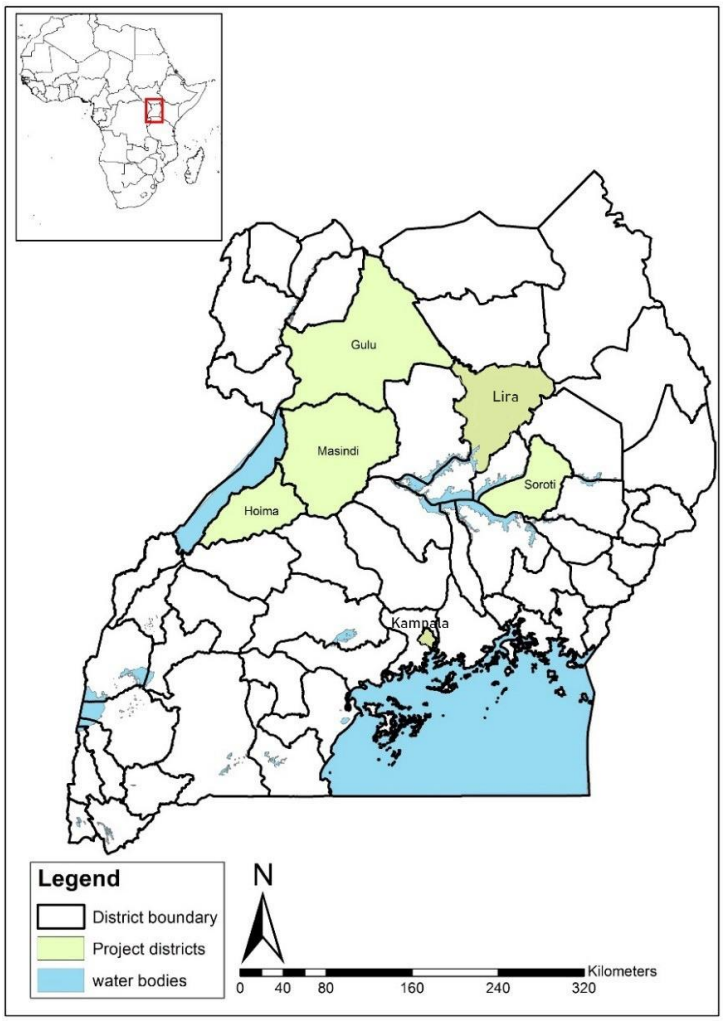

Figure 7. Districts in Uganda from where respondents were drawn.

3.2. Data source and sampling procedures

Together with literature review, key informant interviews and questionnaires were deemed the most appropriate data collection approach for the assessment.

To capture the specialized nature of seed production, certification and the dynamics of the entire grain trading process, a total of 109 key informant interviews were conducted between 2 September–1 October 2018 with 12 public sector officials (regulators, breeders), 38 private sector representatives (seed companies, traders, processors, agro-dealers), 2 subject matter experts, 11 development partner officials, 33 lead farmers and 13 focus group discussions (FGDs) (Table 5).

General and specific information were collected in different types of questionnaires for seed producer groups and grain aggregators. Seed companies, national research organizations and agro-dealers were also interviewed. Finally, lead farmers and community representatives, grain and seed traders and NGOs (including special programs) were also in the interview pool (Annexure 2).

A combination of content analysis and descriptive statistics were used to analyze the data collected.

Table 5. Selection of sample sites and the number of respondents in Uganda.

Respondents	Sampled sites*					Total
	Kampala	Hoima/Masindi	Gulu	Lira	Soroti/Serere	
Traders	0	10	2	3	5	20
Seed companies	4	0	0	1	0	5
Agro-dealers	0	1	2	3	3	9
Processors	0	1	1	0	2	4
Government staff including breeders	2	5	0	1	4	12
Lead farmers	0	5	7	9	12	33
NGOs, special programs	6	4	2	1	0	13
Focus group - SPGs, GAGs**	0	2	3	4	4	13
Total	12	28	17	22	30	109

*Used broadly to refer to locations where interviews were undertaken and vary by respondent type.

** SPGs = Seed producer groups and GAGs = Grain aggregation groups.

4. RESULTS AND DISCUSSIONS

4.1. Seed delivery models

Seeds of GLDC crops are delivered in a mix of models across Africa and the world. These include traditional farm-saved seed, exchanges between friends and family, purchase at local markets to semi-formal QDS systems and special programs by the government and NGOs and the less developed (in terms of reach, access and affordability) formal system of agro-dealer distribution networks or direct seed company sales. In Uganda, farmers cited farm-saved seed as the most reliable source of all GLDC crops of focus, and increasingly the QDS system as the best option to access new varieties. Both models were preferred as they were easy to monitor closely, and it was easy to visit local seed businesses[7] (LSBs) should there be concerns. The agro-dealer distribution system concentrated on maize and vegetable seeds and occasionally those of soybean and sorghum.

Local seed businesses are group driven and structured in a defined operational framework. The benefits of this arrangement include (i) group training, (ii) ready access to new material from research entities and (iii) the ability to bundle other technical services like extension or access to credit. Training in LSBs was often offered by NGOs, the Ministry of Agriculture, extension personnel and the National Agricultural Research Organization (NARO) through their crop-specific breeders.

The groundnut seed value chain was one clear example of a hands-on approach to demand-driven breeding, training and market linkages. The best crop/seed products were sorghum and groundnut, both in the East and North, with millet (and beans) preferred in the West. These were considered necessary for food and income in the cultural context and for output markets, respectively. There were loosely defined partnerships characterizing the role of the private sector, development partners and government in extension and other farmer activities. The role of agricultural extension in improved farm productivity cannot be overemphasized. The capacity of farmers to embrace modern technologies (including improved varieties) rested on awareness that served as a strong impetus for farmers to move from subsistence farming to commercial agriculture.

The study demonstrated the inadequate synergies to ensure better value per dollar invested. All the 13 NGOs interviewed rated partnerships and goodwill as critical factors contributing to the success of their seed program interventions. While some companies were actively engaging farmers in seed production of GLDC crops, more could be done. The model involving LSBs was ideal in generating a pull mechanism with spillover effects and targeted training at the group level by all partners. When entities partner proactively to design low-cost solutions for the seed industry, farmers will enjoy materials developed by breeding institutions.

In some GLDC crop production hubs, humanitarian and development agencies could help drive adoption rates within a market systems development approach. Nevertheless, most of the respondents cited having received a new variety through a unique program in the past. This observation, however, was only project-based without links to either a regular seed source like an agro-dealer, seed company or LSB. Other instances described by NGOs point to a “work in silos” scenario, especially in the livelihoods and resilience programs that deal with seed.

