



FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative



Review of Existing Last Mile Seed Delivery Models and Approaches



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Cover photo: An agro-dealer in his shop in the Beira corridor in Mozambique (IFDC, 2015)

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Feed the Future Consortium Partners in the Feed the Future Global Supporting Seed Systems for Development activity:



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Abbreviations and Acronyms

ACTESA	Alliance for Commodity Trade in Eastern and Southern Africa
AGRA	Alliance for Green Revolution Africa
ADAPT	Agro-Dealers Project in Zambia
ASI	Access to Seeds Index
BMGF	Bill and Melinda Gates Foundation
CBSP	Community-based Seed Producers
CIAT	International Center for Tropical Agriculture
CIP	International Potato Institute
COMESA	Common Market for Eastern and Southern Africa
D4Ag	Digitization for Agriculture
DFS	Digital Financial Services
EGS	Early Generation Seed
FAO	Food and Agriculture Organization of the United Nations
FIPS	Farm Inputs Promotions Africa in Tanzania
FTF INOVA	Feed the Future Mozambique Innovations
GDP	Gross Domestic Product
IARI	International Agricultural Research Institute
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
ICT	Information and Communication Technology
IFDC	International Fertilizer Development Center
ILRI	International Livestock Research Institute
ISSD	Integrated Seed Sector Development
KEPHIS	Kenya Plant Health Inspectorate Service
MEDA	Mennonite Economic Development Associates
NARI	National Agricultural Research Institute
NGO	Non-Governmental Organization
OAF	One Acre Fund
PABRA	Pan-African Bean Research Alliance
PPP	Public-Private Partnerships
QDS	Quality Declared Seed
S34D	Feed the Future Global Supporting Seed Systems for Development activity
SEEDS	Mozambique Smallholder Effective Extension Drive Success project
SME	Small and Medium-sized Enterprises
SSA	Sub-Saharan Africa
SSTP	Scaling Seeds for Technology Partnership
TL	Tropical Legumes
TASAI	The African Seed Access Index
USAID	United States Agency for International Development
VBA	Village Based Advisor
YIFSWA	Yam Improvement for Incomes and Food Security in West Africa

Executive Summary

This literature review on existing reports is focused on seed delivery models for non-maize crops that are important to rural small-scale farmers in Sub-Saharan Africa (SSA). The range of crops covered include grain legumes, roots and tuber crops, other non-maize cereals, and fodder crops. The review begins with an assessment of rural small-scale farmers' needs to determine how various seed delivery systems are modelled to serve these needs at the "last mile." The review continues with a summary of the seed value chain that aids in identifying actors along the chain and the roles that they play in seed systems from a market systems perspective.

The review identifies the various seed systems as articulated in available literature as the formal,¹ informal,² and quality declared systems and then delves into how the different delivery models are organized around these seed systems. The relevant models that have been identified for this particular subject have been categorized into ten models that are described on page 8.

Models specific to vegetatively propagated crops and fodder/forage delivery models have also been described separately so as to not diminish the special challenges faced in these categories. Furthermore, the literature makes note of the importance of gender in seed delivery in SSA.

In addition to the models, other themes emerge that support seed delivery at the last mile,³ which are borne out of the need for value chain actors to innovate for better service delivery and reach rural small-scale farmers. These include bundling and 'piggybacking' strategies of farmer essential products and services within the models, mobile phone advancements in certified seed verification, crop insurance, ICT support for seed systems, digital finance for agricultural inputs, digitization of agriculture and finally, evolving information systems in the form of dashboards that captures the vibrancy and competitiveness of the formal seed sector in African countries (e.g. Access to Seed Index, The African Seed Access Index, etc.). These provide summaries of how all these models are able to achieve their intended purpose: delivering high-quality seeds to rural small-scale farmers.

The amount of literature available on seed systems in SSA is enormous and this review is by no means exhaustive. It is important to note that no one model can be considered a panacea to solving challenges faced by farmers in accessing quality seed; however, this review forms a solid foundation in understanding what investments and efforts have been ploughed into seed systems by all actors, starting with the farmers, governments, non-governmental organizations (NGOs), local and multi-national seed companies, agri-businesses, financial institutions, and the many other seed value chain actors. In addition, the review addresses which areas benefit from innovation and how best other partners can approach future seed development systems projects in the region.

¹ The system which breeds and produces seed of varieties with traceable genetic parentage, and seed which has been produced to meet legally mandated standards and is labelled as such.

² This includes forms of sharing and distributing seed that does not follow legally binding standards and includes farmer-selected and saved seed and potential seed that is procured in grain markets. Seed often moves from the formal system to the informal system as it is recycled. The informal system incorporates farmer-saved seed, for their own use or to be exchanged with other farmers on a barter or cash basis. These seeds can be local landraces, or they can be modern varieties that are open-pollinated, or even some variant of a modern variety. The informal system also incorporates community-based seed multiplication and distribution, e.g., by community groups, farmer associations, and/or NGOs. Multiplication can include both local varieties and modern OPVs.

³ The last mile is the final leg in point of service delivery or retail sale. In international development terms, reaching the last mile (usually rural and often isolated communities) involves reaching villages without paved roads, with little access to communication and poor infrastructure.

Introduction

Many reports from research work carried out in the region have long recognized that improved food production depends critically upon crop specific seed systems that meet the seed needs of a range of farmers, particularly smallholder farmers. An ideal seed system should be able to provide a wide range of farmers access to high-quality and affordable seed, within a reachable distance, with the necessary technical expertise to be able to manage its care through planting, germination, maturity, harvesting, and post-harvest management. Seed systems in most SSA countries focus on a narrow band of crops, particularly maize. Less attention is paid to strategies which are appropriate to tuber crops, legumes, fodder, and horticultural crops. In most countries, government policies relating to the regulation of seed production delayed the emergence of private initiatives in seed production and distribution. Further, the public sector or parastatal agencies control the multiplication and marketing of many newly released varieties of seed. The central issue for many countries in the region is the adoption of appropriate strategies for increasing the availability and use of high-quality planting material by farmers. An effective seed system—comprising breeding, marketing, and the use of seed by farmers for growing crops—must have a strategy for each category of farmer, e.g., small, medium and large farmers. While some farmers can afford to buy hybrid seeds, others would be satisfied with high-quality seed of modern, open-pollinated varieties which they could buy from a variety of sources including neighboring farmers.

The broad rationale for focusing on seed sector interventions is that seed is a vehicle for delivering a range of advances, all of which can benefit smallholders. Seed can be the conduit for moving new varieties, giving farmers access to more productive, yield-enhancing traits. Additionally, in response to climate change, stress-tolerant varieties or clusters of diverse varieties are promoted as ‘good practice’ to enhance system resilience. Multiple options can allow farmers to shift crop or variety portfolios in response to changing conditions (McGuire and Sperling, 2013). Hence, seed is a vehicle linked to promoting productivity, nutrition, and resilience. It is the one entry point that can potentially move forward multiple goals. Varied and often opposing philosophies shape seed sector development and much depends on what actors see as the starting point for system entry. Various organizations focus their resources in private sector seed business development, that is, in the promotion of private commercial seed and formal sector input companies. In contrast, select non-governmental organizations (NGOs) and donors have signaled the need to support more locally driven initiatives and particularly those that organize around the informal, farmer-based, local, or traditional seed systems.

This review examines the available reports, literature, and documented experience on ‘non-maize’ seed systems in SSA, both in the formal and informal systems, and how inputs and other supporting functions are accessed by small-scale farmers, particularly those at the last mile. It also examines the various innovative technological advancements targeting this group in the dissemination of relevant farmer focused information, access to affordable inputs, finance, extension services and initiatives that link farmers to markets as a factor in adoption of new or improved varieties of quality seed.

Methodology

In order to holistically understand seed delivery models, the literature review initially looked at the seed value chain to be able to capture the different players that are involved in the systems and processes involved in delivering seed to farmers. The amount of literature available on seed systems

and the number of actors is vast; however, most of it focuses on the well-developed maize value chain. This review focuses more on recent developments in the non-maize seed systems, including publications and advancements in technology that aid in seed delivery. Visits and discussions with various stakeholders identified in the seed value chain yielded further information that significantly aided in the identification and description of how assorted seed delivery systems are modelled around the different categories of crops in question and the various actors involved.

In this literature review, with regards to non-maize crops of significance (i.e., legumes, roots, tubers, and fodder crops) that are the focus of the Feed the Future Global Supporting Seed Systems for Development activity (S34D), the identified models have been classified as follows:

1. Commodity traders
2. Community-based seed producers
3. Government/Public institutions-based model
4. Relief-based models (Seed aid)
5. Private sector agro-dealer model
6. Village-based advisor model
7. Access to finance driven models
8. Aggregator-based models
9. Models specific to vegetatively propagated crops
10. Fodder/forage delivery models

In addition to producing these models, there exists a vast collection of information on various themes that are common in these models that in one way or another support seed delivery to the last mile. The following common themes identified (not exhaustively) from the literature and stakeholder interviews have been summarized:

- Bundling and ‘piggybacking’ strategies within seed delivery models;
- Mobile phone certified seed verification systems;
- Crop insurance and seed systems;
- ICT support for seed delivery systems;
- Incorporating Digital Financial Services in agriculture input supplies;
- Digitization for Agriculture (D4Ag); and;
- Seed dashboard on enabling environments.

What Do Farmers Need?

Putting the farmer first and fully understanding their consumer needs is central to ensure the correct seed is getting to the relevant markets, which will in turn foster increased production and sustainability. To identify how seed system models operate, it is imperative to identify the needs of small-scale farmers and how the seed systems are organized in the various models to serve those needs. What are the gaps identified and how best are they being addressed through innovative ways that add value to the seed system while remaining sustainable in the long run?

There are several considerations that influence farmers' choice of crops:

- Household food security is vital to farmers as it ensures their livelihood. The combination of crops chosen must ensure food security throughout the seasons.
- Income generation—agricultural products are farmers' main source of income. Selecting crops or varieties without a ready off-taker or market can doom the yearly production.
- Land quality and quantity—when land is scarce, farmers may choose to plant the crop that is most important for their food security (often maize) or high-value crops (like vegetables). Most farmers in SSA cultivate roughly 1-2 acres.
- The need for appropriate inputs—farmers must allocate limited resources among agricultural inputs (fertilizers, seed, pesticides, tools) and other household expenses.
- Consumer preferences and intended use of produce—farmers will select those that meet their households' (for self-consumption, nutrition) and community's or identified market needs (for sales) and preferences in terms of variety, taste, color, size, or cooking characteristics.
- In addition, if the crop is intended for other uses, such as animal feed, e.g., fodder, there are specific varieties that are best suited for this purpose, which differ from those for human consumption.
- Previous farming experience and education. Trained farmers are usually more receptive to changes in production systems.
- Availability of labor—either their own, or household's ability to pay for labor and train laborers as required.

