PLANNING FOR SCALE BRIEF #3

INTEGRATING SEED SYSTEMS

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1 – Introduction

Scaling the adoption of improved varieties and quality seed among smallholder farmers must include both formal and informal seed systems. While the more formal channels of a seed system remain central to scaling, evidence shows that smallholder farmers source the majority of their seed from the informal system; they plant, exchange and sell a wide range of varieties that fall outside the production and distribution functions of the formal sector. Strategies for scaling seed systems, then, require an integrated approach.

Integrated seed systems imply coordinated actions between the formal and informal seed sectors. The term also conveys the interdependence of such systems, with multiple links between that two, with each reacting to the other and changing over time. As definitions of formal and informal have been fluid over the years, we start upfront by outlining the salient characteristics of each system (drawing from FAO, 2004), before discussing their integration.

The *formal seed system* is a deliberately constructed and bounded system, which involves a chain of activities leading to clear products: certified seed of verified varieties (Louwaars, 1994). The guiding principles of the formal seed system are: to maintain varietal identity and purity; and to produce seed of optimal physical, physiological, and sanitary quality. Seed marketing and distribution often takes place through a limited number of officially recognized seed outlets, usually for commercial sale (Louwaars, 1994), although seed may also be distributed (free or for sale) by national research programs, universities or NGOs. A central premise of the formal system is the clear distinction between *seed* and *grain*.

The *informal seed system* (also known as farmer, local, traditional)[1] embraces most of the other ways in which the farmers themselves produce, disseminate, and access seed: directly from their own harvests; through exchange and barter among friends, neighbors, and relatives; and through local grain

1 We note that each of these terms is problematic. *Informal* systems are not purely *farmer* systems in that markets are important. Neither are they purely *local*, since both markets and exchange networks connect various localities, even across large distances. Finally, they are not *traditional* in the strict sense, because they are constantly evolving.

markets. What most characterizes the informal system is its diversity. Varieties may be landraces or mixed race populations. In addition, the seed is of variable quality (of different purity, physical and physiological quality) (Almekinders and Louwaars, 1999). The same functions of multiplication, selection, dissemination, and storage take place in the informal system as in the formal, but they take place as integral parts of crop production and marketing systems, rather than as discrete activities. Although some treat 'seed' in a different manner to grain, the seed/grain distinction is not always clear.

While the labels suggest the two systems to be distinct, in practice, they already share important points of integration. For instance, on the *demand* side, farmers have long drawn from both formal and informal systems, accessing seed for different crops from distinct channels, e.g. maize from agro-dealers and groundnuts from local markets (Sperling and Cooper, 2004). On the *supply* side: an increasing number of breeding programs involve farmers in variety selection; farmers sit on variety release committees; and improved varieties are diffused through local channels. The dilemma in describing 'integrated systems' is that many of these interfaces have been ad hoc, rather than smartly managed, and they tend to be localized, rather than achieved at scale.

Definitions to characterize integrated seed systems are beginning to be formalized but remain open-ended, for example: '*Ways to integrate formal seed systems and farmers' seed systems at the technical and institutional levels*' (Louwaars and De Boef, 2012). To gain clarity, we prefer to avoid labels but rather focus on the defining features of 'who, what, and how' of the seed system integration process. Hence, the key to identifying pivotal points for scaling within an integrated seed system context is to recognize: (1) which actors should be involved; (2) which functions they should serve; and (3) which mechanisms should be used during the integration process to help achieve scale.

Principal actors for the informal sector may include: farmers, traders, processors, cooperatives, and other business people. For the formal sector they may include: public breeding and seed parastatals, universities, NGOs, multinational and national commercial seed and agro-input companies, regulatory bodies, and service (credit and insurance) providers (see Figure 1 below). Not all these actors need to be engaged in strategies for seed system development, but 'best bet' combinations can be planned, tested, promoted and scaled up. Most seed system functions cut across the formal and informal sectors. A short-hand list might include: variety development; seed multiplication; seed quality maintenance; development of delivery and marketing strategies; and information systems to create demand, raise awareness and ensure accountability. Again, not all actors have to be involved in all functions; the key is deciding who should do what to achieve impact at scale.

	Public	Private
Formal	Universities, seed parastatals, national agricultural research institutes (NARIs), international agricultural research institutions (IARIs), regulatory bodies	Small-to-medium enterprises (SMEs), seed companies, multi-national & national seed companies, regulatory bodies, agro-input companies, agro-dealers, financial service providers, credit and insurance providers, seed trade associations
Informal		Farmers, traders, processors, producer organizations , local credit providers, NGOs, community-based seed groups

Figure 1 – Actors in formal and informal seed systems.

The integration of formal and informal systems is beginning to receive greater attention for two main reasons.

Policy-makers and practitioners recognize:

- Both systems have considerable strengths that need to be leveraged more systematically.
- Neither system alone has been able to sufficiently scale up positive benefits for a good range of crops.

Shifts in framing new discussions on seed system integration have generated increasing attention to four features:

- Sustainability – What will happen when donor money disappears?
- Impact – How can seed systems move a greater range of farmer-desired crops and varieties?
- Scale – How can seed systems move seed faster and more widely?
- Profit/market values. How can seed initiatives turn a profit over seasons and years?

Progress in how discussions are changing can be seen in the fact that seed system development is no longer shorthand for *tons of seed produced*. Instead, the concept refers to food security, widespread adoption of improved varieties, market chain development, and economic development more generally. If we want to see these results, then we must refrain from artificially segregating formal from informal in the seed system, and instead create strategies for scale that address the integrated reality.

2 – Opening the 'black box' of the informal seed sector

Before discussing integrated seed systems, we present a core set of attributes of the *informal sector* that make it a critical component of scaling strategies. Our quick review of strategic attributes is not meant to be comprehensive, as a number of good informal seed sector reviews already exist (Almekinders and Louwaars, 1999; De Boef et al., 1993; Sperling and Cooper, 2003; Thiele, 1999; Van Mele et al., 2011). Rather, we selectively highlight seven features that speak to more deliberate linkages between formal and informal seed sector initiatives. The informal seed system attributes presented are not anecdotal. They draw on a solid body of evidence that has been repeated over time, crops and locations. While there are still enormous opportunities for empirical work to improve our understanding of scaling in informal systems, we do have enough good evidence to support strategic investments.

Seven attributes

of the informal sector are important for framing discussions on impact, scale and demand-driven seed supply.

Informal seed systems:

➔ already work at scale
➔ are market-driven
➔ move a wide range of crops
➔ work everywhere
➔ rarely break down entirely
➔ distinguish between seed & grain
➔ are highly dynamic

Seven attributes to remember

1 – Informal systems already work at scale. Informal systems provide the overwhelming bulk of seed that smallholder farmers sow. Common wisdom often puts this figure at upwards of 80% of the seed supply (e.g. Africa Union, 2008). Recent quantitative evidence across six countries, 42 crops, and 10,120 seed source observations shows almost 90% of seed planted by smallholder farmers is sourced from the informal seed supply[2]. Of note is that three countries used in the data set (Kenya, Zimbabwe and Malawi) are among those in Africa with the highest rates of hybrid

2 These datasets emerge from Seed System Security Assessments (SSSAs) in six countries (the reports are listed in the references), including: Kenya, southern Malawi, Zimbabwe, South Sudan, eastern DR Congo, and Haiti.