Researchers felt they were delivering suitable material, but farmers tended to stick to their farm-saved seed and could not replace varieties. A major issue lies in getting quality seed from a reputable source to ensure repeat buying. Having burnt their fingers before from purchases made at agro-dealer outlets

[7] Local seed businesses are farmer groups producing/multiplying seed through linkages with breeding institutions and regulation by the Ministry for quality assurance.

or van sales in markets, farmers felt less inclined to follow the formal system route. Farmers felt that seed quality from companies could not be fully trusted but could be the best with comprehensive regulation.

Distortion risk was observed with government or NGO special programs involving exclusive seed purchases from seed companies. This risk has made it less profitable for agro-dealers who are invariably bypassed and not allowed to join in the bidding.

In the regulations currently under discussion at the Ministry level, QDS has been touted as “seed close to the farmer.” This demonstrates how much seed of improved varieties can be effortlessly adopted in a localized ecology and at a lower cost. Furthermore, the QDS model offers a ready follow-up and recourse mechanism for farmers’ proximity to seed production fields and sales outlets. Hence, QDS is a key mechanism for increasing the productivity of GLDC crops.

The formal seed system's growth depends on integrating stable semi-formal and informal systems to disseminate complementary messages on the need for good seeds. Integration can take the form of ease of access to seed, its affordability and guaranteed quality. Farmers require stable seed delivery systems that guarantee quality, choices and a recourse mechanism. While the QDS system strives to address some of these, pricing must not deter smallholders. In showing that seed suppliers have the interest of farmers at heart, packaging needs to be done in a way that drives affordability, for instance, having up to 100 grams of GLDC crop seed sold so that farmers have a chance to try out an improved variety. However, this was not evident throughout the study, but some seed companies, government programs and special NGO programs had been thought through and implemented.

4.2. Grain market outlook

The fate of grain legumes and dryland cereals depends on the scale of produce and its intended use, i.e., for subsistence or sale to markets and aggregation centres. Generally, upon harvest, grain is dried, threshed, winnowed and sorted before bagging. Subject to farmer circumstances, whether in a group or as a lone seller, deliveries are made to markets and grain aggregation centres, respectively. In Uganda’s seed system, output markets appear to be the critical business drivers even for under-represented GLDC crops. These markets or offtake systems appeared to be a more significant and immediate need for the respondents interviewed. They felt that a ready market for the product could better complement the adoption of an improved variety. This case was exemplified when the question “why is this variety preferred?” came back with 98% of the respondents saying, “it fetches a premium in the market.”

Grain legumes and dryland cereals grain markets are vast in terms of untapped potential for structured trading of produce but “small” when assessed in terms of the quantum of farm delivery. Uganda is one of the top producers and exporters of most GLDC crops, which play a critical role in its economy. There is a clear desire by farmers and traders to have functional output markets responsive to their needs. Respondents could handle orders based on location, i.e., local or regional (Kampala, South Sudan, Rwanda and Kenya) as determined by the customer and crop type.

There is a knowledge gap on quality control from seed planted by farmers to bulked grain by traders. Presently, organized marketing through groups allows grain quality to be standardized before delivery. The need for upfront systems that promote varieties was extensively mentioned and covered most food security crops. Farmers felt that they could bolster their economic situation by using improved and high-yielding varieties while feeding their families. They stated their desire for markets with better produce prices, small seed packs, grain storage facilities in village aggregation centers and timely payment to seed growers.

Grain aggregation as a practice was dominated by local groups/cooperatives' by-laws and buyer preference. For example, when a large institutional buyer like the Food and Agriculture Organization of the United Nations (FAO) or World Food Programme (WFP) sought supplies, specific standards for quality were employed. These mainly were implemented alongside the bylaws to ensure a win-win situation. Groups were clustered based on parishes and specialization in crops with a comparative advantage. The challenge of storage often affected the optimal performance of these entities.

Multiple challenges faced by grain traders and partly aggregation groups were recorded. These included limited access to capital and credit and price fluctuations due to weather or other market forces. Others are low grain quality from farmers (e.g., weevilled, high moisture content, mixed varieties and debris). Specifically, high market rates by the government, transport costs eating into margins and the risk of undersupply, mainly when the market does not desire produce from fields, are other concerns. Traders queried were willing to pay lower for low quality.

Village savings and credit groups appeared to be a competitive source of financing for the traders compared to other formal microfinance institutions. While farmers were not often paid a premium for grain delivered, exceptional circumstances such as the high demand for various GLDC crop varieties prompted additional bonus payments for quantities supplied.

4.3. Early Generation Seed

Breeders have had quality assurance mechanisms in place for EGS production. However, low levels of funding for the activities, lack of demand forecasting capacity[8], limited land with irrigation infrastructure and the capacity for year-round production and strained staff capacity could not always guarantee 100% quality.

It was observed that NaSARRI generally lacked the technical and financial ability to run and maintain a comprehensive program than the National Crops Resources Research Institute (NaCRRI). This could be due to the number of active donors and the financial support complementing the little obtained from the central government and the lack of staff. It was also challenging to produce updated figures on the profitability of the EGS business even though there was a consistent call by stakeholders that monies remitted from sales went to a central pool and was occasionally ploughed back into breeding efforts. Proper market information systems were lacking based on respondents' opinions. These were the main reasons for the limited demand forecast and the inefficiency in synchronizing seed production with markets.

For a majority of the crops, the replacement of foundation seed was an annual event, but access to it was always cost prohibitive. Foundation seed production in itself is tedious and capital intensive. Breeders and subject matter experts consulted cited an increasingly complex operational environment from variety maintenance to development, with an overdependence on external donors through project calls since central government funding barely covered staff costs. There is, therefore, a need for clear policies that speak to investors globally.

Local seed businesses mentioned the high cost of foundation seed hindering farmer access to suitable material from research institutions. As consistently highlighted in the literature, this situation was sometimes complicated by limited quantities, lack of timely access and poor quality.

Despite all the challenges, most of the LSBs interviewed were confident of delivering their targets by adopting a 'seedbox' savings model, wherein group members were asked to save and make pre-orders with breeders possible. In some instances, the breeder was paid after seed sales, introducing the

[8] Prospective seed buyers fail to place timely pre-orders.

possibility of a concept dubbed 'foundation seed on credit'. Without a clear understanding of customer preferences, it will be challenging to drive the demand of seed of GLDC crops since operations beyond the breeding facility are dependent on widely adapted but market/farmer-preferred varieties.

This provides an opportunity for NaSARRI within organized local seed businesses, especially with QDS regulations (now enacted) and seed companies having better terms and flexibility in licensing. LSBs are investing in demand creation at the grassroots level and have learned the art of pre-booking EGS. This partnership could be explored and scaled to drive demand for grain at the farthest end of the chain and quality seed at the LSB-NaSARRI level.