The choice of a wrong or unsuitable crop or variety can highly impact household food security, incomes, and the future adoption of new technologies.

The Seed Value Chain

The seed value chain covers the process of activities from the use of plant genetic resources to the marketing and distribution of seed varieties and qualities to farmers. Seed value chain analysis identifies the operators and service providers and their activities in the seed chain. A seed value chain can be as simple and short as farmer to farmer that forms a complete value chain or the process can be more complex to include plant genetic resources management, variety development, early generation seed (EGS) production, seed multiplication, and seed marketing and dissemination. Even though many variations in composition and structure of value chains exist among dissimilar seed systems, the chain of operational activities is the same and within a seed system even independent from the crop reproduction system. The operational activities being referenced include; plant genetic resources management, variety development, EGS production, seed multiplication, seed marketing and dissemination (ISSD; Issue 3). The operational activities may be in the hands of one stakeholder, e.g., a farmer handling his own seed requirements on farm, involve global seed companies like Monsanto or Syngenta, or implemented by separate organizations that can encompass public genetic resources and breeding programs, community-based seed production schemes, and commercial agro-dealers. The analysis of linkages between value chain operators allows for a better understanding of the functioning of the seed chain. For each component in the chain, different services are provided by a variety of stakeholders. One stakeholder may provide different services to different components in the seed value chain. For example, in the community-based seed system, the extension service may support farmers in the management of their genetic resources but may also support them in the marketing of seed to neighboring communities. The identification and analysis of services provided to the different operators allow for a better understanding of the performance of the seed chain (Bélanger et al., 2013).

The Seed Market System Actors

To identify the various models that are in existence in the region, it is imperative to initially engage in identification of the assorted value chain actors and their role in the seed market using a market systems approach. The market systems consist of three key components:

- The core: this looks at demand and supply actors.
- The supporting functions: those who provide services to the core actors.
- The rules: terms under which all the players operate.

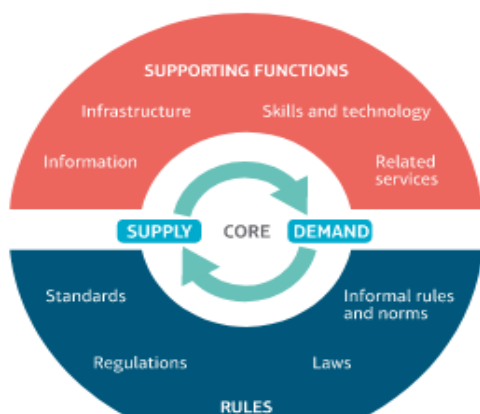


Figure 1. Seed Market Systems Actors.

The Market Systems Structure Summary

A. The Core (Demand and Supply)

Supply

1. Suppliers of planting material (both in formal and informal markets)
 - a. National Agricultural Research Institutions (NARIs), International Agricultural Research Institutions (IARI)
 - b. Farmers, Local Markets
2. Multipliers of planting material
 - a. Government owned seed companies
 - b. Commercial sector seed companies
 - c. Quality Declared Seed (QDS) providers
 - d. Farmers
3. Distributors and retailers of planting material
 - a. Agro-dealers
 - b. Government institutions
 - c. NGOs and Relief-based organizations
 - d. Farmers
 - e. Farmer cooperatives

Demand

1. Demand for planting material (seeds)
 - a. Farmers (Source from both formal and informal markets)
2. Demand for farm produce
 - a. The markets

B. Supporting Functions

These ideally support participants in the formal and informal market systems

1. Finance providers
2. Training providers
3. Farming input providers
4. IT providers

C. Rules

1. Regulatory bodies
2. Informal rules governing relationships between value chain actors

From the outset, actors will have opportunities for playing multiple roles within the value chain to serve diverse farmer needs, thereby giving rise to the concept of bundling their products/ services. For others, the most ideal way to participate in the market system would be through forging desirable partnerships in order to deliver the needed services to the farmer or end market for produce.

Seed Market Systems Available in SSA

To strengthen seed systems, it is necessary to have a comprehensive understanding of how they are organized in relation to being able to serve farmers needs for access to seed. Farmers, particularly small-scale farmers, are involved in multiple kinds of seed systems, which help them produce and obtain the seed they require. These systems have been broadly divided into two types with the emergence of a third intermediate system that seeks to bridge the divide:

- Formal seed system
- Informal seed system
- Quality declared seed system

Formal Seed System

The formal seed system is the easiest to characterize, as it is a deliberately constructed system, which involves a chain of activities leading to clear products, i.e., certified seed of verified varieties (Louwaars, 1994). Guiding principles in the formal system are to maintain varietal identity and purity and to produce seed of optimal physical, physiological, and sanitary quality. Certified seed marketing and distribution take place through a number of officially recognized seed outlets, usually for financial gain (Louwaars, 1994). The central premise of the formal system is that there is a clear distinction between ‘seed’ and ‘grain.’ Loch and Boyce (2003) define the formal seed system as a framework of institutions linked together through a combination of components and processes of production, multiplication, storage, and marketing of improved varieties of specific quality, along with the interactions and support to make seed available to a particular end user.

The formal seed system has been criticized as it struggles to provide women with seeds that are important to them and meet their preferences. Instead, it tends to prioritize higher-value cash crops, an area that is traditionally dominated by men. It is recognized in a lot of literature that women often lack information and knowledge about seeds, and limitations to their mobility and social networks often shut them out of formal information channels, which include training opportunities and extension services. Access to training opportunities is often hindered by household norms and roles. These limitations restrict women’s abilities to use new seed technologies effectively and, when combined with barriers to have and control cash, women must often settle for lower quality seed as it is all they can afford (Alessandra Galiè, 2013).

Informal Seed System

The informal seed system is sometimes referred to as the traditional or farmer-led seed system. The informal seed system activities tend to be integrated and locally organized. The local system embraces most of the other ways in which farmers themselves produce, disseminate, and access seed. It could be directly from their own harvest, through exchange and barter among friends, neighbors, and relatives, or through local grain markets. Encompassing a wider range of seed system variations, what characterizes the local system most is its flexibility. Varieties may be landraces or mixed races and may be heterogeneous (modified through breeding and use). In addition, the seed is of variable purity, physical, and physiological quality (Almekinders & Louwaars, 1999).

The same general steps or processes take place in the informal system as in the formal sector (variety choice, variety testing, introduction, seed multiplication, selection, dissemination, and storage) but

they take place as integral parts of farmers' production systems rather than as discrete activities. The formal and informal seed systems are not always as distinct or separated as the two labels may imply. While some farmers treat “seed” specially, there is not always necessarily a distinction between ‘seed’ and ‘grain.’ The steps do not flow in a sequence, and they are not monitored or controlled by government policies and regulations. Rather, they are guided by local technical knowledge and standards and by local social structures and norms (McGuire, 2001).

As described by Khan et al. (2016), women play a central role in the informal seed systems. Women act as household managers and custodians of seed and their decisions on acquisition including use of seed are important. However, there is little systematic evidence on gendered decision-making regarding seed use within households. Decision-making varies across crops and varieties, often in relation to market orientation. Women in Tanzania and Ethiopia, for instance, have control over seed use for food crops but not for cash crops (Amri 2010). When women do not control the income from crop sales, this may affect their ability to purchase seed. Further, when different household members control the seed and the benefits from that seed, this misalignment can lead to inefficient decision-making (Mudege et al. 2018).

Quality Declared Seed (QDS) System

The emergence and push for an intermediate seed system attempts to reconcile the continuing need to improve seed supply to farmers with the desire to reflect and accommodate the diversity of farming systems in the region. QDS has been the best fit, particularly for crops where highly organized seed systems do not function well for various reasons. QDS seeks to meet the needs of farmers in a flexible way but without compromising basic standards of seed quality. With time, it may contribute to the wider need of diversifying the seed supply system so that farmers may have more seed options. Requirements of a full seed quality control mechanism can be burdensome on the government agencies and seed producers that have to implement it. With constraints in government budgets, the resources to run a full-fledged seed quality control scheme for all crops simply may not exist. Against this background, the purpose of QDS is to offer an alternative, which can be used for those crops, areas and farming systems in which highly developed seed quality control activities are difficult to implement or make relatively little impact. In particular, it may more easily accommodate varieties of crops, which, for different reasons, do not easily fit within a conventional seed quality control scheme (FAO, 2006).

Table 1. Identifying actors in the formal, informal and QDS seed systems

	Public sector	Private sector
Formal	Universities, seed parastatals NARIs, International Agricultural Research Institutes (IARIs), Regulatory bodies	SMEs, seed companies (Multinational, National, Local), regulatory bodies agro-input companies, agro-dealers, financial providers, credit and insurance providers, seed trade associations
Informal		Farmers, traders, processors, producer organizations, local credit providers, NGOs, community-based seed groups
Quality declared seed (QDS) system	NARIs, IARIs	Farmers, NGOs, producer organizations, community-based seed groups, traders

Seed Delivery Models (Focus on Non-Maize Seed Systems)

It is widely understood that smallholder farmers in developing countries source seed and other planting material from both formal and informal seed systems. It is estimated that farmers access up to 90% of their seed from the informal seed system, with 50% of that deriving from the local markets. In a seed system security assessment study (McGuire & Sperling, 2016) that examined some 10,000 seed transactions across five African countries, the investigators discovered that, contrary to conventional wisdom, it appears most smallholder farmers in Africa are not reliant on seeds saved from year to year. Instead, some 55% of seed they plant is purchased in cash mainly from local markets or from friends and fellow farmers. Local markets were found to be particularly important for legumes, accounting for 64% of seeds for crops like beans and cowpea. In contrast, a small proportion of transactions with a low of 2.4% and a high of 17.4% involved the use of certified seed produced by private sector companies and sold through farm supply stores or agro-dealers. This indicates that smallholder farmers are already making important investments in purchasing improved seed. This latent yet growing demand can create incentives for the private sector and through local agribusinesses to invest in developing, producing, and distributing improved seed. An important finding from the McGuire and Sperling (2016) report indicates a more pronounced trend towards local markets for female-headed households. Through gender disaggregation, it was shown that female-headed households steer their seed purchases towards the markets where they could also buy other household supplies. The data also goes on to suggest that those local markets may be particularly important for relatively vulnerable farmers (poorer or female-headed households).