Seed-source	Frequency of use	% of cases	% of seed supplied
Own Stock	2992	29.6	29.9
Friend, neighbor, relative	1576	15.6	8.6
Local market	4050	40.0	50.9
Agro-dealer	266	2.6	2.4
Community-based seed group	54	0.5	0.5
Government	280	2.8	1.6
NGO/FAO	858	8.5	5.7
Contract growers	5	0.0	0.1
Other	39	0.3	0.3
Total	**10120**	**100.0**	**100.0**

Figure 2 – Farmers' sources for three key crops across six countries, 2009–2012. *Informal seed sector sources are shaded. Source: Sperling and McGuire (2013)*

maize seed use. Hence, the sample may over-represent formal sector use. As new countries are added to this set, the proportion of informal seed sector will vary, but the definitive message is that farmers continue to access a high percentage of seed from this sector.

2 – Informal systems are already market-driven. Drawing from the same sample above (more than 10,000 observations), data show that 45% of all transactions involved cash transfer (Figure 3). Planting material is even purchased for crops such as cassava, where stems are obtained directly from plants in the field. There is a very large seed market out there in the informal system that could be better captured through integrated seed system links.

Crop	Frequency of use	%
Own stock	2975	29.4
Exchange	127	1.3
Gift	1255	12.4
Buy	4565	45.2
Vouchers	110	1.1
Direct seed distribution (DSD)	931	9.2
Seed loan	56	0.6
Food aid	23	0.2
Money credit	12	0.1
Casual labor	34	0.3
Other	22	0.2
Total	**10110**	**100.0**

Figure 3 – Mechanisms by which farmers source seed for three key crops across six countries, 2009–2012. *Source: Sperling and McGuire (2013)*

3 – A wide range of crops move through informal systems. A wide range of crops moves through informal seed systems (for example, the sample above included 42 crops). The diversity of the system allows for logistics channels that differ by crop. Local markets are the major venue for much of the legume seed sale, including beans, pigeonpea, cowpea, groundnuts and Bambara nut among others.[3] In contrast, social networks (neighbors, kin, or friends) are standard conduits for moving planting material of vegetatively-propagated crops (VPCs) such as cassava, sweetpotato, and banana.

These are generalizations, of course. Some cases of small entrepreneurs selling VPCs exist, for example, the Sustainable Cassava Seed Systems Project in Nigeria (Walsh, 2013), and these incipient markets merit further analysis for understanding how to introduce scaling. Potato is another such crop where small, local seed multipliers gain a reputation for quality seed. Hybrid seed of horticultural crops is also occasionally sold in local home-goods shops and open market venues. The major exception is hybrid maize, which is not systematically sold in informal channels – although even for hybrid maize, informal markets develop when formal sector supply is compromised (see point 5 below).

3 Derived from Seed System Security Assessments (SSSAs).

4 – Informal systems work everywhere. Informal seed channels exist everywhere, no matter how remote the farming community. Even in isolated communities where road structures are non-existent, informal channels operate through local exchange or via visits from mobile traders.[4] More usually, open markets are held on a scheduled basis in one particular community, or in several communities, rotating within a regional area (Lipper et al., 2010). For VPCs, the purchase of informal planting material is particularly noticeable when planting material is in short supply, for example, following dry periods.

Informal channels persist even where the formal seed sector is well-developed for highly commercialized crops. For example, in Kenya and Malawi, where the population is comparatively well-served by agro-dealer outlet stores, data from the Seed System Security Assessments conducted in 2011 show that smallholder farmers in the two samples sourced 69% of their maize seed from informal channels (SSSA, 2011a and 2011b). Even when comparing purchase points in informal systems (markets) to those in formal systems (agro-dealers), the comparison is noteworthy: 27.8% of seed was sourced from local markets versus 20.3% from formal agro-dealers (Sperling and McGuire, 2013).

5 – Informal systems rarely break down entirely, they are resilient. Informal seed systems are responsive and durable. To illustrate, we describe two extreme cases. First, informal seed systems were functioning within months of the civil war in Rwanda ending. Farmers sourced 92% of their bean seed from local channels (including 52% from markets), and 97% of potato seed from local channels (including 42% from markets). Formal channels for potato had collapsed four years earlier at the initial stages of civil unrest (Sperling, 1996).

Second, during the instability in Zimbabwe, when the currency was being devalued (and had collapsed to $100 trillion Zimbabwean dollars to the US$1), farmers still continued to buy hybrid maize, but not through formal channels. Traders and alternative markets filled the formal sector gap at the rate of 10kg maize = 1 goat (McGuire and Sperling, 2013). These extreme cases indicate that informal channels are a compelling force, especially when it comes to sustainable seed sector development and at scale.

6 – Informal systems clearly distinguish between seed and grain, with monetary premiums for seed. Farmers plant seed, not grain, and traders recognizing this market respond accordingly. While much has been written on how farmers themselves source and select seed (Badstue, 2006; Christinck, 2002; Bellon, 2004), here we summarize signals of seed

4 See (SSSA, 2010b) and (SSSA, 2012).

trader management behavior. By traders, we are referring especially to those larger traders who control the supply of agricultural goods in and out of a region (often moving 150–200 metric tons in any given season). By seed, we are referring to 'potential seed', i.e. grain that has the quality attributes that allow it to be sown (Sperling and McGuire, 2010).

As a quick overview, three signals, in particular, suggest that select traders capitalize on this 'potential seed market'.

➔ During the sowing period, large traders interested in potential seed source from agro-ecological areas that provide adapted material. In the example from Kenya, traders serving the area of Kathonzweni source three major crops from well-defined zones (Figure 4).