The move towards a multi-stakeholder platform will guarantee a better match between the supply of and demand for specific varieties, wherein information digitization, group training, participatory farmer evaluations and linkages to input/output markets will occur. It is typical for the private sector to be involved and invest in EGS when the seed is highly profitable and generates significant and stable demand, such as creating a demand for Epurpur variety of sorghum through Nile Breweries' low-cost beer. However, the lack of quality seed in the market for farmers who already have experienced returns on investment can turn into a disincentive.

Synergies between seed-related projects can lead to more robust value chains, minimize duplication of efforts and lead to more agreeable integration of seed systems. For example, a processor and a prominent seed trader mentioned their frustration in mapping out a value chain to produce what they need locally and regionally for their clients. Having them work in synergy with breeding institutions will enable the development of varieties that address investor needs.

Strategic programs, emerging trends and implementation of policies play a critical role in defining farmers' field and household productivity. Understanding seed needs at the smallholder level and across industry stakeholders will enable sound and sustainable interventions. For instance, NaSARRI should relook at their strategies of sustainable seed production and demand creation. This move will enable them to establish a more robust working relationship with value chain actors, seed producers build markets, and create an environment that draws the risk-averse to try out new varieties.

The renewed interest by NARO Holdings to venture into certified seed production of GLDC crops is welcome. However, a line needs to be drawn on the key mandate of EGS production. While all these were noted, the challenge of inadequate land for production came up among research entities, local seed businesses and seed companies. If the seed system structure and function improve, the next limiting factor will be arable land with potential for irrigation infrastructure.

4.4. Certified and Quality Declared Seed

Agriculture development in Uganda currently enjoys a level of optimism that stems from the growth of market-oriented agriculture. This was evident in horticulture and field crops agribusiness drives. For example, sorghum has grown to be an income generator, bringing households much needed income from farming. Farmers' demand for improved varieties of GLDC crops' seed is high and increasing but easily eroded by the limited access to quality seed. Farmers often know which variety is good for them after witnessing its productivity and resilience on farm and its post-harvest condition for home consumption or sale in markets.

This study documented the evidence of increasing demand for improved varieties but low access to them. A general air of caution was discernible in depending on the formal system for improved varieties. This saw farmers keep a considerable proportion of farm-saved seed of GLDC crops. However, local seed businesses were seen playing a pivotal role in filling the gap in quality, timely

supply and affordable cost of seed, thus helping in partly meeting the demand. This constraint can only be addressed by a multi-layered approach in breeding institutions' work.

Crosscutting issues observed in the field in both sub-sectors ranged from lack of access to quality seed, limited to no agronomic information, and credit, to over-regulation of the seed industry. Institutional buyers, mainly relief agencies and the government, have procured large amounts of certified seed from seed companies. Although this may be good business for the seed companies, a question could arise whether this will affect their interest and actual operations to serve smallholder farmers.

Community seed banks presented an opportunity to conserve genetic diversity, especially of beans and millets. Existing national seed legislation is shifting the landscape for seed classes available to farmers and how seed certification will be structured. LSBs ensure QDS can be produced within a locality and sold to farmers having met set standards, thus driving the integration of seed systems. These changes are set against a promising growth of the seed industry, opportunities for regional integration and a desire for household food and income security.

Breeder seed was sourced from NaSARRI to produce certified seed, and maintenance breeding was undertaken whenever low volumes were anticipated. Production costs of certified seed were relatively higher than those of QDS, given the additional regulation and value addition activities involved. Mark up to production cost was computed after payments to out-growers whose management was always tedious, mainly because of the added cost involved in regular training on seed production and maintenance. Like the maize seed system that is primarily formal, there were significant weak links cited, such as seed quality assurance systems and certification and lack of 'cheap' fiscal services to back investments. This sub-sector was largely private sector driven, but a government entity expressly stated its strategic move to target the sale of certified seed of GLDC crops that private companies were less interested in, in addition to producing EGS of other crops. Companies interviewed preferred the sale of certified seed of the GLDC crops on pre-orders and applied for loans or overdrafts to supplement cash flow when needed. For seed companies, packaging had a bearing on their market penetration strategies, especially in the case of millet and sorghum that were sold in packets of ≤2 kilograms.

Currently, the QDS class is recognized in Uganda's National Seed Policy of 2018, which is a ray of hope for alternatives to both certified seed and seed from informal sources. Most of the local seed businesses interviewed presented profitability scenarios that looked positive and justified their activities. The crops dealt with included sorghum, beans, cowpea, sesame, millet, pigeonpea and groundnut. The major thrusts of this semi-formal system, apart from the regulations, are the entities involved in capacity building and market linkages, which ensure sustainability and promote a culture that embeds professionalism in all activities.

Farmer organizations remain fundamental to the well-being of smallholders. This study observed that farmers in groups had lower transaction costs when obtaining new agricultural information, adopting new technologies, or accessing input and output markets. Most groups expressed satisfaction with customers making purchases at their stores instead of deliveries being made to them. The significant hurdles cited in the production of this seed class, i.e., QDS, are: (i) the restrictive nature of the sale, i.e., it cannot be sold beyond its production district, and (ii) timeliness and access of quality and sufficient volumes from breeding institutions. Overall, more partnerships between stakeholders, i.e., NaSARRI, farmers, international research organizations, cooperatives and NGOs, are needed. So are the provision of technical services to farmers by scientists, supporting strong links to agro-based industries and encouraging technology dissemination in rural areas.

4.5. Seed delivery mechanisms

Informal farmer-to-farmer seed exchange is common in Eastern Africa. These sources have been modelled over time around individual growing and maintenance of varieties. Adopting technologies like improved varieties of GLDC crops in Uganda hinged on access to training, taking into account farmer status, what crops they grow, their resource endowments and the capacity to tolerate risks. Information on seed, including unique traits, reached respondents mainly through peer-to-peer conversations, producer group meetings, demonstrations or the radio. Seed companies dealing in GLDC crops are few in Uganda, but they explored production and sales at a higher level, often indirectly to farmers. Five seed companies were interviewed, three large private sector driven and two parastatals (NARO Holdings and Makerere University Seed Unit). The private sector-driven companies preferred to sell seed through large consignments, pre-ordered by the government as part of special seed programs or incorporated by NGOs in livelihood programs.

The current formal seed systems fronted by governments appear to overlook seed access, especially distance to source, timeliness and affordability. Agro-dealer locations were often in more prominent town centers, with farmers having to incur travel costs to get the seed. Alternatively, seed companies that managed to have demonstration farms for non-maize crops used field days as points of sale, providing publicity for new varieties but limited by seasonality and location. Some challenges are seldom met adequately, so seed produced cannot be sold at low cost without continuous subsidies.