According to the literature, most of the private seed industry has not found the certified legume seed business lucrative; once farmers get new germplasm they tend to re-sow from their own harvests for many seasons, instead of purchasing seed anew from certified sources (David & Sperling, 1999). Cost-benefit analyses indicate that certified (formal sector) bean seed is two to four times the cost of seed found in local markets (Sperling, 1992) and that farmers do not see these increased costs translating into comparable yield increases on the farm. Incentives to buy certified bean seed are few, unless the producer is aiming for a specific market or, in other words, niche market needs that have strong output market linkages. For vegetatively propagated crops, few commercial options have been identified beyond some initial success with Irish potato (Sperling et al., 2014). They also appear to take a similar route as that of new bean varieties developed by NARI, although private sector entities have also made a breakthrough in this front for certified seed with increasing village-based seed producers filling the gap. Lessons from the Mozambique Smallholder Effective Extension Drive Success (SEEDS) project indicate that, although maize seed is still the most popular certified seed required in the last mile rural setup, farmers were still keen to request certified legume seed, indicating that they are conscious that certified seed is as important for their own food security and as an input for cash crops (NCBA CLUSA, 2017).

Discussions with the private sector seed companies in Kenya contradict this as they all indicate that they are unable to satisfy demand for certified bean seed, which points to a need to further investigate the current status of farmer demand and change in perceptions or buyer behavior.

Commodity Traders

Commodity traders have long been recognized as an important source of seed for many farming communities in Africa in the informal seed system. Sperling et al. (2013) named seven attributes that typify informal markets:

- Already work at scale
- Market-driven
- Move a wide range of crops
- Work everywhere
- Rarely break down entirely
- Distinguish between grain and seed
- Highly dynamic

According to Sperling et al. (2013), as a source of seed, local markets were found to be particularly important for legumes, accounting for 64% of seeds for crops like beans and cowpeas. This proportion dwarfs all other delivery models, especially for legumes. Local traders bring in grain, which is subsequently sorted and used by farmers for seed. For a long time, it was believed that farmers would buy seed at the local market only if they had failed to harvest their own seed, or lost their stocks, or were unable to obtain seed from family, friends, and neighbors. However, practical seed system analysis has sharpened the understanding of the role of the local seed/grain market. Thinking has evolved along these lines (Sperling et al., 2006):

- Initial belief that sourcing seed in local markets was a symptom of the failure of the farmers' own ability to produce seed from harvest.
- Acceptance that market seed is an important complement to farmers' own production and also to commercial, formal sector seed.
- Realization that the market seed channels are relatively efficient and that farmers rely on local market seed for sound reasons of convenience, availability of varieties, price, and adequate quality.

Across SSA, market-related findings demonstrate that market-sourced seed, particularly for self-pollinated crops, serves as the core for seed security, especially for women as described by McGuire and Sperling (2016) and more vulnerable farm families. Local grain markets, from which farmers obtain seed, prove durable in stress periods (during drought, flood and even instances of civil strife). The genetic quality of seed sourced in markets is most often acceptable to farmers, as it is generally grown in nearby agro-ecological contexts that match their own needs. The physiological and phytosanitary quality of seed purchased in local markets can be partially regulated (by sorting and acquisition from known contacts) and is often objectively good. Local seed/grain markets are often important channels for moving new varieties. In fact, for some crops, local markets move new varieties more effectively than formal diffusion channels. Markets prove to be a useful source for re-accessing seed of desired types and quantities that had been lost or temporarily abandoned in times of stress (Sperling et al., 2004).

The local commodity traders can provide a desirable range of crops and varieties, on time, and at acceptable quality and price. As it stands, seed/grain markets are the major source of seed for many farmers in many different cropping systems in Africa.

Community-Based Seed Producers

Community seed production has been recognized to occupy a middle ground between the informal and the formal seed production systems. Community seed production system is a more organized system of production that cannot be considered to meet the protocols of the formal system; however, it adopts some of the practices that make it a more quality-based system than the informal system. Most would be classified as QDS producers. After commodity traders, community-based seed production (CBSP) is identified as the second most common seed delivery model throughout SSA. CBSP is defined as seed production that is neither formal commercial seed production nor farmer managed seed production. Almekinders and Louwaars (1999) describe community-based seed production as serving two main objectives:

- Increase farmer access to varieties (often but not always new); and
- Increase quality of local and improved varieties through variety maintenance, selection, handling, and storage.

One main feature of CBSP is that it frequently involves a subsidy, which is channeled through various NGOs working in the regions. It is predicated on the adage that seed is a public good with private benefits; however, this does not negate the role of incentives schemes and the profit motive to raise efficiency for different actors in the system (FAO and ICRISAT, 2015). The approach of this model is based on working with farmer groups usually within a value chain project. Many CBSP production schemes in projects are initiated because of a general concern of lack of seed in the region that can be occasioned by environmental factors (e.g., drought) or civil disturbances and in instances where formal seed markets have failed to penetrate the market due to affordability or lack of investment in the desired seed types—a trend witnessed in legumes and vegetatively propagated crops. Bänziger et al. (2004), in their analysis of designing community-based seed production schemes, identify four models of community-based seed production systems which are summarized in the table below.

Table 2. Four model schemes for community-based seed production.

	Models 1-3. A farmer group, a school, or an individual farmer catering to the seed demands of neighboring farmers			Model 4. A group of farmers or a farmer with a significant area producing seed for a private seed company
Output	Model 1. Certified seed	Model 2. Quality-declared or standard seed	Model 3. Informal seed: the farmer uses proper seed production practices, but there is no external control or monitoring	Certified seed produced on contract
Source of seed	Foundation seed from a seed company or a public sector breeding program	Certified seed from a seed company or a public sector breeding program	Certified seed from a seed company or seed of any other valued variety (e.g. landrace)	Foundation seed from the contracting seed company
Transport of source seed to seed producer	Seed producer or NGO		Seed producer	Seed company
Sourcing of other inputs (fertilizer, land prep etc.)	Seed producer or NGO		Seed producer	Seed producer
Training of seed producers	NGO		NGO	Seed company
Quality control	Seed services paid by NGO or seed producer		Not done	Seed company or seed services paid by seed producer
Cleaning, storing, packaging, and marketing	Seed producer or NGO		Seed producer	Seed company
Price of the seed is kept low because of ...	1. A considerable proportion of seed production costs is covered by NGO/public funds. 2. Costs associated with marketing are minimized.		Costs associated with marketing are minimized.	1. Each seed producer (group) is producing a large amount of seed (large area, good crop management). 2. Seed producers are clustered to minimize transport costs.
Sustainability issues	Who is taking over the role (financial support, transport, organization) of the NGO in the long-term?		What is the incentive for the farmer to maintain quality standards that involve costs (e.g. isolation, roguing)?	A mutually beneficial agreement between seed company and seed producer
Other issues	1. Is a private seed company prepared to sell foundation seed? 2. Seed company and public breeding programs need to be advised in time (one year before) about the need for foundation seed. 3. Foundation seed is more expensive than certified seed.	Quality declared or standard seed typically commands a lower price than certified seed	Informally produced seed commands a lower price than quality-declared, standard or certified seed, often little more than grain. A farmer's reputation is the main reason for another farmer paying a higher price for seed than grain.	

Source: Successful community-based seed production strategies; M. Bänziger, P.S. Setimela, and M. Mwala

Most appropriate in the description of these models are those that fall in Models 1 to 3, which will fit the profile of community-based seed production by small-scale farmers in SSA, which involves farmer groups or individual local seed businesses that cater to the seed demands of neighboring farmers. Most of the subsidy provided is usually directed at training farmers on seed production and business skills that aim to drive sustainability of the resultant CBSP system once the project funding ends. Training farmers in CBSP may have an impact on farmers' access to seed, provided seed production costs can be kept lower than those of the existing seed sector price and the quality of the

seed produced meets the farmers' expectations. A good example is Farm Africa⁴, which is helping 5,000 resource-poor subsistence farmers in Kitui County in Kenya by supporting the community-based production of drought tolerant crop seeds. The project enables farmers to improve their incomes sustainably by growing drought-tolerant, commercially attractive sorghum and green gram crops. The farmers are encouraged to work collectively in producer groups, which helps them increase production volumes and profit through joint marketing. Agronomy training is provided to improve crop production and postharvest handling; business training is given to enable farmers to access commercial markets at competitive prices.

The importance of women as active participants as CBSPs cannot be understated. There is evidence from available literature to show that that women's roles as seed producers can be empowering and they are increasingly taking on stronger and leading roles in community seed systems and small seed enterprises even though they must overcome financial and other barriers (Chowdhury, 2014). Local institutions such as seed banks, cooperatives, and small seed enterprises are increasingly important in bridging the gap of access to seed by women through decentralizing seed multiplication. These institutions not only improve seed supply for their communities, but also generate local employment and income, creating opportunities for development of gender-responsive seed systems. Involving women in seed production and management gives access to varieties that better meet their needs, generates extra income, and contribute to women's empowerment (Mudege et al. 2020).

Government/Public Institution Based Models

The predominant model for diffusing non-maize crops in most African countries as identified by Rubyogo et al. (2010) is based on formal institutions, i.e., government or public institutions. NARIs stand at the apex of a set of linear and vertical relationships. NARIs work to develop successful varieties and, after variety release, produce an initial supply of breeder and foundation seed. The NARIs of East, Central, and Southern Africa have devoted considerable efforts to breeding and selecting bean germplasm, focusing on key regional biotic and abiotic traits and screening for particular 'market classes' (i.e., clusters of bean types sought in regional and export markets (PABRA, 2002).

With the NARI-produced breeder and foundation seed, government seed parastatals and a few commercial seed companies then take over subsequent production of certified seed to sell directly to customers in private, public and NGO sectors. These groups then redistribute seed through their various channels. Once the new varieties reach farmers, they are then diffused among communities through gift, exchange, or sale at local markets.