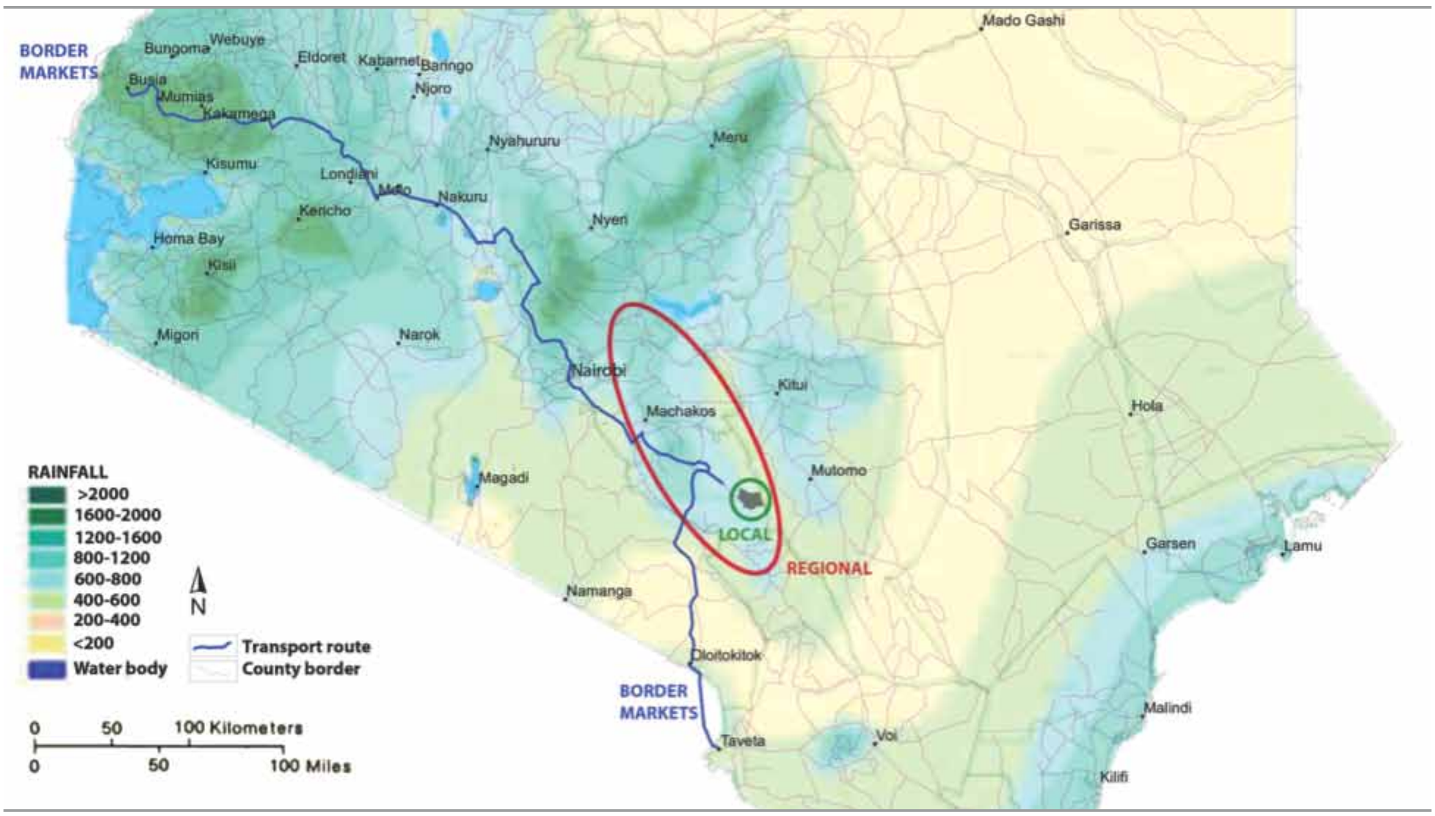

Figure 4 – Potential sources of seed for Kathonzweni, Kenya. Green ring represents local sources (maize), red ring regional sources (green gram, cowpea). Source: SSSA (2011a)

➔ Traders aiming to tap into potential seed markets adapt a series of practices that help add value to their product so that it can be used as seed. Figure 5 lists eleven of these possible practices gathered from trader interviews across eight African countries. Empirical work from Kenya shows the frequency of such 'seed management behavior.' In

2011, over half of the traders interviewed used at least seven different practices to better serve their market.

Management practice	Green Gram	Millet	Cow Pea	Pigeon Pea	Maize	Sorghum
Source grain from specific regions	■	■	■	■	■	■
Seek out varieties	■	■	■	■	■	■
Buy from specific growers	■	■	■	■	■	■
Keep varieties pure	■	■	■	■	■	■
Separate freshly harvested stocks	■	■	■	■		■
Grade stocks				■		
Conduct germination tests				■		
Use special storage conditions	■			■	■	■
Sort out waste				■		
Sort out bad grains/seed				■		
Sell seed and grains separately	■	■	■	■		

Figure 5 – Trader practices in managing potential seed. *Shading indicates that over 50 % of those in the SSSA sample (from Kenya in September 2011, with a sample size of 52) indicated they regularly employ this practice. Source: SSSA (2011a)*

→ At sowing periods, there are well-recognized price differentials between grain suited for sowing and grain that is suitable for consumption only. Two price rises are observed. First, prices spike for the most sought-after varieties for sowing. In high stress areas, varieties differ by as much as 25–50% (see, for example, root rot resistant varieties in western Kenya (Otsyula et al., 2004)). Second, around trading time, traders may distinguish among batches of the same variety that are more or less well sorted and stocked and demand a modest price premium (≈ 5%) for potential planting materials. Figure 6 maps these rises conceptually.

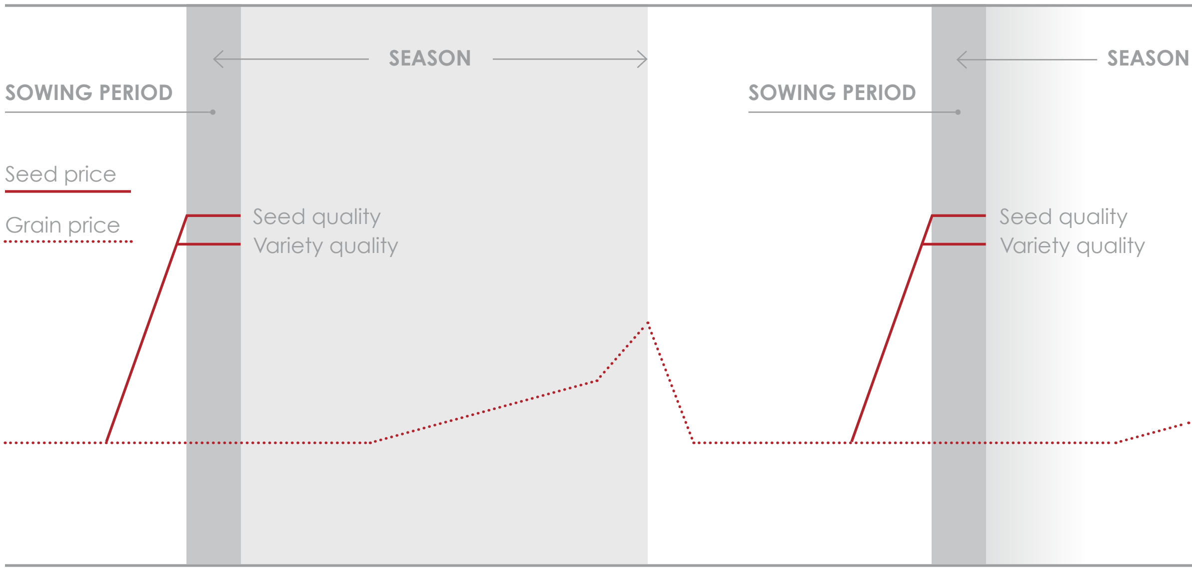

Figure 6: Trends in crop and seed prices in local seed/grain markets through seasons. *Showing seed price peaks at sowing time and grain price peaks before harvest. Seed price differential takes into account variety quality and, sometimes, additional seed quality features. Source: Reproduced from Sperling and McGuire (2010)*

7 – **A good deal of dynamism drives informal seed systems, which makes them open to partnering and improvement.** As a last notable characteristic of informal seed systems, it is important to recognize their dynamism. Informal systems change through time and can respond to change, both features of which are important for demand-driven seed market systems. Over time, seed markets in some areas have become proportionally more important, as larger amounts of seed are being obtained off-farm, and bartering mechanisms are declining in many areas (Lipper et al., 2010). Also, local seed channels and markets serve as an important conduit for obtaining new varieties. One study of groundnut showed farmers using informal markets expressly to get new varieties 62% of the time (ICRISAT, 2010).