The preference to take pre-orders for GLDC crop seed comes with an immediate need for large payments that help boost company cash flow. Despite the established agro-dealer distribution networks for maize, sorghum, rice or vegetables, the companies considered this a lucrative delivery mechanism to repeat sales at the farmer level. All the NGOs interviewed had seed interventions that focused on supporting production (mostly of grain) and providing affordable (sometimes free) quality seed to smallholders. They mainly achieved their goal through farmer mobilization by creating cooperatives, group training and extension, lobbying, policy advocacy and credit.

Defined by more regulatory control, the formal system appears more restrictive, retards the variety release process to farmers while narrowing their seed choices. While farmers can buy hybrid seeds, many would-be satisfied with the excellent quality seed of modern varieties readily accessible from neighbours. In Uganda, farmers mainly used the informal system to offer their preferred varieties on time, enabling planting as soon as the season started. The semi-formal system (QDS) also provided a steady seed source of improved varieties at a lower cost.

Improved GLDC seed delivery mechanisms can be anchored on two strategies to meet farmer needs: the promotion of a structured but integrated trading platform that links smallholders to grain buyers and the development of an enabling environment that supports micro policy reform of systemic issues in the seed sector. While the first will help achieve efficient access to markets, inputs and credit and lead to more preferred seeds of improved varieties, the second will lead to engagement with the national seed trade and agro-dealer associations to help achieve impact, especially when it comes to more awareness and capacity building.

4.6. Opportunities

There is a need to continuously increase awareness and implement policies that create an enabling environment and linkages between all stakeholders in the GLDC crop value chain. While local and regional opportunities exist for all genders and youth, each player's role needs to be specified with their complementary value. For example, if companies concentrate on the next generation and women farmers, many of these opportunities will translate into food, income and nutrition security. In the GLDC crop value chain, aggregators, off-takers and traders are crucial in driving seed demand.

Most lead farmers felt there was much to lose with a defective output system. Nile Breweries, which gave farmers seed to plant and came back for the grain to manufacture beer is one example of what drove some farmers to grow sorghum varieties SC Sila and Epurpur.

All the GLDC crops in this study had the potential for multiple uses. Their value chains could be extended into regional and international output markets. With COMESA's harmonization of seed regulations coming into force, market uncertainty of seed will be reduced. Uganda enjoys a favourable year-round climate with two seasons in most agro-ecological zones in seed production and trading compared to its neighbours. The EAC has relied on opening up countries to opportunities by reducing non-tariff barriers. These countries are on the verge of enjoying similar seed laws and regulations following reviews and alignment with COMESA requirements. However, while these regulations have been there since 2014, seed industries in the market bloc continue to be ridden with challenges such as inadequate awareness, inefficiencies at border crossing points and a lack of trust in the seed certification and quality assurance processes. The regulations point to significant steps that have been taken to lay the foundation for seamless regional trade. More efforts are inevitable if the seed industry adopts a market systems approach to seed sector development. In achieving this, reforms will need to be market driven, with private sector players (companies and seed associations) playing a lead role.

The state of poor business in the sale of seeds of GLDC crops, which are open and self-pollinating due to farmers recycling, is far from over. Concessional distribution by special development programs or relief agencies cement farmers' dependency. In this context, harmonized regulations seek to promote a seed supply approach anchored on economies of scale. These regulations will ensure the region has sufficient seed stock produced and available for sale. They will incentivize those who are trading in specific varieties to sell in different countries. The standards or rules within these markets will most likely help enhance the timeliness of seed supply and its overall quality. With more entrants into local seed entrepreneurship in Uganda, greater investments in seed production backed by competition in seed supply will drive seed cost down to benefit smallholder farmers.

Youth and women currently form a significant segment of seed producer groups and grain aggregation associations. With more training and access to capital, they could venture into value addition and target lucrative markets locally, regionally and internationally. A couple of large traders interviewed mentioned that they were well established in grain supplies to South Sudan, Rwanda and Kenya. They had agent models of grain aggregation linked to a pool of farmers who grew GLDC grain. A bigger question raised was about seed access level since different customer segments preferred specific varieties that sometimes were hard to come by.

The role of researchers remains valuable, especially in the light of demand-led breeding that addresses processors' needs. This comes at a time when financing for EGS production is not at the desired level; hence the limited quantities at seed producers' level. It can be an opportunity for youth and women to be seed producers in local seed businesses to grow QDS or be outgrowers for seed companies. Models around an alliance like the Pan African Bean Research Alliance (PABRA) could also offer lessons on scaling technologies across borders. PABRA's focus on thematic areas of sustainability, nutrition, food systems, and resilient agriculture draws its success from enhanced partnerships among stakeholders in the bean value chains, including linkages to markets.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Many efforts are currently on in the area of seed system development. Past successes and failures may inform some, while others are add-ons to livelihood programs. The efforts have not adequately addressed the bigger question of sustainable and reliable supply chains for quality seed of improved varieties. Most of the recorded impact has depended on funding streams and a focus on 'what could be the next big seed supply strategy'. There is great potential for business in demand-led breeding, local seed producer groups, and seed companies trading in GLDC seed. However, profitability and sustainability depend on understanding the needs in the different value chain segments and getting most, if not all, of the donor or government seed projects to be market smart.

There is excellent potential for farmers to adopt modern varieties if their access to basic seed increases through trained local seed businesses set up professionally. Seed companies with strategies to produce, market and sell seed based on farmers' needs could prove remunerative in the medium to long term. The interviews underlined the importance of future investments into efforts that ensure a reliable supply of EGS, working capital for producers and traders and relevant data or information localization. Understanding varietal attributes and starting from a baseline allows farmers to evaluate the quality and suitability of varieties within their agroecological zones. Unforeseen climate change challenges could be easily targeted through proactive capacity enhancement, for example irrigation infrastructure or demand-led breeding for unique traits like drought, disease and pest tolerance. If farmers were organized and then had access to technology, digitization would make a huge difference.

This report concludes that farmers' sustained access to a steady flow of high quality seed of improved varieties of GLDC crops could be enhanced through competitive but commercially-oriented seed systems. Much traction can be gained if government and development partners focus on strengthening the private sector's capacity to produce and distribute seed. Farmers will be released from the subsistence trap of low yields and limited grain supply through improved varieties that raise yields and increase grain demand by improved supply and reduced prices. Any attempt to crowd out or create disincentives for private sector seed businesses will promote status quo.

Future studies could deal with the prior identification of local seed businesses and not necessarily any group within a given location. In addition, there is a need for extra flexibility in the lead time to the study before actual field work.

5.2. Recommendations

This study focused on what could make the GLDC seed value chain more sustainable. Constraints were identified across the value chain, some with specificity while others were broadbased. Strategies to move these systems to the next level will need multi-pronged approaches that focus on institutional strengthening, policies and policy dialogue and trade.

5.2.1. Institutional strengthening

5.2.1.1. Capacity building

All stakeholders need to enhance capacity in all they do. Regulators also need to understand the dynamics in agriculture and, specifically, the seed industry to embrace refresher training. From more trials and demonstrations on the farm to designated purchase points of seed, farmers need to see and believe by experiencing their unique attributes.