As described above, government agencies dealing in seed delivery are closely linked to the NARI as a source of certified seed especially for grain legumes. Government ministries linked to agriculture are normally given the responsibility for seed distribution programs in those countries in which the state is directly involved in the supply of agricultural inputs and where there are no other reliable and effective distribution channels. The mandate of government departments is usually to serve all categories of seed users. Therefore, they are obliged to supply a diverse range, including seeds of low value grains, to areas of both high and low productivity. Government departments tend to be heavily bureaucratic, with time consuming communications processes that are not responsive to the

⁴ FarmAfrica.org

needs of the market. It has also been argued that they slow development of the private sector in areas where they are heavily involved; however, they do play an important role in the dissemination of new varieties and in times of emergency. The usual mode of distribution will be through seed voucher systems, trade fairs or given for free.

A voucher scheme is a delivery mechanism that provides farmers with a voucher that they can exchange for inputs at existing shops (i.e., retailers/suppliers). The shops must be registered with the scheme for the duration of the scheme, usually several weeks or several months.

An input trade fair is a specific type of voucher scheme in which a temporary market is organized to provide a targeted population with access to agricultural inputs through the exchange of vouchers. An input trade fair typically lasts a single day.

The main objective of input trade fairs and voucher schemes is to provide access to agricultural inputs to farmers who are vulnerable, food- or seed-insecure or live in communities affected by a crisis. They can be set up as:

- An emergency response to a disaster (e.g., drought, flood, earthquake, civil strife) – after a disaster farmers’ ability to purchase agricultural inputs can be so diminished that they cannot start agricultural production.
- A social protection mechanism – depending on rainfed agriculture to sustain their livelihoods, many farmers are vulnerable to extreme natural hazards and average seasonal cycles.

Input trade fairs and voucher schemes can be employed to address seasonal cash-flow bottlenecks and support communities whose livelihoods are threatened by hazards such as high prices, declining soil fertility and poor health. Input trade fairs and, specifically, seed fairs have also been set up as a mechanism to protect crop and varietal diversity. These fairs are organized with the explicit objective of facilitating exchange among farmers and consequently supporting seed diversity and seed system resilience (FAO, 2006a).

Even when there is no humanitarian crisis, seed fairs can achieve the following objectives:

- Facilitate information sharing among farmers regarding performance of different varieties.
- Provide farmers with access to a wider range of crops and varieties that better addresses their needs.
- Target special groups like women and other vulnerable members of a community.

State-Owned Corporations

An important component of the government model is the existence of state-owned corporations (e.g., Kenya seed). These public sector corporations have an independent management and financial structure, albeit underwritten by government. As such, they may have some financial autonomy but their operational strategies and approach to pricing are usually determined by official policy, rather than by market forces. Management is frequently expected to operate amid conflicting social and commercial objectives, while not losing money. Although profit may not be an actual aim, pricing to achieve full cost recovery should be. Their operations are linked to the farmers through private sector based agro-dealer networks that permeate the rural areas. The main challenge has been the distance that most farmers have to cover to access seed and the availability of a wider range of options for farmers in addition to maize seed.

NGO and Relief-Based Models (Seed Aid)

Seed aid delivery has been an innovative and effective step forward in helping farmers recover, re-establish, and sustain their farming systems. The main reasons why individual NGOs are involved in seed activities can be grouped into three main categories:

- Relief: to provide relief or rehabilitation after emergencies.
- Development: to provide access to seed along with other agricultural inputs, often due to the perceived failure of the formal sector to reach communities or groups within them.
- Advocacy: to support local communities' efforts to maintain seed themselves and, in particular, to strengthen farmers' rights to plant genetic resources.

NGOs' seed activities can substitute for, complement, or create an alternative to existing formal sector seed activities (Cromwell and Wiggins 1993).

Various NGOs and relief agencies operating within the region engage in seed aid as a routine complement to food aid assistance. The rationale of providing seed aid centers on the notion that communities affected by emergency (e.g., drought, flood, short-term civil disruption) should have basic seed and tools as quickly as possible, so as to hasten the process of producing their own food and/or making money from crop sales.

The overall aim of seed relief activities is to:

- Contribute to food and livelihood security by ensuring that farmers, especially vulnerable farmers, have access to seed (planting material) of adequate quality;
- Contribute to long-term restoration, rehabilitation, or improvement of agricultural systems, and;
- Contribute to supporting food production, which should decrease dependence on seed relief and repeated food aid.

Seed is distributed using the voucher system, which can be either cash or seed-based or given free of charge based on the organization's assessment of the communities they work in or the prevailing relief program operations in place at that point in time. This is usually donor funded support in the seed delivery system and will normally cease after the project ends. The long-term effects of these are usually varied, with some farmers continuing to seek improved seeds through other means while, in other cases, they would resort to what they were using before the project.

Government and NGOs are identified as a primary source of new seed varieties in many communities with farmers accessing up to two-thirds of their new varieties by these sources (McGuire & Sperling, 2013).

Private Sector Agro-Dealer Model

Agro-dealers are recognized as forming an essential link in the formal seed system distribution network between seed companies (including other farming input suppliers) and the seed consumers (farmers). This model is driven by profit-seeking entrepreneurs who often run several business streams within their premises (hardware, agro-vet, etc.). Agro-dealers are an important part of the farm inputs value chain, playing a major role in ensuring that farmers have access to important agricultural inputs required to improve agricultural productivity on their farms (Poullisse, 2007). Agro-dealers are defined generally as small-scale independent stockists or inputs dealers who play an

important role in distributing farm inputs (Odame & Muange, 2012). The major roles played by the agro-dealer network in rural areas are providing access to farm inputs, financing through local credit arrangements with customers and, to varying degrees, some level of local extension service provision. Some are also able to provide technical education on inputs and new technologies through demonstration plots, field days and local shows.

The increased adoption of productivity-boosting inputs has been largely driven by private, local agribusinesses, including private, independent seed companies, fertilizer importers, and distributors. These businesses provide the critical link in the value chain that the ever-growing village-based agro-dealer network avails to these input providers, including certified seed, to the small-scale farmers. However, much remains to be done to broaden the inputs markets and the type of innovative solutions that rural agro-dealers are able to provide at the last mile. Major hurdles persist in developing a robust farmer focused agro-dealer network in much of SSA. Most of the rural landscape is underserved with respect to functional agro-dealers, i.e., one-stop shops where farmers can get the inputs and information that they require. This is primarily because they tend to concentrate in cities and other big towns that are far away from the farmers, therefore making inputs inaccessible to farmers. Apart from exceptions such as Kenya, farmers in most SSA countries are more than 20 km away from the closest input shop. Agro-dealers sometimes fail to stock the required types of inputs both in quantity, variety, and correct requirement for the agro-ecological zone as needed by farmers, especially at the start of planting season. Regarding seed availability, a study commissioned by Kenya Markets Trust and Agri Experience in Kenya found that 100% of agro-dealers interviewed stocked maize seed, while only 41% reported stocking bean seeds, 16% sorghum seed, 10% finger millet, and 4% green gram. This points to the dynamics of demand and supply of certified seed varieties, which is central to the agro-dealers choice of stocks (Baesian Consulting Group, 2016).

It has also been identified that many agro-dealers lack business management skills, knowledge of good agronomic practices, and financial planning to advise well on the use of inputs. In addition to this, working capital remains a key challenge for the agro-dealer network in SSA. Most of those in operation do not have enough funding to run and grow their business. The cost of seasonal credit from banks and financial institutions in Africa is high, at 20-30% interest rates per annum, which is neither attractive to most agro-dealers nor is it profitable for those who have accessed the credit. Even for those who want to borrow, the financial institutions are as reluctant to lend to agro-dealers as they are to farmers due to perceived and real risks. The credit arrangements are based solely on the relationship and trust between the agro-dealer and the specific customer; either from their neighbor, or from the same community or well-respected person in the community, like a teacher. The credit is not provided in terms of 'cash advances', but more as an arrangement—i.e., paid back upon harvest or sale of outputs.

Considering these challenges, over the past decade organizations such as IFDC, CNFA and AGRA have been involved extensively in various agro-dealer related development programs in the region. These organizations have made significant investments in growing the agro-dealer network in SSA. Most of the interventions involved facilitation of training and certification to enhance service orientation to small-scale farmers. They are also focused on providing linkages and improving business relations with town-based input suppliers. Agro-dealers have gained a new reputation as critical value chain actors much in demand by governments, donor partners, regulatory agencies, and farmer-based organizations. Over the years, these interventions shortened the distance farmers must travel to access inputs (in some countries to less than 2 km) and have increased farmer productivity.

This timely availability is often a key challenge, particularly for women whose mobility is restricted by gender norms in most of the rural areas. Due to constraints women face around mobility and access to affordable and safe transport options, the main determinant of where women buy their inputs is distance (Peterman et al., 2010). Agro-dealer strengthening has also involved institutional building activities, which consists of organizing the agro-dealers into professional business associations with the capacity to provide business services to their members. The introduction of value-adding activities such as capacity building, financial linkages, demand creation, among others, has rapidly increased the valuation of the associations by the members and boosted membership and financial capacity of the associations (AGRA, 2015). Key findings from Feed the Future Mozambique Innovations (FTF INOVA), which might also reflect the situation in other SSA countries, indicated that agro-dealer businesses and business networks in are male dominated but hiring more women assistants. The study showed that the industry recognized women as being trustworthy, hard-working, and good at dealing with clients. By investing in female agro-agents, input distributors and retailers could effectively target the last mile, particularly female farmers who face restrictions on their mobility and time. One of the key recommendations of the study was the opportunity for development of a “Female Agro-dealer model”. The business case for this was justified by the notion that more female village-based agro-dealers and agro-agents can improve the reliability and creditworthiness of the agents that input distributors work with, as well as improve their potential outreach by opening more opportunities to sell to women directly. It goes on to state that adopting gender-sensitive practices can help with hiring, retention, and promotion of female agro-dealers and agro-agents (FTF INOVA, 2018).

Seed Agents

In certain development projects, like the CARE Agro-Dealers Project (ADAPT) in Zambia, one of the models that has been adopted to increase availability of seed to rural based small-scale farmers has been through the use of seed agents in partnerships with existing agro-dealers or seed companies. These agents somewhat resemble Village-based Advisor (VBA) models and facilitate trade between farmers and associated agro-dealers and seed companies to form the critical last mile link. Experience with seed agents has been observed with maize and vegetable seeds and there is limited literature that indicates their participation with the other types of seeds that are the focus of this literature review.