3 – Scaling by moving seed of public sector varieties further and more quickly

There are many areas of scaling where it is virtually impossible to consider implementation strategies without working across both formal and informal seed systems. Achieving scale in vegetatively propagated crop systems, for instance, requires careful analysis of a range of approaches that depend on the interface between formal and informal systems, and the ability to scale in each. The following three sections discuss areas in which scaling demands a good understanding of the integrated seed system perspective. In this first section, we examine how the integrated system can be used to move seed of new public sector varieties further and more quickly. The following section considers how an integrated seed system can offer a greater range of crops to serve heterogeneous markets. Lastly, Section 5 considers vegetatively propagated crops, and focuses, in particular, on the challenge of delivering clean materials at scale. The delivery, broader multiplication, and production of clean seed and planting materials (i.e guaranteeing access, availability and quality) are issues that cross-cut all crop types. Below, we select a few illustrative examples to suggest the strategic mechanisms for scaling up.

Moving public sector varieties broadly into seed systems has historically been a slow process with limited success. In Ethiopia, for example, a total of 581 varieties were formally released from 1965 to 2008. Over the course of almost five decades, less than 10% of those varieties have had modest adoption rates (Desalegn, as cited in Teshale et al., 2013). Even when a variety does prove popular among farmers, variety turnover can be slow. In another example from Ethiopia, the white pea bean variety called Mexican 142 has been dominating since its release in 1972, more than forty years ago (Katungi et al., 2010). As we note throughout this work, the slow-moving diffusion of public sector varieties not only infers unattained potential, but also hampers efficiency in public resources spent on plant breeding.

There are many reasons why public sector varieties are not seen at scale in smallholder farmers' fields. The introductory brief in this series noted failures in getting the right attributes of seed, challenges relating to adoption, and also delivery constraints. Recognizing the complexity of adoption, here we focus only on delivery constraints and discuss: (1) proximity of outlets; (2) seed pack size; and (3) marketing and information.

Proximity of outlets

Even for public varieties of crops that flow through formal sector channels (e.g. maize and horticultural crops), formal sector outlets rarely cover the full range of varieties that farmers need. The further farmers must travel to purchase inputs or sell their crop, the less likely they are to adopt new technologies (see, for example, Suri (2006)). Formal channels of distribution are limited in their reach and, particularly, private sector formal channels are limited simply by the fact that distribution costs are high and there are points beyond which it is not profitable to expand. Farrow et al. (2010) mapped agro-dealer outlets in a drought-prone area of Nzaui in Kenya, and showed that only 23% of farmers were within a one-hour walk of a formal agro-dealer outlet.

Experience shows that outlets can be scaled up by building on existing *non-seed* networks and locations where farmers have access to products, services and information. These can be used for moving seed and seed-related information. Scaling strategies might consider leveraging networks and outlets that: (1) require no new infrastructural development; and (2) have proven to be durable, prior to adding the dimension of seed sales. Good experiences have been achieved already using this strategy.

- ➔ Seed sale has been added to 'Mom and Pop' stores (i.e. those that sell tea and sugar and other basic staples in rural areas). For example, from 2002–2007, CARE International facilitated the procurement of seed and fertilizers by rural shop vendors based near Masvingo town, in Zimbabwe. Wholesale loans were initially backed by NGO guarantees. Three years later, rural dealers themselves linked directly with wholesalers as trusted business relationships evolved. The evolution was halted mainly by currency inflation (SSSA, 2009).
- ➔ Seed sale routinely takes place in supermarkets in Malawi where, for instance, maize seed identified by pink or green coloring, along with clear variety labels, signal that seed is being sold. Horticultural seed is also on sale and, inadvertently, bean seed, as the one-kilo packs bagged for consumption are sometimes bought for planting. Within the supermarket model, there may be room to expand the range of seed offered.
- ➔ Seed sale through traders has, to the authors' knowledge, not yet been explored, perhaps in some locations due to seed law restrictions (see 'pack size' below). The volumes moved by traders and their geographic scope of action make them interesting candidates as public sector seed vendors. Conditioning and storage issues would need to be addressed mainly if stock turnover is slow.
- ➔ Seed loans have sometimes proven effective for moving seed of public sector varieties. The term 'seed loans' refers to processes whereby an institution (e.g. a government or NGO) gives rural farmers *seed on loan* with the stipulation that it be repaid with interest (often double) back to a collector or passed on to another set of farmers. The process is likely scalable. For example, Nangina, in western Kenya, facilitated the diffusion of new bean varieties directly to 55,000 farmers over the three-year period, 2008–2010. Indirectly, varieties moved at an even larger scale when harvests were quickly fed into local market channels. As a diffusion mechanism, loans are justifiably criticized when stocks paid back are of inferior quality, or when payback does not occur at all. Seed loan programs would need to be better designed and monitored for scaling up. Seed loans coupled with micro-finance or village savings and loans (VSL) programs might be effective and impact-oriented.

Seed pack size

It is now well accepted in rural marketing that package size can determine market size, particularly in emerging and developing country markets. Hindustan Unilever in India is often associated with the 'small-pack revolution' in rural markets. By redesigning packaging, the price point changes and companies are able to reach entirely new markets (Paul-Bossuet, 2011).

Many seed companies in Africa still sell seed in larger pack sizes[5] – normally a minimum 2 kg bag for the legumes; and 10, 20 or 50 kg bag sizes for maize.

Changing the size of packages can involve costs for a company, including sourcing new packaging materials, re-engineering the information on labels and investing in new equipment. But there is also the possibility of increasing revenues. Smaller packs for some products can mean higher profit margins and market expansion into new supply channels. Companies that make the move to smaller packs are betting that the increased revenue outweighs the costs.

Significant efforts have been made over the last five years to facilitate the delivery and sale of public sector varieties by packing seed in smaller units, which farmers find more affordable and cost-effective. In 2012 alone, a single initiative, Tropical Legumes II, sold 943,170 small seed packs (100g, 250g, and upwards) of six legume crops in 13 African countries (Sperling and Boettiger, 2013). The small pack model has also allowed several types of vendors to engage in the certified seed delivery geared to smallholder farmers, especially national agricultural research systems (NARS) and farmers' groups.

Some private sector companies are moving to this model at scale. For example, Drylands in eastern Kenya has packed an estimated 50Mt tons of beans in small packs for the main 2013 season small pack delivery has also been associated with the sale of quality declared seed (QDS) in Tanzania and Madagascar, with individual farmer entrepreneurs and farmers' groups taking the lead (Rubyogo, 2013). We note that in Madagascar, QDS seed is also sold in bulk, and farmers can buy any quantity desired, even just a 'handful'; see, for example, the GRET project in the region of Ambovombe in southern Madagascar (Sperling, 2013). However, the approach remains fairly localized and requires strong on-site quality controls.

The full potential for scaling strategies based on small packs has not yet been fully explored, however. Transporting lower volumes to more distribution outlets can, for example, fundamentally change logistical costs (e.g. replacing truck delivery with frequent delivery by motorbikes). These changes may mean there are new options to leverage more of the commercial routes of the informal sector, but more work is needed to understand the financial implications.