Women traders and farmers highlighted the need for focused training on bundling of technologies. They wished to be part of specialized women groups that would allow them to voice their concerns and needs unrestrained by culture and tradition, especially in mixed focus group discussions. It further reinforces the fact that technology adoption is greatly influenced by access to training.

Exchange visits for regulators and breeders accompanied by private seed producers to appreciate seed systems in other countries that function well are encouraged. A unanimous need was felt to gain insights into systems in place and their efficiency in addressing farmers' seed demand for improved varieties. This could be through private-public sector partnerships to ensure sustainability following the implementation of good practices and discarding of bad ones. Investments in climate-smart complementary technologies like efficient irrigation practices are preferred but not yet adequately studied locally or funded at scale.

Farmers' expectations of seed suppliers/producers are summarized as follows:

- Availability of affordable small seed packs in outlet stores at any given time
- Agro-dealer training to hone their competence to advise farmers on best practices for varieties they stock
- Countrywide demonstrations that allow farmers to appreciate new varieties in the field
- Farmer engagement in both participatory and demand-led breeding to factor in their preferences and
- Training of lead farmers to become models for experiential learning in communities.

5.2.1.2. Financing

Across all the interviews with respondents, access to finance to meet cash obligations was highlighted. For researchers, it was the desire to have liquidity so that the next season's activities are not affected. For example, the government should look at a decentralized way of putting money from seed sales back into active demand-led breeding. With this comes a guarantee that a variety preferred by farmers will be available in the next season. There seemed to be a lack of prioritization by breeding institutions in ploughing back funds generated from EGS sales, leading to subsequent underfunded processes. Professionalism in business entails a purposeful setting aside of funds to help improve processes.

Traders expect immediate returns from supplying their produce. While credit may be advanced to loyal customers, the same is not true when traders want to stock. This skewed nature of transactions often affects how much they can take from farmers. Having a market surplus is constrained by either post-harvest losses or low selling prices on the farmers' side. A microfinance institution (including village-level ones) could help improve the cash situation. The thinking around these institutions should be embedded in training on group formation.

All seed companies interviewed felt that local banks did not treat agribusinesses as lucrative. Often, the high interest rates compelled them to consider overdrafts as opposed to loans. This remains a significant concern, especially when they need to pay and get seed from their outgrowers. More partnerships between government, agricultural research institutions and other private sector entities could help identify eligible but low-risk ventures for financing, ensuring that at least segments, if not all of the seed value chain, have reduced cash flow challenges.

5.2.2. Policy and policy dialogue

5.2.2.1. Seed certification and classes

A practical legal framework is key to supporting Uganda's economy, and its Gross Domestic Product (GDP) that is dependent on agriculture. There have been many advantages in getting seed certified for sale through agro-dealers, recognized entities for seed distribution by law. However, this has isolated many smallholder farmers due to a lack of knowledge on their availability and use, prohibitive cost, low seed quality and the absence of farmer-appropriate varieties that can eliminate the use of their own saved seed. The issue of distance to reliable and reputable agro-dealers troubled farmers, especially when asked why they did not use seed of improved varieties. A deliberate effort by development partners and the Ministry has seen the drafting of regulations on QDS. Local seed businesses have produced this seed closer to farmers and have partially helped integrate formal and informal seed systems. Greater awareness of this seed class as a complementary one to certified seed is required. Building the capacity of seed businesses and suppliers will help them embrace the professionalism required in the industry, thereby enabling a free enterprise that propels a nation's growth.

Equally important is developing a farmer recourse mechanism, especially when they purchase seed from dealers. The confidence a farmer builds to the point of being loyal to a brand is quickly eroded with an experience with counterfeit or low quality seed. Stiffer penalties for seed counterfeiting and tamper-proof mechanisms in packaging are imperative. With a constantly updated list of registered seed suppliers, the industry could look forward to easy access to searchable databases to boost transparency and avoid 'briefcase seed companies.' Another suggestion was to develop varieties that could be replanted for three seasons before being replaced with fresh seed. It serves as an alternative for any cash-strapped smallholder.

5.2.2.2. Extension and other input services

Agricultural extension services are expected to drive reduction in rural poverty. The extent to which this can be achieved depends on prevailing circumstances. Farmers (and traders) felt the extension system was weak compared to 10 years ago, mainly due to the lack of adequate financing to move across far-flung districts. As an upstream activity, extension works reasonably well where input systems are well developed. It provides an understanding of why and how to use technology. More funding to extension works, but it is better to ensure farmers get up-to-date information in a structured framework. An array of digital tools or visual aids could be developed and disseminated with the needs of farmers in mind. An avenue to avail credit through cooperatives is also feasible. Government policies to enhance access to technology is also vital to spur agricultural development.

Access to quality seed by smallholders can be improved by eliminating unscrupulous dealers in the seed value chain. The model has been tried in Kenya through a coin scratch verification technology with an additional component of direct calls to the regulator's hotline. Seed companies could also have authorized stockists and share this information with farmers. Informal and formal systems could be integrated by supporting farmers to operate their seed banks and local seed businesses. Encouraging the formal seed system to venture into GLDC crop seeds and reviewing sales through small seed packages will also help drive demand for quality seeds of improved varieties. Farmers emphasized the need for seed companies. The Ministry of Agriculture and agro-dealers (and special programs) organize regular meetings to discuss seed-related concerns; this will help unravel any underlying constraints to quality seed access and variety adoption.

5.2.3. Trade

5.2.3.1. Output markets

Demand-led breeding often produces what consumers need, such as farmers, processors and special programs run by NGOs. Value chain analyses that identify needs in different segments have to be prioritized. Uganda's geography and relatively stable climate allow it to be a hub for seed and grain production. A lot of the seed and food relief (mainly pulses and cereals) for troubled countries like the Central African Republic and South Sudan are sourced from Uganda. Seed companies could play the additional role of linking farmers to grain/output markets after they identify a private sector entity interested in their variety.

Clear policies are needed providing incentives for value chain actors to build systems to improve efficiency in both seed and grain production. For example, in the case of seed, the size of a seed package is a clear indicator of whether an industry has the smallholder's interests/needs at heart. This was not evident among large seed producers and companies. In addition, the preferred sale of GLDC crop seeds to large buyers meant this was a far-fetched hope. In the case of grain, a clause that ensures mandatory blending of flours, e.g., sorghum + maize, would help drive demand for sorghum seed; this has already been done by some breweries. Through an internal policy, breweries have maize and sorghum blends in the manufacture of a beer brand. This process yielded a low-cost beer alternative and provided a market for an additional commodity, i.e., maize. In addition, school programs could curb the double burden of malnutrition through grain legumes in diversified diets.