Village-Based Advisors Models

Extension services in SSA remain weak or dysfunctional, characterized by poor staffing, insufficient funds for supporting public extension, limited involvement of rural farmers in extension processes, and lack of appropriate extension methods. Public extension systems have been criticized for taking a top-down approach and failing to adapt to meet the needs of smallholder farmers in an era of rapid marketization. Available evidence from the literature also shows that private extension systems have been just as ineffective as public extension institutions. This limits coverage of extension services, particularly across rural regions, and adapting technological packages to community-specific contexts. Moreover, extension service providers tend to focus on commercial and high-value crops, with less attention to traditional and other farmer-preferred food crops like legumes, roots and tubers which are all important food crops to SSA households and markets.

In an effort to overcome the barriers of availing sustainable and relevant extension service support to rural small-scale farmers, the use of village-based intermediaries to help disseminate information to farmers has taken center stage in many extension initiatives in developing countries (Lukuyu et al., 2012). The VBA is a novel approach that has the aim of reaching a large number of farmers in communities at low cost and is especially considered more effective when combined with group-based extension approaches that help reduce transaction costs. It is also considered more inclusive and offers a wide-reaching alternative in supporting agricultural innovation. VBAs are farmers who live in the village and are trained to provide assorted advice and services to farmers.

The core of the VBA model is predicated on finding locally trusted farmers and turning them into self-employed micro-businesses supplying agro-inputs and information services to neighboring farming families. It is anticipated that as VBAs provide information to farmers, they also promote agricultural inputs, which provides them with a means of economic diversification and thus contributes to making this approach sustainable. The VBA model focuses on building sustainable extension services and brokering linkages between input supply and demand.

Selection of VBAs is usually based on a set of criteria including residence in the community, ability to communicate well, ability to work voluntarily, facilitate access to inputs, demonstrate practices, and participate in scheduled trainings. In some instances, community members may participate in selecting the VBAs and focus on those members who command respect and trust within the community in addition to the set selection criteria. VBAs are not paid for their services but, when farmers buy small commercial packs from them, they receive the retailers' margin. (Priest, 2012). VBAs' ability to spread information and innovations may be due to their knowledge and location in the farming communities, making them ideal to communicate with fellow farmers.

A recent study (Kansiime et al., 2018) that looked at the VBA approach piloted by Farm Inputs Promotions Africa (FIPS)⁵ in Tanzania concludes that the VBA approach can help reach many farmers with new technologies within a short period of time. VBAs are able to provide adequate information to farmers and greatly influence farmers to adopt new technologies. They are also capable of giving similar information to farmers irrespective of extension support materials at their disposal—an indication of the learning they achieved. It also demonstrated that VBAs could deliver accurate information and hence facilitate effective uptake of technologies without distortions, a feat that is critical for technology and/or information transfer, especially in an environment with a paucity of agricultural information providers. The study also reveals that VBAs worked as volunteers and did not receive financial compensation from the project but received small financial incentives by direct sales of the products due to farmers' low input demand and low purchasing power, which is a threat to the sustainability of this approach. The model also identifies that VBAs had other non-cash-based motivations, such as respect from community members, gaining knowledge from training received, and networking with other VBAs.

However, regarding sustainability, several scholars have suggested the need for a more organized incentive structure for VBAs. Facilitating VBAs to start income-generating activities related to the technologies they are promoting may help enhance the economic benefits they receive for being farmer trainers (Lukuyu et al., 2012) One such suggested income generating activity is farmer seed entrepreneurship. This would achieve dual results—enhancing access to quality seed by farmers and

⁵ <http://fipsafrica.org>

developing cash incentives for VBAs to further engage as trainers. Other interventions, such as business training for VBAs, building formal linkages with input providers such as seed companies or agro-dealers and support for access to business credit can also help boost their income-generating activities at the same time addressing input accessibility issues (Kiptot & Franzel, 2015).

Access to Finance Driven Models

Smallholder farmers, representing an estimated 500 million families and over 2 billion people, constitute the largest global population segment of people living on less than \$2 dollars per day. Financial institutions do reach some of these low-income rural households, but at a high cost with short-term loan products that are not able to address the needs of their clients in a comprehensive manner. The “Inflection Point” report (Dalberg, 2016) reveals the huge gap that exists between the offer of credit, estimated at USD50 billion and the demand from smallholder farmers globally estimated at \$220 billion dollars, or about 4.5 times the existing offer. Women and men face similar risks and barriers to accessing financial services in the agricultural sector. However, only in the case of women they face the risks more acutely. This emanates from the invisible role of women in income generation in agricultural households, the limited ownership and control over assets, the low levels of training (compared to male farmers), and low levels of participation in producer groups. These are often presented as important impediments to women in accessing finance by various authors. The lack of access to finance, along with lack of training, becomes a limiting factor in women accessing better inputs and achieving higher yields. “Improving rural women’s access to financial services is a proven strategy for contributing to rural women’s social and economic empowerment, as well as improving overall the livelihoods of rural households and communities” (FAO, 2011). Having access to financial services allows rural women to procure the inputs, labor, and equipment they need for their agricultural or rural off-farm activities. The financial sector has historically shied away from the small-scale agricultural sector, which presents several highly constraining characteristics, which include:

- High operating costs for transacting loans and other financial services to less educated farmers.
- Low-income populations in remote, rural areas with weak infrastructure.
- Absence of collateral due mostly to land tenure restrictions.
- Concentration challenges arising as farmers in a given area generally borrow at the same time and often engage in the same types of activities.
- Systemic and correlated risks linked to agriculture such as production risks (i.e., pests and spoilage), price volatility, as well as environmental and weather shocks that can render a farmer’s income irregular and repayment to the lender uncertain.

Across SSA, agriculture is a vital sector that contributes 20-30% of Gross Domestic Product (GDP), employs 60-85% of the population, yet usually attracts less than 5% of domestic lending. Most smallholder farmers have difficulty obtaining appropriately structured financial services to meet their needs, which comprise a combination of short-term working capital, medium-term equipment financing, and longer-term capital investments, savings products, and risk management products.

Credit provision by banks in Africa is often overregulated and inflexible and does not take adequate consideration of the specificities of the agricultural sector, resulting in a mismatch between financial products and needs of agricultural enterprises (MFW4A, 2012).

Quantifying the need for agricultural financing assumes that farmers can convert financing into income increases (cash or in-kind) that justify the cost of such financing. The potential for such income increases among smallholders is well documented, though may require effective intervention. Successful cases of improving farmer income found that interventions built on productivity-enhancing technologies (quality fertilizers, better seeds, improved livestock, and micro-irrigation) yielded 80-140% income gains, whereas those focusing on value chain inefficiencies registered in the 20-60% range. These productivity-enhancing technologies typically require finance and are precisely the target of many agricultural financing solutions for smallholders. Matching loan repayment terms to agricultural cash flows is critical and results in higher repayment rates (Hystra, 2015).

Financial service providers are emerging as new entities with innovative products that are able to penetrate the seed and farm input markets by leveraging improving access to finance as a driver of quality inputs to farmers. From among the selected cases, the One Acre Fund (OAF) in East Africa suggests how this model may function. However, because it is registered as an NGO and uses donations to fund a significant portion of its total expenses, OAF does not have the same incentives and perspectives as companies engaged in input lending to smallholder farmers (e.g., Tulaa, Agri-wallet, and Apollo Agriculture).

Where lenders drive input supply, their objective is to expand and often diversify their loan portfolio. To do so, lenders offer loan products that match the timeframe and credit demands of the crop(s) on which the inputs will be applied. Other services (e.g., insurance) and complementary products may be bundled with the loan and sold as a package. Payment is typically structured so that all or most of it is due following the harvest. Lenders' approaches to risk reduction have been through the provision of seed and other inputs themselves instead of cash disbursements, or via selected locally based agents and agro-dealers with whom they have signed contracts. Through this approach, cash-strapped small-scale farmers are able to access high-quality inputs on credit and repay over a period of time with repayment installments that are commensurate with their income, something that the mainstream financial services providers have been unable to accept. For example, Tulaa, Agri-wallet and Apollo Agriculture are financial service providers who advance quality inputs and loans for planting sizes as small as half an acre at a cost of roughly \$90 dollars in a bundled package that includes mainly fertilizer, certified seed, agronomic training, and crop insurance. The farmers repay this loan over a fixed period during the season with amounts that are as low as \$2.5 dollars per month, with the larger main payment due at harvest time.

Aggregation Based Models

The main premise of aggregation models in agriculture comes from the fact that, through this approach, groups of low-income small-scale farmers who are customers or suppliers become economically viable trading partners able to access markets that they would otherwise not be able to on their own. Aggregation of smallholder farmers into groups links them with both input suppliers and produce off-takers, which helps achieve economies of scale along the value chain. It also helps smallholders to meet the standards and requirements of modern markets, address other barriers to access markets, improve their productivity through increased access to services and markets, and enhance their competitiveness by reducing the transaction costs of entities choosing to work with them (Monitor group, 2011). The aggregation models can be viewed from input aggregation (producers) or an output aggregation (off-takers/contract farming) perspective.

While women represent most producers, they still are often concentrated in the less profitable stages of the value chain and struggle to engage in the value chain's more lucrative activities. Establishing their own organizations can help them overcome these constraints, increase their economic and social power, and improve access to needed services and markets. "Innovative institutional and operational mechanisms and business models need to be developed to enable small-scale producers, especially women, to seize market opportunities along agricultural value chains, while taking into account issues of gender-based power inequalities and access to choices and resources" (Elbehri & Lee, 2011).

Collective Producers Models

This model is based on membership of farmers to producer groups, usually cooperatives, registered farmer groups or even informal associations of farmers with common interests. The common theme is usually a grouping of farmers with collective production needs. The entity then assumes the responsibility of coordinating farm inputs access for their members and non-members. Depending on the nature of the agreements the grouping may also provide other complementary services, including extension services, storage, market information, or crop marketing. The main reasons farmers aggregate themselves into groups or more formal producer organizations include:

- Market access – a key constraint of smallholder farming is access to guaranteed markets for crops. When farmers are aggregated and have higher volumes to offer, they have greater bargaining power including diversifying their off-taker base.
- Service provision – aggregation provides significant increases in income for smallholder farmers by providing demand-driven services, which facilitate increased productivity.
- Bargaining power – stemming from increased access to multiple and diversified markets, collective action gives farmers bargaining power to secure better prices and services because of their bigger numbers as a consumer base and their outputs due to higher tradeable volumes.
- Cost saving – aggregation enables smallholders to reduce transaction and overhead costs by purchasing inputs together, reducing the cost of transport per farmer and accessing discounts through bulk purchasing.