Marketing and information

Field demonstrations, agricultural shows, posters and technical leaflets are some of the standard marketing tools of the formal seed industry. This is

5 In our interviews for this work, many people said that the situation is changing fast as companies identify new markets for smaller packs of seeds and adjust to the changes needed. We also realized that authors interpret 'small' in different ways; MacRobert (2009), for example, refers to small packs of maize as 2–10 kg.

changing, however, with the increased use of mobile phones in Africa. Some 86% of the population currently has access to mobile phones. Many also have access to mobile banking services. As we have noted in other Planning for Scale briefs, the use of mobile phones will impact seed business development (Putter, 2013).

In addition to technological changes, rural marketing is a growing field (see, for example, Accenture (2013)) and there are lessons that have not yet been applied to the seed sector in sub-Saharan Africa. Planning for Scale Brief #3: Demand discusses marketing in more detail. Here, however, we focus specifically on the importance of marketing strategies that can transcend the artificial divide between formal and informal sectors.

Test initiatives have aimed to promote the use of mobile phones to provide information on seed availability and supplier location, and to allow farmers to report back on variety performance and seed quality (Farrow et al., 2010). To date, much of the *classic* information strategy around seed systems has focused on creating awareness on, or demand for, new varieties and improved seed. Mechanisms such as field demonstrations, agricultural shows, and posters/technical leaflets tend to describe variety attributes and also serve as one-way communication systems (with information flowing out to farmers). New forms of interactive communication are now possible and are likely to foster scale.

Variety information also needs to be better tied to concrete seed outlet possibilities (see ‘Widening the Range of Crops’, below). Those testing new varieties, especially in on-farm trials, could be linked systematically to mobile systems of feedback (Van Etten, 2011). As with the case of small packs, engaging large traders in information conduits about new varieties and new seed stock locations could also facilitate important scaling benefits. Varied entry points for linking would need to be tested. Scaling public varieties will depend on the adaptive use of technology to reach many more farmers through informal channels with information about new products. Figure 7 cites some examples.

Potential scaling investments for moving new public sector varieties more quickly

The following is a preliminary list of potential investments that use integrated seed systems to move new public sector varieties more quickly. These can contribute to either individual, tailored scaling strategies, or to the broader ability to scale adoption of improved varieties among smallholder farmers.

Figure 7 – Summary of scaling tools: how to move new public sector varieties further and more rapidly.

SCALING GOAL	Increase the proximity of outlets to get seed closer to farmers
HOW TO DO IT	➔ License 'mom and pop' (general goods) stores to sell seed. Invest in training. ➔ Expand current seed sale in supermarkets to include a wider range of seed varieties (in small packs). ➔ Consign sale to large-scale traders of small seed packs to move through existing informal networks. ➔ Professionalize the seed loan process in select areas, coupled with micro-finance initiatives. ➔ Expand geo-referencing capacities. For example, map agro-dealer outlets related to target stresses (e.g. drought tolerance). Target in key gap areas.
SCALING GOAL	Reduce the size of seed packs for purchase
HOW TO DO IT	➔ Conduct strategic research on pack size by crop and context. (Consider adjusting packaging materials). ➔ Use small pack strategy for QDS seed also – to reduce cost and expand availability.
SCALING GOAL	Improve marketing and access to information about varieties by farmers and traders
HOW TO DO IT	➔ Enable SMS two-way information networks. For example, collect farmers' information on availability and location of seed suppliers. ➔ Create more systems for mobile phone feedback that engage large-scale traders, aggregating their market experience in, for instance, in select varieties. ➔ Create more mobile phone-based feedback systems that interact with a range of users, collecting and aggregating data on variety performance and seed quality.

4 – Widening the range of crops available

In this section, we address the challenges of making seed available for the wide range of crops and varieties farmers may desire. In many countries, the formal private sector routinely focuses on maize and key horticultural crops, and the formal public sector can only partially fill the rest of the gap, perhaps multiplying rice, groundnut, beans and other majority crops to serve its smallholder farmer base. However extensive formal sector supply may be, there remains a gap between seed availability, and the demand for seed of a diverse set of crops that farmers may want and need. Hence, here we focus on models of *decentralized seed production* or *small scale seed enterprise*, which give attention to these neglected crops that may also be of major importance for farmers' nutrition and income, and for farming system resilience.

A number of informative compendia exist on decentralized and smaller-scale production, including, to name a few: Almekinders and Louwaars (1999); Rohrbach et al. (2002); Setimela et al. (2004); Thijssen et al. (2008); and Walsh and Remington (2013). These provide detailed and varied case study insights. However, even considered cumulatively, these analyses leave a number of gaps in the literature, and in our understanding of how decentralized multiplication can alleviate seed availability constraints. First, none appear to present a typology of *decentralized seed production and delivery systems*. Thus, it is not possible to compare the results of model X with those of model Y (even recognizing that there are multiple variations of any one type of decentralized seed production model). Second, very few of the studies have assessed economic costs and benefits (Rohrbach et al., 2002; Katungi et al., 2011; Kamara, 2010), by asking, for instance: *How much does it cost the producer to multiply and sell the seed? What are their estimated profits? What do farmers earn from their initial investment of seed?* Third, none of the work to date addresses scaling issues. Two aspects are especially important here for developing strategies for scaling the availability of seed in integrated seed systems: (1) how to tie decentralized units together in a coordinated way to *achieve* scale; and (2) how best to start decentralized production *at scale*.

In the spirit of moving forward the discussion of scaling up the availability of seed, we look at preconditions for scaling up seed availability, and then turn to examine actual experience in the field. Six themes are addressed:

- ➔ Key features for more successful, decentralized and small seed business enterprises
- ➔ Seed cost data and elements needed to assess cost
- ➔ Certified versus other quality seed
- ➔ Organizational networks and innovation
- ➔ Strategic brokering
- ➔ Producer information bases

Key features for success

Key minimal features have been identified as preconditions for more successful integrated seed enterprises (and these complement those listed in the *Planning for Scale Introduction*). Without listing all the features, we focus on several that stand out as particularly important[6]:

6 This list is derived, in part, from: Rohrbach et al. (2002); Setimela et al (2006); Van Mele et al. (2011).

- ➔ The variety has to be a highly demanded one
- ➔ The variety has to stay in demand or, more likely, an evolving group of highly demanded varieties needs to move through the seed producer pipeline
- ➔ Seed multipliers need guaranteed access to initial supplies of high quality seed (either foundation seed or, less costly, certified seed)
- ➔ A clear, compelling marketing strategy needs to be in place—targeted to client and aim
- ➔ Costs need to be *low* to compete with seed found on open seed/grain markets (or the gains from planting quality seed must demonstrably exceed the additional cost)

These seed-related features need to be supplemented with services that are linked to agro-enterprise in general, for example: input access, storage, processing equipment and transport capacity (Bentley et al., 2011). Much of the current integrated seed system work to date has focused on the supply side issues (e.g. techniques of seed multiplication) rather than addressing the full set of required features.