5.2.3.2. Regional integration

Harmonized seed regulations in trade offer hope for sales volumes in both seed and grain. As a member of COMESA, Uganda could tap into benefits by subscribing to the statutes that will dictate seed movement. The country's ongoing setting up of an International Seed Trade Association (ISTA)-accredited laboratory for seed testing reaffirms its bargaining power in seed trade within the region, given the critical trading partners attached to accreditation. Regional grain hubs could be developed that share standards backed by clear policies.

Comparative advantages cut across all business models. Uganda exports a lot of grain legumes and dryland cereals, often not well marketed. Its position is dependent on ensuring effective, efficient and appropriate laws that enhance a viable business environment. Modest efforts at branding will help in positioning itself as a market leader and earn loyalty. In the context of grain aggregators and even local seed businesses, there is a decisive move towards branding and getting it right in terms of weights and measures. Such a step could involve getting electronic weighing scales that build customer trust in technology and allow a variety of weights to be sold. There is glaring evidence of opportunities for women and youth in seed and grain production. In the groups interviewed, the women/youth to men ratio was always high, signalling a desire by these segments to drive the agribusiness agenda in the community, especially for GLDC crops. With the African Continental Free Trade Area currently underway, Uganda has promising opportunities with grain of GLDC crops. The government's commitment to being a signatory and participating in its ratification puts the country on an incredible upward trajectory. With a seed market that is still developing, the seed system needs a boost to ensure farmers' access.

ANNEXURES

ANNEXURE 1: Yield, area and production of GLDC crops in Uganda.

All figures are based on data from FAOSTAT (accessed on 12 July 2019).

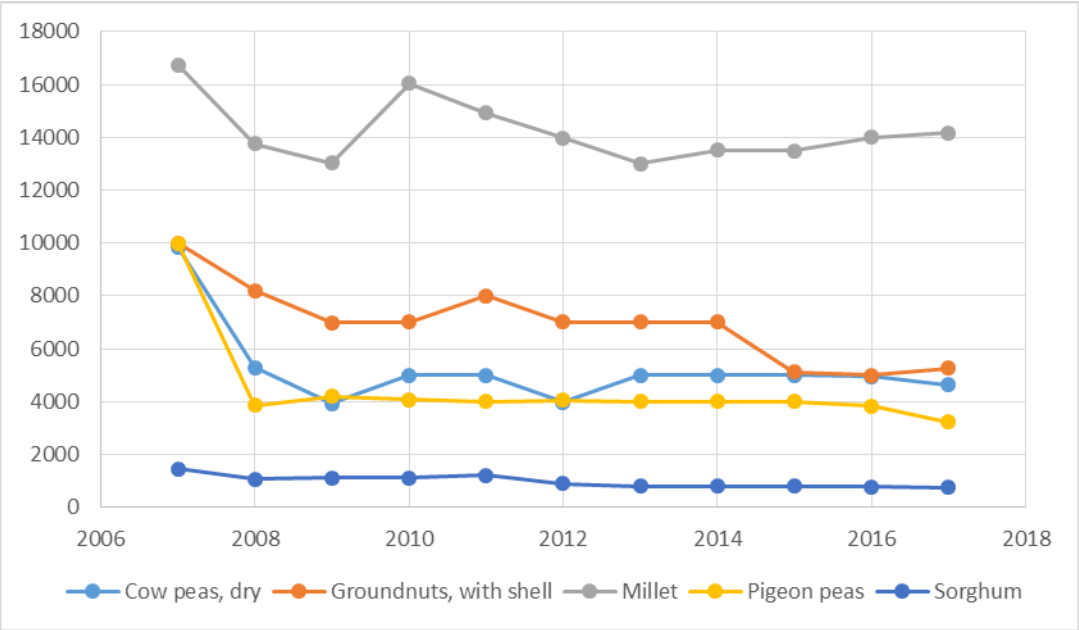

Figure 1. Yield (kg/ha) of GLDC crops in Uganda, 2007-2017.

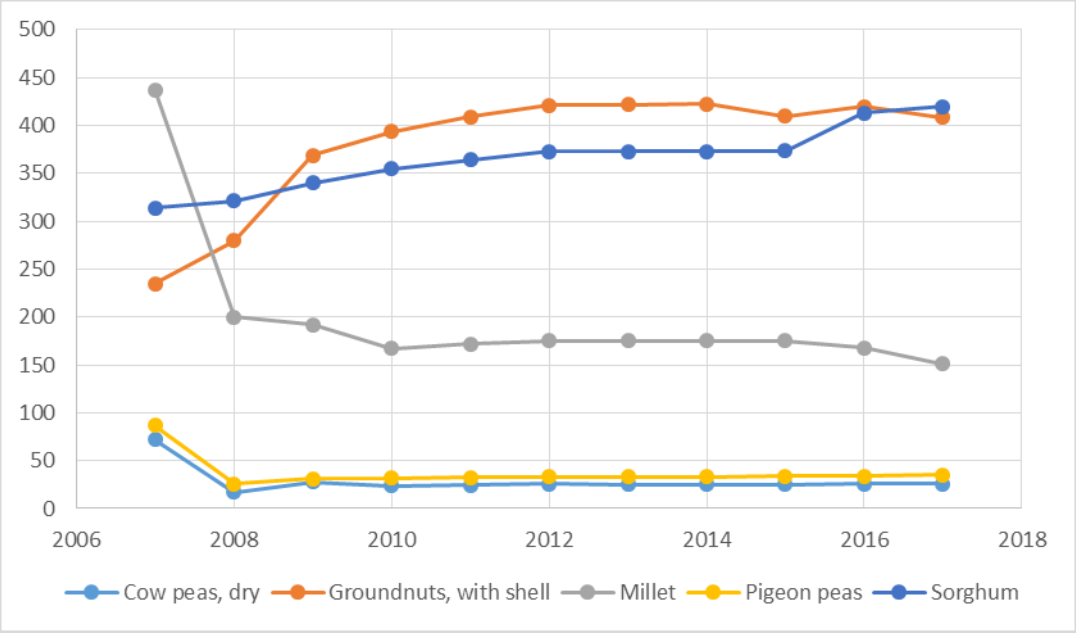

Figure 2. Area ('000 ha) of GLDC crops harvested in Uganda, 2007-2017.