Despite these enormous benefits to farmer-led producer models, it is estimated that worldwide only about 10% of the world's smallholder farmers are aggregated as producers or other kinds of farmer-based organizations, which shows just how challenging it is to organize farmer-based activities, e.g., Grow Africa working group.

Off-Taker Models

Off-taker is usually the party that is buying the produce of the smallholder farmers. Off-taker models come with different variations or labels of the model like contract farming or out-grower schemes; however, the principal concept behind them remains the same, that of aggregation. Aggregation is a fundamental component of all business models, which are either fully or partially reliant on externally produced crop supply, and where smallholder farmers are the main producers. Off-takers have a requirement to guarantee supply, and through aggregation companies are able to provide the logistical capacity to collate the output of thousands of farmers scattered in remote rural areas. This model also enables capacity building of those farmers through the provision of services that support on-time delivery at the required volumes and quality for the benefit of the off-taker company. Off-taker models serve the need of access to markets for farmers, where the purchaser,

usually a market aggregator, facilitates access to inputs for the farmers with the main interest being to acquire their produce for processing or onward supply to other market entities that would utilize it in their operations (e.g., supermarkets, factories, schools, export, etc.). Depending on the agreements, inputs may be delivered to farmers at the beginning of the season, usually on credit, on the understanding that farmers will sell their crop to the buyer upon harvest. The credit may be provided by buyers themselves or by a financial institution. Buyers may use formal or non-formal contracts to ensure they receive the crop (Miller et al., 2010).

A Growth for Africa working paper identifies key elements that are crucial for the model to succeed where enterprises that deal with small scale farmers are involved. These are:

- Anchoring contracts with large buyers at the top of the supply chain. Consistent, high demand for produce is essential to the success of this model. In turn, forward commitments, premium pricing offers, and volume purchase agreements provided to their suppliers enable aggregators to acquire the output of numerous smallholder farmers at reduced risk and on acceptable terms.
- Offering value-added services and inputs to smallholder farmers. This helps aggregators ensure the reliability of supply. These services vary but include provision of agricultural inputs, training and extension services, sorting, drying and storage services, transport, and at times access to credit.
- Leveraging or creating associations or clusters of farmers. This lowers costs when collecting from a large area and reduces the number of interactions an aggregator must facilitate. In some cases, this approach brings together enough farmers and acreage to support shared purchase or rental of mechanized equipment.

Where the off-taker models have been successful in providing a win-win situation, it has been able to provide many farmers and agri-businesses an opportunity to work with large established organizations. One example is of East African Breweries Ltd (EABL), an alcoholic beverage manufacturer, and BIDCO EA, a leading local food processor based in Kenya who works with Shalom, an NGO based in Meru region of Kenya, primarily working with farmer groups. Shalom acts as an aggregator with over 30,000 farmers in 71 farmer groups in the region to supply sorghum and soya beans for beer and cooking oil production, respectively. In another example, Afro-Kai engages more than 9,000 farmers across Uganda through the trade, aggregation, processing, and transport of sorghum, barley, cassava, groundnuts, and maize. The core business is commodity processing and trading, but Afro-Kai has also been contracted by Nile Breweries as its barley and sorghum handler, processor, and third-party extension service provider.

There is a lot of literature that also investigates the exploitative nature of the model where many of the poor and illiterate farmers enter into unprofitable production contracts, where too much power is given to the companies to the detriment of small-scale farmers (Smalley, 2013).

Vegetatively Propagated Crops Delivery Models: Roots and Tubers

Despite their importance for food security, nutrition, and rural livelihoods, seed systems for root and tuber crops receive relatively low attention from development-oriented research and commercial seed producers because reproducing and distributing the planting materials for vegetatively propagated crops presents complex problems and many logistical issues for their extensive use (FAO, 2011). This is particularly an issue for smallholder farmers for many reasons:

- Absence of formal seed systems (except potato).

- Lack of knowledge of phytosanitary measures and quarantine issues related to safe movement of germplasm, plants, and planting material across regions.
- Lack of consistent supplies of good quality planting material.
- Variable demand for clean planting material.
- Bulkiness and perishability of planting materials.
- Use of traditional varietal mixtures, including local varieties.

The resulting seed delivery systems are therefore quite distinct and characterized by being farmer and trader dominated, highly dependent on public research and development, and less formally regulated. Most of the delivery models tilt towards a decentralized multiplication process to increase availability of disease-free planting material to farmers.

For most farmers, their main source for planting material for vegetatively propagated crops is from saved seed or exchange with fellow farmers. The quality declared planting material process was developed to guide the production of clean, disease-free planting material of vegetatively reproduced crops. Its overall goal has been to raise the physiological and phytosanitary quality of the plant reproductive materials available to smallholders and, as a consequence, to increase agricultural production and productivity. It is meant to be implemented primarily by seed producers at community level or field extension workers (FAO, 2007). In Kenya, formal quality control and certification regulations exist for multiplication of starter seed for potatoes, but few seed growers choose to make use of this system. They prefer to multiply seed potato without certification and trade the seed to nearby farmers based on their reputation for quality seed potato. In Uganda, a seed potato growers association with a self-policing quality control system multiplies a significant proportion of the starter seed available, while the remainder is distributed through NGOs to farmer groups or is bought by individual seed potato multipliers (Tindimubona et al., 2000). In Ethiopia, starter seed is multiplied by farmer groups, collaborating with the potato research center (Getachew & Mela, 2000; German, 2006) without an elaborate quality control system. The Accelerated Value Chain Development (AVCD)⁶ project in Kenya through the International Potato Center (CIP) is also working on creating a network of farmers to engage in potato seed growing as a business that supplies other small-scale farmers within their locality. Using a hub seed multiplier approach, selected farmers are able to engage in producing clean seed potatoes and sell them locally to farmers who would otherwise not have easy access to high-quality planting material.

Forage Seeds Delivery Models

The genesis of a strong and stable animal feed resource base, usually the roughages, depends on the use of proven forage technologies. However, such forage technologies require the availability of seeds and planting materials that are easily and economically accessible by the livestock keepers (Mengistu et al., 2016). Farmers in SSA largely rely on crop residues, naturally occurring pastures and, to a limited extent, cultivated forages. To support this demand, vegetative propagation is often used, but this is not without limitations. While naturally occurring, pastures are likely to be of poor quality, and vegetative propagation can carry the risk of the spread of diseases and pests. In addition, vegetative materials are laborious to work with due to bulkiness.

⁶ <https://avcdkenya.net>

The fodder/forage seed value chain in SSA can be classified as largely underdeveloped in comparison to other regions in the world where livestock production thrives. It has been described as weak and barely functional with inadequate research on forage seeds and a general lack of reliable forage seed production, processing, and distribution schemes, along with poorly developed seed marketing systems and limited involvement of private seed companies (Fikre, 2018). One of the main reasons identified for this is the lack of stable demand for forage seeds. This arises as a result of the perennial nature of most grasses whereby, with good management, several re-growths can be made from the same crop over several seasons (ILRI, 2015).

Forage seed availability comprises formal and informal channels. There are few companies in the region that deal in certified fodder seed with the major one being Kenya Seed, which has had substantial forage seed production and marketing. With projected increases in demand for livestock products and emerging fodder markets, there is a developing interest in forage seeds in the formal sector with various companies showing an interest in the region. For example, Advanta Seeds Company from India is promoting growing of fodder sorghum and Tropical Seeds Company is exploring the sale of seeds of fodder species viz., *Brachiaria* hybrid seeds in Kenya (CIAT, 2016).

The informal system mainly includes forages that are propagated by use of vegetative parts. The forages vegetatively propagated include Napier grass (*Pennisetum purpureum*, also known as elephant grass), sweet potato vines, while seed-producing ones include Vetch, Lupin, Desmodium, fodder trees and Lablab. The availability of and access to seed and planting material already poses a significant bottleneck. Fodder seed improvement in the informal seed system is driven by farmer groups, NARs, donor-funded research organizations, and Agricultural Training Centers.

Seed Systems and Gender

To propose seed systems and interventions that allow equitable access to seed for both women and men, it is important to understand the local social and gender context for which the interventions are designed. Despite the many efforts designed to enhance seed security for small scale farmers, gender related gaps exist across the seed systems, from the breeding process, production, selection, and distribution stages, as well as how the seeds are used and who reaps the benefits from this use. The participation of women in development and propagation of new or improved varieties cannot be ignored. The focus of formal breeding programs has traditionally been towards high-value crops and species with significant productivity and commercialization potential and, when engaging with smallholder producers, they have often interacted only with men, consequently overlooking traits preferred by women farmers. Lodin et al. (2012) notes that varieties and breeds with low market value but are nonetheless important for nutrition are often left out in breeding programs. They also argue that “some new varieties may even have had traits that could disempower women, for instance by increasing their labor burden or requiring complementary inputs to which women had less access than men.”

Galie et al. (2017) offers the solution to this through the adoption of a gender-responsive approach to development of new varieties, which can help change the gender norms that have previously channeled benefits to male farmers only and ensure that both women and men benefit equally from the co-developed varieties. As previously highlighted, Mudege et al. (2020) reported that involving women in seed production and management at the community level gives them access to varieties that better addresses their needs, generates extra income through employment, and contributes to women empowerment. However, systemic gender inequities and community biases experienced by

women often prevent them from reaping the full benefits of such community-based seed production initiatives. This is primarily because of women's limited access to finance, access to seed processing equipment, and inability to attract and retain skilled labor; additionally, they may suffer from delays in payments for their services. The situation can be further aggravated by the burden of domestic work and other care responsibilities, lack of support from the spouse, and the general bias against women in business (Nyantakyi-Frimpong et al. 2019).

The formal seed sector had been criticized earlier in the report as struggling to provide women with seeds that are important to them and meet their preferences. By recognizing that women are an important segment of the seed markets, innovations are emerging that seek to improve women's access to seed. Private seed companies are employing new marketing efforts that include demonstration plots by women in locations accessible to women, development of videos featuring not only men but also women as their clients, and an approach of offering smaller packaging, which may better suit the needs of women, who often require less seed (Mudege et al., 2018). However, these efforts have focused on commercial crops and varieties for which profits are assured, not on open or self-pollinated crops which is the focus of this report. For women to be fully engaged in and benefit from both the formal and informal seed systems, many structural barriers and harmful gender norms must be overcome. Berber et al (2020) propose a forward-looking research-for-development agenda that will inform the design and implementation of gender-responsive seed systems and seed policy. Such an approach would be able to shed light on important areas like gender dynamics and norms in seed systems, analyze gendered impacts of innovative seed systems development approaches, and be able to generate gender-disaggregated seed systems indicators. Through this approach, policy and development programs can then be truly able to advance seed systems that are non-discriminatory to small-scale farmers in the rural areas. Berber et al (2020) concludes by stating that gender equality and women's empowerment should be the next frontier for seed system development.