Seed cost data and elements needed to assess cost

Programs that are deemed 'successful' in international development are often not those that are cost-effective, or profitable. In keeping with the focus on this work, we seek *sustainable* scale; therefore, the ability of an informal seed producer, for example, to remain profitable after donor funding disappears, is essential. The recent compendium by the Food and Agriculture Organization of the United Nations (FAO), on African Seed Enterprises, summarized nine cases and defined an enterprise as *successful* if it still existed for several years running, even *with* subsidies. No audits were carried out and no financial information was reviewed (Bentley et al., 2011).

Searches for cost data on decentralized seed enterprises in Africa (including small-to-medium enterprises-SMEs) located only a handful of cases. In 2010, the International Institute of Tropical Agriculture (IITA) calculated the cost benefits of its 'community-based seed systems' (CBSS) work for cowpea and soybean seed multiplication in Nigeria. The gross margins per hectare (ha) were $168 and $252, respectively (Kamara, 2010). A cost-benefit analysis on bean seed production was conducted in Kenya, roughly during the same period. This concluded that profits from bean seed production were comparable and amounted to $219/ha, with variety productivity being the main factor for cash gain (Katungi et al., 2011). Costs were also estimated for several projects where the results were shown to be not profitable. In lowland coastal Kenya, maize was produced by community groups and sold at 100 Ksh/kg versus 13 Ksh/kg for grain, but the expenses incurred did not cover the costs (Chivatsi et al., 2002). In Tanzania, three community-based production initiatives were reviewed with estimates concluding that most seed producers were not making a profit: cost was estimated at Tsh 251.88/

kg while the breakeven price for seed was calculated at Tsh 252/kg (Rohrbach et al., 2002).

To summarize, data on costs, revenues and profitability are rare for decentralized seed initiatives, even where there has been substantial donor investment. Certainly, determining whether a seed enterprise can be profitable should be a precondition for deciding whether it can or should be scaled up. Analyses of the scale needed for seed production/delivery models to achieve profitability should be built into initiatives that aim to achieve sustainability and higher levels of impact. However, such financial analyses, at scale, are completely absent. Finally, there are seed system specialists who suggest that a commercial lens on all seed production and delivery models is unrealistic, and that more targeted work needs to distinguish those types of seed initiatives that could achieve commercial viability, and those which will always need subsidies. The argument goes that select subsidized cases could deliver public sector benefits to outweigh the costs, especially in contexts of widespread outbreaks of disease (Walsh and Remington, 2013). Even in this scenario, we argue that the lack of financial analysis significantly constrains evidence-based decision-making.

Seed quality: certified versus other quality seed

Determination of the seed quality needed to market a product is a central element in the cost analysis. It also fundamentally determines whether the product can be labeled as seed at all. Many major syntheses on decentralized production and SMEs strongly suggest that policies need modification if programs are to scale up and/or meet most small-scale farmers' needs. Several conclusions are common. For example, consider this quote from Bentley et al. (2011): '*Certified seed is overrated. Many successful [seed business] enterprises do not certify their seed, and none of the seed potato enterprises [among the case study samples] do….*' The transaction costs and the social contact needed for certification favor larger enterprises and lock out smallholder farmers. In some cases, analysts even question if initiatives could technically meet quality declared seed (QDS) standards (Rohrbach et al., 2002). Furthermore, farmers may be willing to pay a premium for *new varieties* (see 'Pack Size', above), but paying a premium for *higher quality seed* is an entirely different issue (Rohrbach et al., 2002).

QDS programs are in place in a number of African countries (for example, in Zambia and Tanzania, and beginning in Madagascar), but they seem to represent a relaxing of regulations rather than a positive application of standard new regulations (McEwan et al., 2012). It bears emphasis that non-certified seed, or non-formal sector seed does not necessarily mean lower seed quality for the farmer or significantly higher risk. There are contexts where farmer-produced seed is of good quality even when compared to seed that is formally produced (Buruchara and David, 1994; Otsyula et al., 2004; Thiele, 1999). One difference is that specialist informal seed multipliers trade locally and on their reputation, rather than on the brand of a government-issued label. Indeed, the real value of certification is enabling trust when seed is bought from sources where the buyer does not have a direct relationship with the original seed multiplier.

The quality of informal sector-produced seed has also been known to be unusually responsive to the adoption of innovations, which suggests that improvements can be catalyzed. In reference to storage improvements, one multi-project review showed that farmers pick up hermetic storage methods quickly (for maize, beans and cowpea) and this has led to an even greater awareness of seed quality issues, including purity (CRS, 2013). Perhaps more important in terms of scale, large traders respond to opportunities that demand seed quality to be heightened. As an example, in order to participate in CARE's seed relief program in eastern Ethiopia in 2002, large traders employed a range of seed quality enhancing practices, including: changing warehouse conditions, maintaining specific seed stores, and separating out specific varieties (McGuire and Sperling, 2010).

The same phenomenon of heightened quality has been recently linked to food procurement. An evaluation of the Purchase 4 Progress (P4P) program showed participating traders making investments in quality assurance equipment, which led to better quality food products in local markets (WFP, 2013).

Decentralized organizational networks and innovation

Investment in organizational networks was a critical factor in making seed and planting material available to 18.3 million bean farmers working with the Pan-Africa Bean Research Alliance (Sperling and Boettiger, 2013), and to 1.35 million cassava farmers linked to the Great Lakes Cassava Initiative (GLCI). In both these examples, networks united decentralized producers with higher-level structures. These higher-level structures , in turn, shaped clear divisions of labor (NARS, NGOs, farmers' groups and entrepreneurs, private companies, grain traders); provided up-to-date training and technical information; and, in some cases, stimulated key marketing opportunities (to private sector, institutional buyers, and sometimes subsidy programs). In the case of the Pan-Africa Bean Research Alliance (PABRA), the scaling model crossed 28 national systems (including hundreds of partners) and was particularly important for multiplying scores of varieties targeted to varied ecological zones, and for scaling up to address regional market needs (Sperling and Boettiger, 2013). For GLCI, the scaling had to take place through mobilizing multiple units spread over large areas geographically; this occurred not just to scale up availability of planting material (GLCI worked with 50 implementing partners) but also to control and isolate the spread of Cassava Brown Streak (Walsh, 2013; Peters, 2013).

Structured demand initiatives (e.g. those tied to aid procurement) can sometimes also spur organizational innovation and seed availability, even allowing systems to scale for distinct time periods. The FAO frequently ties its emergency aid input trade fairs to well-monitored seed production groups (see, for example, the case of Zimbabwe, Mozambique and Haiti in Kugbei (2013). The Purchase for Progress (P4P) group also significantly stimulated food production for aid distribution from 2010-13, involving signed contracts with 398 farmers' organizations in 20 countries (P4P, 2013). How these initiatives will evolve to longer-term scaling up of seed production capacity remains to be verified.

Start-up and maintenance costs are incurred in the process of creating, catalyzing and strengthening such expansive networks. Higher-level structures also have to be facilitated to remain dynamic and accountable to decentralized member bases. Scaling investments for rendering networks functional for seed production and delivery have the potential for large pay-offs, but further value can be gained when other functions piggy-backed those associated with seed availability; for example, functions linked to demand creation and joint marketing.