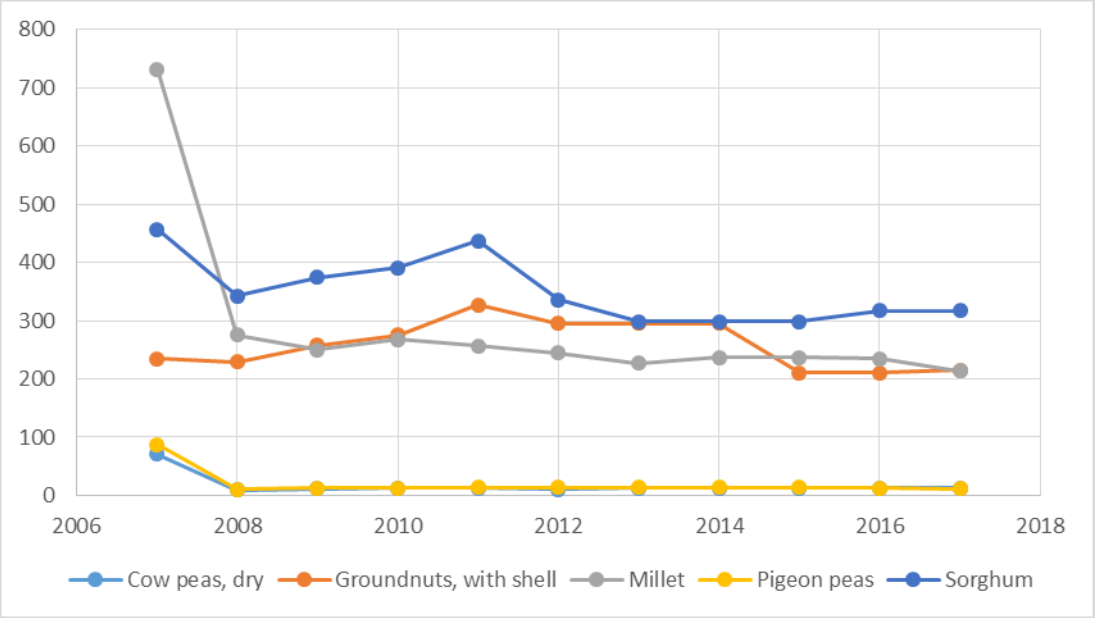

Figure 3. Production ('000 MT) of GLDC crops in Uganda, 2007-2017.

Annexure 2: The questions asked to different kinds of respondents, wherein both qualitative and quantitative data was collected.

1. Targeted key informants

1. EGS informants
   a. Government breeder programs
   b. University breeder programs
   c. Private company breeder programs
   d. CGIAR breeder programs operating in the country
   e. Other relevant stakeholders.

2. Certified seed and QDS informants
   a. Seed companies (public/private)
   b. Special seed systems projects/programs
   c. Seed producer organizations (community, etc.)
   d. Certification and quality assurance bodies

3. Seed delivery mechanisms
   a. Seed companies (public/private)
   b. Special seed systems projects/programs
   c. Seed producer organizations (community, etc.)
   d. Seed traders/agro-vets, agro-shops, any other seed outlets
   e. Open-air market traders (trusted for seed source)
   f. Relief seed distribution programs/actors (fairs, etc.)

1. Actors involved in the production of various seed classes (breeder, foundation, certified and QDS)

1. Describe the sorghum/groundnut/millets/chickpea seed system in your region. The question is specific to the actor, depending on the crop being dealt with.
2. What role do you play in the seed system?
3. Who are the leading players you are collaborating with?
4. How many crops are you producing seed for? Name the latest in the past season, name/variety.
5. What varieties do you produce (cropwise)?
6. Why do you produce only these varieties? List reasons in order of importance.
7. What class of seed do you produce? Do you sell or distribute it free? If you sell, then to whom?
8. How much seed do you produce per year for each of the crops mentioned above? Specify the variety where applicable.
9. What are the most important varieties currently in farmers' hands?
10. Who are your primary sources of breeder/foundation seed?
11. Do you buy seed, or are you given it free?
12. If you buy breeder/foundation seed, how often (number of years) does it take to renew the same variety?
13. What challenges/constraints (technical, infrastructure, institutional and financial) do you face in the seed class(es) you produce?
14. How do you cope with these challenges?
15. What specific challenges do you face in obtaining early generation seed? And what have been your coping strategies?
16. What opportunities do you see or have taken up (technical, infrastructure, institutional, financial and cultural) in the production of seed class(es)?
17. How would you describe the seed market?
18. What is your seed supplying capacity? And what does it present in terms of meeting farmers' seed demand in your area?
19. What specific marketing challenges do you face? And what have been your coping strategies?
20. How would you best describe the profitability of your seed business by crop and variety?
    a. Annual total production by crop and variety
    b. Detailed production costs by crop and variety
        i. Fixed costs
        ii. Variable costs
        iii. Amount sold by crop and variety
        iv. Average prices of sold quantities
21. What kind of external support have you received so far that keeps you in the seed business? (If none, go to question 24.)
22. What would happen if this support is withdrawn?
23. What should be done for you to self-run your seed business without external support?
24. What are you doing uniquely to ensure to meet customer/client needs in the long term?
25. What are your seed delivery models? And which ones work best?
26. Are there any other topics important to you but not covered so far?
27. Your concluding remarks.

3. Overall key informants' (seed producers, seed traders, agro-vet)

1. Describe the sorghum/groundnut/millets/chickpea seed system in your region. This question is specific to actors, depending on the crop they are dealing with.
    a. Who are the leading players?
    b. Why are they critical players for the seed systems?
    c. What class of seed do they supply?
2. What role does your organization play in the seed system?
3. What are the most important varieties supported by the seed system?
4. Why are they important?
5. Have the most important varieties changed over time? [Yes] [No]. If yes, what do you think are the reasons? List at least 3 reasons in order of importance. If no, skip to question 9.
6. Do you know of important varieties that were dropped from the seed system? [Yes] [No]. If yes, which ones? If no, skip to question 8.
7. Why were they dropped? List at least 3 reasons in order of importance.
8. Does your organization gather information on farmers' seed preferences? [Yes] [No]. If no, skip to question 10.
    a. If yes, what processes do you use to obtain information from farmers?
    b. How is the information processed for company/organization utilization?
    c. Is the information used to guide decisions or priorities?
    d. Have there been significant changes in priorities based on this kind of information?
9. How do you stay abreast of farmer seed needs?
10. What are your seed distribution options?
11. What is your seed adoption rate? Do you face challenges in meeting the demand for seeds in your area?
12. What varieties of the crop [determined at interview] are you promoting? Why?
13. What do you think of your own saved seeds used by farmers as a source of seed?
    a. Any positives about it?
    b. Any negatives about it?
    c. What percentage of seeds used at the farm are own saved seeds?
14. How are seeds saved in the community?
15. What varieties do the farmers retain in their own saved seed process? Why?
16. What is the role of women in the management of their own saved seeds?
17. Would women be a market for the seed of improved varieties? Why? Why not?
18. What are your avenues for communicating to farmers and women farmers?
19. Do you have marketing programs/strategies to reach farmers that are not through the stockists/agro-vet shops?
20. What informed the starting of such models? Are they successful?
21. Is there any model that is designed to reach out to women as a market segment? If yes, how does it work? What has been its impact? If not, why?
22. Have there been massive disruptions in seed access in this community? If yes, describe the cause, impact and how the community got around this.