Emerging Themes that Support Seed Systems

Bundling and 'Piggybacking' Strategy Within Seed Delivery Models

Bundling and 'piggybacking' solutions are a matter of aligning value for all stakeholders involved with business sustainability while creating real customer value for the small-scale farmers by offering a product and service mix that is relevant, accessible, and affordable.

Delivering any inputs that small-scale farmers require as a standalone item may not make long-term economic sense, yet they are the largest group of producers responsible for global food security. Bundling therefore makes sense for the simple fact that it affords many companies and entrepreneurs an avenue through which its products and services have the potential opportunity to reach millions of previously inaccessible consumers.

'Piggybacking' on networks as a distribution model is based on partnerships with networks that are well established in local contexts that can provide a direct network of targeted communities and often have valuable knowledge of the market.

Some of the benefits of bundling and piggybacking include:

- Effective promotional tools for marketers to have consumers try out new products with existing ones that they are already using.
- Leverage the use of existing services and channels to increase outreach for new products and services.
- Reduce costs of distribution and consumer education as new products piggyback on existing channels and products.
- Increase loyalty to products/service offerings.
- Give additional revenue streams to partners engaging in service provision thereby increasing chances of sustainability.
- Give the consumer access to multiple products and services at a competitive price through a 'one stop' shop.

Some of the common seed systems product and service mixes available as bundled options include:

- Certified seed;
- Fertilizer and other crop inputs, like herbicides and pesticides;
- Extension services;
- Access to financing facility or input loans;
- Crop insurance;
- Access to markets;
- Post-harvest management (cleaning, drying, packaging), and;
- Transport services.

The various seed delivery models will offer a different mix of products and services depending on a wide array of factors that will vary from region to region, crop to crop, farmer to farmer. There is the need to emphasize the fact that “one size does not fit all” while offering bundled services.

Mobile Phone Certified Seed Verification Systems

Common Market for Eastern and Southern Africa (COMESA) launched a partnership with global technology firm mPedigree to improve the agro-inputs protection technology among its members. The partnership, launched under the COMESA Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA) Seed program, has helped COMESA countries to eliminate fake and counterfeit agro-inputs materials, like seeds and fertilizers, among its member states.

Photos 1 & 2. Examples of stickers and scratch cards to trace seed.



Seed certificates and verification of the seeds can now be done electronically in Kenya, and farmers are able to trace the source of their seeds by way of scratching a Kenya Plant Health Inspectorate Service (KEPHIS) issued sticker that is available on every packet of seed authorized for sale for any packaging below 5 kg. The code revealed is then sent via SMS to the short code number 1393 and a response will be generated that confirms whether the seed in that packet purchased is certified or not. For every seed package that will have a COMESA sticker (see photos 1 & 2 above), it means the source of that seed has been documented and can be tracked on the receiving end.

Crop Insurance and Seed Systems

There is evidence that access to agricultural insurance leads to significantly larger agricultural investment and riskier, yet more rewarding, production choices in agriculture. The binding constraint to farmer investment is uninsured risk: when provided with insurance against the primary catastrophic risk they face, farmers can find resources to increase expenditure on their farms. Such evidence establishes risk as the most binding constraint, even more than access to finance (ILO, 2017). Insured farmers are more likely to plant higher-yield/higher-risk crops, invest more in fertilizers, and adopt other production-enhancing methods. Uptake is more common in areas that experienced several years of below-average rainfall or crop yields. It is also higher when the insurance is presented by a trusted third party, such as an NGO or well-established company. In the absence of insurance, many small farmers engage in costly mitigation strategies to prevent loss, using savings or selling off assets in the event of loss. Micro-insurance can prevent these losses. Indexed insurance reduces administrative costs by eliminating the need for claim inspection and verification. Index-based agricultural micro-insurance costs significantly less than traditional insurance because insurers do not need to verify individual claims. To ensure affordability by the target group, governments frequently subsidize micro-insurance schemes. Even so, low willingness to pay and high price sensitivity hinder uptake (Biener & Eling, 2012).

However, this is not to say that only insurance, more so standalone insurance, on its own is enough. Providing standalone insurance products—especially in new markets where they are untested and given consumers’ lack of understanding and trust—can be difficult and unprofitable. Bundling insurance offers the opportunity to the insurer or the implementing entity to bundle their product with a value chain component (output or input) that is necessary for the farmer. By bundling insurance with other smallholder-focused financial and non-financial services, practitioners can develop a customized suite of products, services, and delivery modes that offer substantial and tangible client value.

For the insurer, bundling is an opportunity to:

- Leverage existing non-insurance services to increase outreach and penetration and compensate for lack of own staff/distribution in rural markets;
- Utilize the partner’s goodwill and get customers to try the insurance offering;
- Reduce costs of distribution, customer education, and premium collection through pre-financing by the partner or the aggregator, and;
- Have reduced anti-selection/fraud due to bundled nature (especially for mandatory products).

For the provider of non-insurance services such as a bank or farming input provider, bundling with insurance can offer several advantages. These include:

- Reduction of agriculture lending risk;

- Use of insurance as a sales promotion tool for farming inputs;
- Increased loyalty to the product, and;
- Additional revenue stream in terms of commission or service fees from the insurer.

From the farmer's point of view, a bundled insurance product can provide:

- Access to insurance on a cost-effective basis;
- Easier access to credit and improved farm inputs especially the costlier certified seed;
- Loan repayment relief and access to loans for the next season (in case of default due to unfavorable production);
- Ease of payment of premiums, if service provider pre-finances or subsidizes premiums, and;
- Access to multiple services at a competitive price through the 'one-stop' shop.

Index-based agricultural micro-insurance can increase farmers' income and productivity by increasing their willingness to invest and engage in riskier practices (Cole et al., 2012). An example of the insurance product is one developed by Syngenta. In the seed packets that farmers purchase, there is a small card with a code. The farmers can send a free text message to Syngenta with the code, which also transmits their location coordinates. These are used to collect data from weather stations and satellite images. If it turns out that the farmer's field was too wet or too dry in the first two weeks after sowing, the farmer automatically gets his or her money back.

ICT Support for Seed Systems

With one billion small-scale farmers worldwide, extension is urgently seeking for the best ways to support these farmers in terms of information, technology, advice, and empowerment. One promising area of agricultural extension to reach large number of farmers is using ICT: mobile technology, innovative community radio and television programs, mobile phones in combination with radio, video shows, information kiosks, web portals, rural tele-centers, farmer call centers, video-conference, offline multimedia CDs, and open distance learning, among others. Agricultural education and extension can play a critical role in the transformation process to transfer technology, support learning, assist farmers in problem-solving, and enable them to become more actively embedded in the agricultural knowledge and information system (Christoplos & Kidd, 2000).

ICT-based agricultural extension brings incredible opportunities and has the potential of enabling the empowerment of farming communities. Mobile communications technology has quickly become one of the most common ways of transmitting voice, data, and services for use in a wide variety of economic sectors in Africa. Given this dramatic change, mobile applications (m-apps) in general and mobile applications for agricultural and rural development (m-ARD apps) hold significant potential for advancing development. Most m-ARD apps focus on improving agriculture supply chain integration and have a wide range of functions, such as providing market information, increasing access to extension services, and facilitating market links. Users are also diverse, including farmers, produce buyers, cooperatives, input suppliers, content providers, and other stakeholders who demand useful services (Kiambi, 2016).

Digitization for Agriculture (D4Ag)

Technology is critical to positively affecting change and driving development. It is bringing countries closer together, reducing barriers to trade, and offering a window of opportunity to 'digital native'

youth entrepreneurs at the vanguard of innovation applied to different economic sectors. In agriculture, digitization could be a game changer in boosting productivity, profitability, and resilience to climate change. However, despite its growth, progress towards D4Ag has been slow to serve the smallholders that produce 80% of Africa's agricultural output. An inclusive, digitally enabled agricultural transformation could help achieve meaningful livelihood improvements. D4Ag addresses a wide scope of factors and conditions affecting farms, farmers, and the agri-food sector. The volume of data and the supporting layer of new digital agricultural solutions are growing exponentially while the quality of that data is rapidly evolving (CTA,2019⁷). Currently there are around 33 million farmers who have been captured in the digitization process. There is a potential to increase this to 200 million by the year 2030. Areas where digitization has been useful for farmers and livestock keepers include:

- Advisory and information services: This includes digitally delivered information on topics such as agronomic best practices, pests and diseases, weather updates for planning purposes and market prices for crops/livestock and livestock products of interest. (*Examples include I-con® and Ujuzi kilimo® which are digital advisory service available to small holder farmers.*)
- Market linkages: Digitally enabled solutions on platforms that link smallholder farmers to quality farm inputs suppliers (e.g., seeds, fertilizers, herbicides/pesticides), off-take markets, agro-dealers and other service providers, wholesalers, retailers, or even to end-consumers. (*Examples include Digifarm® and Tulaa® which are digitally enabled value chain integrators.*)
- Financial access: Digital financial services suited for smallholder farmers, such as digital payments, savings, smallholder loans, agricultural insurance, all of which increase financial access. (*Examples include Agri-wallet, Acre Africa, Apollo agriculture which are financial service providers that specifically target farmers.*)
- Supply chain management: Digital supply chain management solutions can be business-to-business services that help agribusinesses, farmer cooperatives, input agro-dealers and other smallholder farmer value chain intermediaries to manage their smallholder relationships in ways that lower costs through greater efficiency to meet market needs. (*Examples include M-pedigree® for certified seed traceability, Farmforce® and Eprod®.*)

Digitization also affords the chance to directly target women small scale farmers due to the capture of large volumes of high-quality gender-disaggregated data, which can be used to better understand their unique needs and assist service providers to design tailored solutions that address those needs like greater access of women farmers to relevant extension services advice, access to finance, agri-inputs and markets for their produce.