Strategic brokering

Brokering for seed supply has resulted in seed availability achievements at scale. This type of brokering usually involves links to better market development and more integration of market actors all along the market chain. The brokering of different types can be seminal: linking formal to non-formal groups (for example, certified seed producers to large-scale seed/grain traders), or linking lower level producers and sellers to more aggregated ones (specialized seed producers to agro-enterprise companies). Brokering can result in leaps in the availability of seed and grain. The case of scaling up white pea bean in Ethiopia, to tie in with export markets, is well known, and amounted to $117.5 million between 2004 and 2007 (EIAR, 2009). Interestingly, brokering partnerships seems to exhibit the same pattern as many of our other scaling features. The brokerage function itself is difficult to scale or to start at scale, and unfolds at more decentralized levels of partnership building. (Sperling and Boettiger, 2013). Strategic research in this area of brokering partnerships could produce certain pay-offs.

Unified seed producer information bases

Information bases on seed multipliers, to help join individuals and smaller groups together into bigger and more coherent supplier networks, are just starting to be constructed. For instance, in Uganda, seed multipliers of beans were mapped on a central grid in 2013, and the mapping of Kenyan and Rwandan seed multipliers should be completed by early 2015. Information has been charted by location and includes details on crop, variety, quantity of seed produced and harvest period. The names, telephone numbers and location details of the multipliers are entered into a unified directory which spans seed companies, producer associations and cooperatives, women's collectives and community-based seed producer groups. Such coordinated information systems, which should be made available on the web, are meant to link suppliers to buyers, share up-to-date market information and spur further seed supply production by tying producers (and sometimes larger producers) to a wider set of markets (Rubyogo, 2013).

Overall, in reviewing initiatives to scale up seed availability, we can see modest advances, especially in the area of organization, brokering and synthesized information bases. Some basic prerequisites for scaling availability merit further and immediate attention, particularly in the areas of generating financial data specific to production and delivery models, and in good analyses of the benefits and risks related to flexibility in seed quality. Notable, is that scale in seed availability has been achieved to date largely by uniting multiple lower level units. At this point, we have identified no integrated seed availability models that have *started* at scale.

Potential scaling investments for widening the range of crops available

The following is a preliminary list of potential investments that use integrated seed systems to widen seed availability for a greater range of crops. These can contribute to either to more decentralized, tailored scaling strategies, or to more united upper level entities that link multipliers across crops and space.

Figure 8 – Summary of scaling tools: widening the range of crops available, focusing on seed supply.

SCALING GOAL

Determine more cost-effective models for decentralized seed production and delivery

HOW TO DO IT

- ➔ Develop full typology of integrated seed system production and delivery models currently in place.
- ➔ Analyze cost-returns, at diverse scales of production and delivery (promote better bets, eliminate non-sustainable elements).
- ➔ Identify salient features of seed system contexts that demand tailoring of production and/or delivery. (e.g. crop type, level of infrastructure, market end use). The aim: to match 'best bet' decentralized models with context.

SCALING GOAL | **Broaden seed quality options to meet end-user needs at lower cost**

HOW TO DO IT

- ➔ Analyze quality declared seed (QDS) gains, costs, risks—across key crops. Promote QDS where profitable and risks are reduced.
- ➔ Analyze truthfully labeled seed (TLS) gains, costs, risks, where profitable and risk-reduced. Promote TLS where profitability and risks are reduced.

SCALING GOAL | **Catalyze organizational innovation in seed and agro-enterprise platforms**

HOW TO DO IT

- ➔ Catalyze platforms that link formal and informal seed producers and traders. Across 'like crops' (e.g. legumes) leverage opportunities for scale in production + marketing, and sustainability.
- ➔ Explicitly link decentralized producer units to higher-level marketing and information sharing conduits. Ensure higher-level accountability to members.
- ➔ Review how structured food demand initiatives can be tied to new varieties and good seed use.

SCALING GOAL | **Broker strategic formal-informal seed system partnerships**

HOW TO DO IT

- ➔ Review range of partners and functions in integrated system and identify key brokering links. Linking large-scale traders to new variety information and the sale of small packs may prove a good entry point.

SCALING GOAL | **Construct dynamic seed multiplier information databases and networks (Geographically-referenced, Web-posted)**

HOW TO DO IT

- ➔ Create dynamic databases of all seed multipliers, including country-specific as well as regoinal. Use compilation to link suppliers to buyers.

5 – Catalyzing scale in VPC systems with a focus on clean materials

To end our analysis of scaling options and integrated seed systems, we briefly address innovations in the seed quality domain, and focus especially on vegetatively-propagated crops (VPCs). Scaling seed systems for vegetatively-propagated crops, such as banana and plantain (Musa), cassava, potato, sweetpotato, taro and yam, is challenging. As noted in a recent workshop dedicated to root, tuber and banana systems '*recurrent stresses, e.g. virulent pests and diseases and climate change, mean that even the local seed systems, which provide 99%+ of the planting materials currently sown, may not function in ways which guarantee a modicum of household security. Also, VPC seed systems pose special challenges (in contrast to grain-based cereal and legumes): inter alia, relatively low multiplication rates, perishability of planting materials, susceptibility to infection by viruses and other pathogens, relative bulkiness, and difficulties in transport.*' (CGIAR-RTB, 2013).

Although VPC seed systems do all share common characteristics (above), it is worth noting that they vary widely in their reproductive strategies and in the nature and local importance of each crop. Integrated systems will need to reflect these important differences, analyses of which are outside the scope of this study. It is also worth emphasizing that potato (known often as 'Irish potato' in Africa) differs from the other VPCs in that it is not only an important cash crop, but also one grown widely in the northern hemisphere and outside the tropics. Indeed, countries such as Mali import all of their basic potato seed from Europe on an annual basis (approximately US$2 million of seed per year) and a number of European seed multipliers are exploring the supply of certified seed directly to other countries in sub-Saharan Africa, including Kenya. Another atypical feature of potato is that some varieties appear to be very widely (even globally) adapted. While these are noted as unique characteristics of the potato, the rapidly changing status of cassava as a potential cash crop could, however, radically change opportunities for introducing more structured seed systems for cassava in the near future.

VPC seed systems, with perhaps the exception of potato, *must* be integrated. Even for potato, however, the use of quality seed in sub-Saharan Africa still accounts for far less than 10% of the need. In short, the high costs of planting material and multiplication, and the constant need for seed quality maintenance, result in little private sector interest and low public sector capacity. The ongoing threat of Cassava Mosaic Virus and Cassava Brown Streak in eastern and central Africa, which have endured and evolved over three decades, indicates the magnitude of the challenge. Unlike for legumes and cereals, VPC-linked interventions have to go well beyond an injection of new varieties: seed quality threats can be constant ones, negatively impacting both local and modern varieties.

The authors know of no seed quality interventions for VPCs that have really gone to scale in a sustainable way. Some promising propagation techniques and approaches have been used in pilot programs, which may be on the verge of being scaled up, but 'proof of concept' must still be translated to 'proof of scale.' Among these, we note two in particular. The 2009–2011 '3G' seed potato project intervention in Kenya, Rwanda and Uganda, carried out by the International Potato Center (CIP), introduced aeroponics and other rapid multiplication technologies in the context of an integrated system so as to reduce field generations from six to three (CIP, 2012). To date, the '3G' approach has resulted in an integrated seed system supplying seed of CIP/Kenya Agricultural Research Institute (KARI) varieties to an estimated 30,000 smallholder farmers. Second, The International Center for Tropical Agriculture (CIAT) developed tissue culture techniques to control a range of systematic pests and diseases in the 1970s (Roca, 1984), and then simplified them more recently for use in rural areas of Colombia. As one element, rural laboratories are based on local materials and media, using for example, fruit juices and pressure cookers (Escobar et al., 2013). Both propagation techniques appear to have significant potential to scale up, and are being reviewed for their practicality as well as for their cost-effectiveness. The two are also being linked to larger agro-enterprise possibilities.