23. In case of political instability, how is seed recovery organized in the community?
24. Any other remarks?

4. Community representatives (lead farmers, farmer organizations, chiefs, District Local Government, etc.)

1. Could you describe how members of your community access sorghum/ groundnut/ millets/ chickpea seed, the leading suppliers, and the overall process? Specify the crop type, depending on the crop the community grows.
2. What are the most important varieties of crop **x** that the community grows?
3. Why are these varieties important?
4. Are there varieties of this crop that you used to grow but don't grow anymore? [Yes] [No]. If no, skip to question 5.
    a. If yes, please list them
    b. Why don't you grow them anymore?
5. Do you get all the varieties you need to grow this crop from the formal seed systems (shops)?
    a. If not, which varieties do you like that are not in the formal seed systems?
    b. Where do you get these other varieties from?
6. If a farmer in your community is growing 10 kg of seed, how much of this seed is your own saved seed? How much is from other sources? What would those sources be?
7. How do you obtain information from seed distributors/promoters?
    a. How does the seed information reach you?
    b. Is the seed information you receive helpful in guiding decision-making or prioritization at the farm level? At the community level?
    c. Are there members of the community that don't access this kind of seed inform ation? [Yes] [No]. If no, skip to question 8.
    d. If yes, where do they get information on new seeds or new varieties from?
8. What do you think of your own saved seeds used by farmers as a seed source for crop **x**?
9. How are seeds saved in the community?
    a. Who saves the seed?
    b. What equipment do they use for saving the seeds?
    c. What methods do they use for saving the seeds?
    d. Is there any household that doesn't use its own saved seeds? [Yes] [No]
10. What is the role of women in the management of their own saved seeds? What role do men play in their own saved seeds?
11. What varieties of their own saved seed do the farmers maintain? Why?
12. Would women be a market for seed of improved varieties? Why/why not?

5. Actors involved in specific seed systems interventions/projects (project managers, relief program managers, seed companies, researchers, government officials and farmer organizations)

1. Describe the seed systems initiative/intervention in a few sentences.
2. List the main issues that led to the idea of implementing the initiative/intervention.
3. Who along the commodity value chain were the main targets of the initiative/intervention?
4. Describe the different stakeholders involved and their respective roles.
5. Which were the crops targeted?
6. What varieties were involved/targeted per crop and why?
7. Describe in a few sentences the way the initiative/intervention was implemented.
8. List the key activities the initiative/intervention focused on.

9. How would you describe the success of the initiative/intervention?
10. List the key factors that make the initiative/intervention successful, on a 7-point scale.
11. Was the seed systems initiative more successful for some crops than for others? [Yes] [No]. If no, move to question 12.
12. How many primary actors were reached? What is the proportion of last-mile farmers?
13. What specific steps were taken to reach last mile smallholders with seed of improved varieties?
14. Describe in what way the seed systems initiative integrated the formal and the informal sectors?
15. List the main constraints/challenges that hindered the progress/delivery of the initiative/intervention.
16. How did you deal with the different challenges?
17. What are the critical areas to consider for future initiatives to move GLDC seed systems to the next level?
18. Describe the characteristics/components of ideal and functional seed systems for GLDC crops.

6. Government officials, seed certification and quality assurance body on opportunities for regional integration

1. Describe the national sorghum/groundnut/millets/chickpea seed system.
2. Who are the leading players you collaborate with?
3. What role do you play in the seed system?
4. Describe any unique opportunities that can be targeted to enhance the national seed systems for GLDC crops.
5. Describe the regional (e.g., EAC, COMESA) sorghum/groundnut/millets/chickpea seed system.
6. Describe existing regional initiatives that facilitate seed business and critical areas for interventions.
7. Highlight key gaps between national and regional (e.g., EAC, COMESA) seed policies and areas for harmonization.

7. Processors, traders and exporters

1. What specific GLDC crops (sorghum/groundnut/millets/chickpea) do you trade/process?
2. List the specific market traits you look for by GLDC crop.
3. Which specific traits do you miss? Specify by crop.
4. Who are your suppliers?
5. Do you have a formal contract or specific arrangements with your suppliers? If yes, specify.
6. What are the significant challenges you face in your business to obtain desired products?
7. How do you cope with the challenges?
8. Do you pay a premium price for quality or desired specific traits? If yes, elaborate with specific examples.
9. What is your purchasing capacity per year (in metric tons)? Specify by crop.

ANNEXURE 3. Cost-benefit analysis of seed production of GLDC crops in Uganda.

Table 1. The production budget for seed multiplication - Christian Union Farmers' Cooperative Society (soybean).

Items	Quantity	Rate (UGX)	Total amount (UGX)
Seed (kg)	25	7,000	175,000
Rhizobia	1	10,000	10,000
Triple Superphosphate (kg)	10	3,000	30,000
Rope (roll)	1	18,000	18,000
First land opening	1	90,000	90,000
Second land opening	1	90,000	90,000
Planting	1	80,000	80,000
Bird scanning	1	30,000	30,000
First weeding	1	60,000	60,000
Second weeding	1	60,000	60,000
Rouging	1	5,000	5,000
Spraying pump lease	3	2,000	6,000
Chemical	1	15,000	15,000
Labour/spraying	1	15,000	15,000
Harvesting	1	40,000	40,000
Transport home	1	20,000	20,000
Threshing/cleaning	1	40,000	40,000
Gunny bag purchase	8	1,300	10,400
Sorting/bagging	8	5,000	40,000
Labour/packing	8	10,000	80,000
Rope (roll)	1	2,500	2,500
The total amount required per acre			916,900
Production per acre (kg)	1	800	800
Price per kilogram (UGK)	1	1800	1800
Total possible amount at harvest per acre			1,440,000
Profit per acre (UGK)	1	523,100	

Source: Alito Joint Christian Union Farmers' Cooperative Society, September 2018

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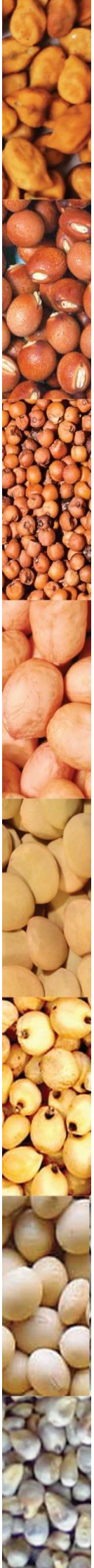

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The CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) brings together research on seven legumes (chickpea, cowpea, pigeonpea, groundnut, lentil, soybean and common bean) and three cereals (pearl millet, finger millet and sorghum) to deliver improved livelihoods and nutrition by prioritizing demand driven innovations to increase production and market opportunities along value chains.
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