According to The Digitisation of African Agriculture Report, 2018-2019 (Tsan et al., 2019), bundling of these four services (advisory services, market linkages, access to financial services, and supply chain management) can help increase farmers' yield by 168% and incomes by 57%, which demonstrates the opportunity for investments in this arena that will contribute significantly in improving farming livelihoods in the region. However, it's important to note that these authors' findings were based on limited data and should be construed as an indication of what is possible, not a definitive representation of the space or use case. D4Ag has been touted as a game changer in

⁷ CTA is a joint institution operating under the framework of the Cotonou Agreement between the ACP Group of States (Africa, the Caribbean, and the Pacific) and the EU Member States (European Union). CTA is funded by the European Union. <https://www.cta.int/en>. The report can be found here: <https://cgspage.cgiar.org/bitstream/handle/10568/106645/ICT093E.pdf>

supporting and accelerating agricultural transformation across the continent. Digital solutions for farmers are recognized to be transformative because they offer access to tailored information and insights that allow individuals to optimize their production, gain access to appropriate products and services, and explore new linkages with markets. It simultaneously offers enterprises in the value chain a deeper understanding of their target segments, allowing them to better tailor their interventions to the needs of smallholder farmers, and bridges the divide that exists between rural last mile farmers and other value chain actors that need access to that market.

Digital Financial Services

Access to finance and financial related services have been identified as a critical factor in improving access to seeds and related inputs for farmers. As a tool to expand financial inclusion in rural areas, Digital Financial Services (DFS) have emerged as a powerful tool to expand access to the formal financial system, building upon the rapid growth of digital and mobile telephone infrastructure and the advent of branchless banking, which offers the ability to transact outside of a traditional bank branch. From this perspective, the potential to drastically reduce distances between financial institutions and their customers in hard-to-reach areas enable transactions at a fraction of the cost relative to conventional brick and mortar operations and represents an opportunity to deepen outreach of financial services providers to underserved communities for farm inputs and operations. DFS are addressing a number of traditional pain points in the context of agricultural finance, making it easier for farmers to save, borrow, manage irregular income, obtain inputs, and insure against loss, and as mobile phone access, network coverage, and digital ecosystems continue to expand, we can expect to see more financial service providers targeting the largely untapped smallholder client base (Grosman et al., 2014). Increasingly inclusive and integrated value chains present advantageous entry opportunities for financial institutions to tap into traditionally prohibitive market segments using innovative lending models, while innovations in data management and digital financial services hold the tremendous potential to address challenges of risk, scalability, and cost that can discourage them from financing the agricultural sector. In addition to exploring new lending models and enabling support services, financial institutions seeking to go the last mile in amplifying financial inclusion for rural populations must work to understand the complex financial, environmental, and socioeconomic context in which smallholder farmers are embedded as a fundamental prerequisite to providing appropriate financial services (Incofin, 2016).

Early Generation Seed Delivery Models

Although a great deal of previous development funding has been used to breed new varieties and to encourage farmers to adopt them, the availability of Early-Generation Seed (EGS) continues to be limited by bottlenecks in the supply chain. These problems are particularly significant for non-hybrid varieties and less-commercialized food crops developed by public-sector institutions. Improved coordination among system actors is necessary to reduce the barriers surrounding EGS provision and production and thereby strengthen climate-adaptive and adaptable seed systems (Cramer, 2019).

Despite focused donor initiatives (e.g., AGRA-PASS, ISSD etc.), obstacles remain, especially involving the private sector in the development and dissemination of non-maize seed crops through formal sector. This is primarily due to major bottlenecks towards access in EGS from the public sector for bulking or further multiplication by private firms involved. Such bottlenecks include complicated and disparate licensing agreements among the various regional genetics'

suppliers; lack of availability of sufficient breeder seed from licensors; and lack of financial resources, technical knowhow, and infrastructure to maintain EGS. The access to quality EGS is independent of what type of quality seed they supply, whether certified, quality declared, or trusted seed, with the latter referring to informal seed channels.

To an extent, few such hurdles have been reduced in accessing EGS for maize through major public-private partnership (PPP) initiatives funded through focused donor investments in recent years, e.g., AGRA-PASS supported small seed firms, Drought Tolerant Maize for Africa (DTMA) and Water Efficient Maize for Africa (WEMA) deployment initiatives, and the most recent program funded in the production of good quality, new productive foundation seed production enterprises by QualiBasic Seeds.

The findings of a widely vetted global study (USAID-BMGF, 2015) on commercial and sustainable EGS supply documented differences in the commercial potential (e.g., profitability) of different classes of seed in the value chain for different crops and provided insights on the ways EGS supply should be structured for different crop types with distinct responsibilities for public and private stakeholders. Most SSA countries are small; they have small formal commercial seed markets but with large and dominant institutional markets, e.g., government input subsidy schemes and food safety interventions. Few crops are attractive to commercial companies or government parastatals. The capacity of NARS to produce and maintain a steady supply of new improved crop varieties and their basic seed in many countries is constrained—especially for small grains, legumes, root and tuber crops. In all other food crops, private sector provision of EGS has been limited to present due to market failure for EGS, combined with thin and small seed markets. Other constraints include underfunded public research systems that are handicapped institutionally and financially in their support and collaboration with the private sector in EGS systems and oftentimes combined with inappropriate policies and regulations, with limited enforcement capacity in terms of both quantity and quality of EGS supply (Boef et al., 2016). Given the critical role of CGIAR crop improvement programs in the development of new varieties and their current involvement in EGS supply, it is recommended to review and redesign their role in crop improvement programs, and explore ways in which CGIAR programs can contribute to more structural solutions in EGS supply. As their involvement is mostly crop-based, this action is highly related to crop-based interventions but is embedded within a more national program (Boef et al 2016). Promising examples are as follows:

- Pan-African Bean Research Alliance (PABRA) has established well-functioning PPPs including seed companies, out-growers, NARS, CGIAR Centers, and donors.
- International Crops Research Institute for the Semi-Arid Tropics' (ICRISAT's) seed revolving funds for groundnuts and pigeon pea provide another example for a PPP that involves a variety of stakeholders.
- Mennonite Economic Development Associates (MEDA) and national public and private sector partners in Tanzania engage in the development of models for the commercial supply of cassava EGS.
- International Institute of Tropical Agriculture (IITA) and partners in Ghana and Nigeria are developing models for the commercial EGS supply for yam within the Yam Improvement for Incomes and Food Security in West Africa (YIFSWA) project.
- Syngenta Foundation is engaged in supporting various PPPs with diversity of crops including various grain and root and tuber crops in both Eastern and Western Africa.

Even though, as seen above, PPPs are found successful in delivery of EGS, their relative success in delivery depends on the structure of the seed sector, strength of research and regulatory institutions, balance in terms of capacities between private and public players, as well as the existence, competence, and viability of parastatal companies, small- and medium-size companies, and national seed companies, local seed businesses and seed producers.

In addition to seed delivery models, there are associated services emerging to leverage or ease seed delivery systems that allow documentation of the information or knowledge generated. Some of these services are very vital in understanding the existing models in operation and provides valuable insights to decision makers especially on the variables affecting the enabling environment of seed market functions.

Seed dashboards on enabling environment

Since its establishment in 2012, the Access to Seeds Index (ASI)⁸ has set out to increase transparency around the seed industry and encourage the industry to enhance its contribution to the 2030 sustainable development agenda. The index seeks primarily to identify leadership and good practices, providing an evidence base for the discussion on where and how the seed industry can step up its efforts. The index particularly highlights the importance of local and regional companies in providing access to seeds for smallholder farmers. Although most attention goes to globally active seed companies, which dominate many seed markets with advanced breeding programs, the industry is highly diverse and locally driven. Small and medium national and regional companies outperform their global peers in multiple areas relevant for reaching smallholders, but they also provide linkages between farmers and global players through research and distribution partnerships.

The African Seed Access Index (TASAI)⁹ monitors indicators that are essential to seed sector development in Africa. TASAI appraises the structure and economic performance of the formal seed sector and aims to publish an annual score card that captures the vibrancy and competitiveness of the formal seed sector in African countries. It is a useful tool for government, policymakers, development agencies, seed enterprises and farmers. For the top four grain and legume crops in each country, the index tracks 20 indicators in five categories: Research and Development, Industry Competitiveness, Seed Policy and Regulations, Institutional Support, and Service to Smallholder Farmers. One of the weaknesses of the seed index as its currently constituted is that it does not provide gender-disaggregated data, nor does it include some crops that may be of importance to women, such as vegetatively propagated crops and varieties important for family nutrition and livestock. Opportunities for improvement of the index exist for collecting gender-disaggregated data at scale. If such data were added, the index could help inform national governments and development actors in designing gender-responsive seed policies.

Key Lessons Learned

Farmers, whether large-scale or small-scale, know good traits when they see them. Although it sounds obvious, the assumption that smallholder farmers make rational decisions about adoption based on the value of a variety may be the single most important key to scaling a seed system.

⁸ <https://www.accesstoseeds.org/>

⁹ www.tasai.org

Putting the farmer first, and fully understanding their customers' needs, is central in making sure that the right seed is getting to the right markets, in the right quantities, at the right time, for the right price, at the right condition with the right planting information, which will in turn foster sustainability. In this context, it is key to develop programs that allow increased access or reach to farmers for 'new varieties' and 'affordable'. Reaching the last mile including remote, difficult to access areas for non-maize crops requires creative models, that support alternate marketing channels. This requires exploring and integrating a range of options with proven solutions (such as small seed packs (SSPs), mobile seed shops, seed fairs, and partnerships with retail networks, etc.) in the existing or new models. More equitable access of both men and women to resources, information, and decision-making is critical for the success of any seed-based business models. The closer the input source (<5 km) to the farm the better, especially for women farmers. Lack of engagement between the public and private sectors in non-maize crops is more apparent in Africa than South and Southeast Asia where relationships between the sectors are often collaborative and catalytic. Yet, designing scaling programs for diverse farming systems, associated crop-seed systems (formal dominant, informal, semi-formal based), and policy environment requires careful evaluation in terms of the economic and social benefits it can derive. An enabling environment that facilitates the development of complementary seed channels both local, community-based (informal), and more formal seed organizations supported by both the private and public sector is necessary to reach out to millions at the last mile. Donors and development partners have also paid attention to the evolution of the seed sector in SSA countries, and several strategic initiatives have been taken up in the recent years, such as AGRA-PASS initiatives, Scaling Seeds for Technology Partnership (SSTP), Tropical Legumes (TL), Seeds2B, and QualiBasic Seeds, to name a few. Finally, women in Africa play a crucial role in household agricultural decisions, including decision on seed varieties. Women's access to these new seed varieties is key to any last mile seed delivery strategies that involve scaling.

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