More generally, strategies for producing clean VPC planting materials at scale have been given a boost of attention by the recently initiated CGIAR Crop Research Program (CRP) on roots, tubers and bananas (RTB). This program has set as one of its prime seed system research goals the identification of common tools and techniques to improve quality seed multiplication, asking what works best and where (CGIAR-RTB, 2013). We anticipate good progress in this arena in the next few years.

Experiences in working with VPC seed systems at scale are yielding some important lessons. Those linked specifically to the function of supplying clean planting material are summarized in Figure 9. It is worth noting two distinct, over-arching, and often confused, objectives that scaling strategies can work toward. The first, encompasses schemes designed to rapidly diffuse publicly-bred improved varieties (for example, virus resistant cassava) into largely informal seed systems, with the expectation that communities will maintain the new variety, even in the absence of supplying 'clean' planting material on an ongoing basis. In the specific case of introducing and diffusing new virus resistant germplasm, then, this can also be seen as an entirely alternative strategy to supplying 'clean' planting material on an ongoing basis. Other programs pursue a second objective, which is to build on or facilitate trade in supplying 'clean' material on an ongoing basis, using informal, formal or integrated approaches. The rationale here is also a conduit for introducing new publicly-bred varieties (the seed of which often trades at a premium in the early years), but the two distinct rationales are often confused.

Potential scaling investments for catalyzing scale in VPC systems

Figure 9 – Summary of scaling tools: catalyzing scale in VPC systems, focusing on clean materials.

SCALING GOAL

Ensure real demand for VPC clean materials

HOW TO DO IT

- ➔ Focus first and foremost on variety.
- ➔ Establish cost-benefits of farmers' adoption of quality planting material. Is the farmer willing to pay? If so: How much?
- ➔ Distribute/sell planting material in small bags (potato) or small quantities to stimulate awareness (linked to small pack size).
- ➔ Stimulate market linkages (commercial off-takers) to drive clean seed supply. Input and credit availability may be tied to new planting material inputs.

SCALING GOAL **Identify rapid/more streamlined multiplication techniques**

HOW TO DO IT

- ➔ Confirm select rapid multiplication techniques.
- ➔ Establish decentralized rural tissue culture laboratories.
- ➔ Identify low-disease pressure multiplication sites, often with good availability of water.

SCALING GOAL **Create an ongoing process of clean planting material production linking actors at varied levels**

HOW TO DO IT

- ➔ Stimulate systematic links between primary multipliers and decentralized, secondary seed multipliers.
- ➔ Provide information on the identity and whereabouts of quality seed suppliers (seed catalogues, etc.).
- ➔ Establish demonstration sites, including those linked to decentralized seed multipliers.
- ➔ Profile, and train local seed multipliers in entrepreneurial and quality management skills.

At times, the problem of developing sustainable VPC seed systems in developing countries has been approached through the lens of experience in potato seed systems in Europe and to a lesser extent North America. It is worth remembering that European systems such as the formal potato seed systems, requiring as they do the adoption of 100% certified seed, often reflect their position as seed exporters and not simply as potato producers.

The logic is that unless an African country or region wishes to become known as a specialist seed exporter, then the high-level adoption of formal seed would actually be undesirable (even if it could be achieved). It is interesting that the adoption of certified potato seed in China and India accounts for about 20% of the planted area, while rising to about 30% in Brazil. This also suggests that an integrated approach is necessary and indeed desirable, relating to the simple logistics of supplying certified planting material (seed) at scale.

A number of scaling interventions have proved successful for developing VPC seed systems either alone or in combination. As stated before, farmers' demand for particular varieties is of course the principle determinant of success. This is a tautology, of course, but equally so many attempts have been made to scale fundamentally flawed varieties that it bears repeating. Indeed, there are cases such as the informal and unreleased potato variety *Shangi*, which achieved an estimated 40% adoption in Kenya in very few years, entirely through farmer-to-farmer exchange without any external intervention. The successful farmer-to-farmer exchange of the NASPOT series of sweetpotato varieties from Uganda's National Agricultural Research Organization (NARO) is also testament to the skill of the breeder.

Some scaling lessons linked to the provision of clean materials include:

- Decentralized and local secondary seed multipliers form an important link between primary multipliers (which could be based on certified input seed) and seed buyers. Mostly trading on their reputation, they are also an ideal additional source of extension advice on the merits of clean seed and new varieties. Care should be taken to avoid distorting any existing seed markets through over-reliance on institutional markets.
- Provision of planting material in small bags or in small quantities is proving a popular device for raising awareness on the benefits of clean seed and new varieties at little risk to the buyer. If the variety is being introduced simply on its own merits, then it is also a cost effective method of campaign-based distribution.
- Designing VPC seed systems, where market linkages are in place or can be established, opens up avenues for the off-taker supplying clean seed (and recovering the cost from harvest receipts) or offering collateral for seed and other input purchases. Overtly linking seed and other input provision to the availability of credit brings other issues of logistics, organization and timing.

6 – Conclusion

There is considerable evidence that integrated seed system development can achieve important scaling opportunities that the formal sector alone cannot. For instance, integrated seed systems have the potential to move public sector varieties more widely, extending geographic and social coverage, with significant food and economic pay-offs. This can be achieved in relatively short time periods. According to Rohrbach et al. (2002): '*Increases of as little as 10–15% in the adoption rates for new, more productive varieties can increase aggregate national income by millions of dollars.*' Innovations in delivery outlets, pack size and information conduits represent concrete investments that can increase the scale of impact relatively quickly. To achieve these impacts, integrated approaches will be needed to move a greater range of cereal and legume crops, as well as to move most vegetatively-propagated crops (VPCs). In VPCs, an integrated seed system would be the main driver for seed system impact and scaling up, as a formal sector complement is near non-existent.

In terms of widening the range of crops on offer (which will be key for nutrition and resilience gains, as well as those linked to food security), there is an urgent need to invest in fundamental groundwork. Typologies of major seed production and delivery models must be characterized. Cost-return analyses of organizational options need to be broadly implemented and analyzed. The possibility for broadening seed quality for select crops needs to be explored. To date, the successes that have been achieved at scale have mostly hinged on breakthroughs in organizational innovation (i.e. developing networks uniting formal and informal seed actors that operate at national, regional and even pan-African scales). The importance of such organizational innovation, including the building of social capital that promotes integrated linkages, should not be underestimated.

Underlying all investments, there is a need for greater precision communications about integrated seed systems. There are benefits to pushing for greater practicality in the use of the term, specifying which players are being linked in novel ways to achieve which functions and by which mechanisms. Current thinking needs to embrace the issues of scale, as there are enormous opportunities for advancing integrated seed system approaches to scale the adoption of improved varieties and good quality seed among smallholder farmers.

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