LITERATURE REVIEW

Agricultural Technology Delivery Experience: Legume Seed and Last Mile Smallholders

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Executive Summary

This review looks at seed distribution and other technology dissemination models that may be relevant to legume seed, and the challenges that those models have encountered. It then charts potential solutions that have been pioneered from outside companies and social enterprises, solutions that could be applied to the models to get quality and improved seed into the hands of smallholders. Finally, the review concludes with lessons that could potentially help models reach marginalized producers, 'the last mile'. The focus here on 'last mile' refers to farmers who might be geographically, politically or socially removed from access to innovations. Note also that many crops and varieties are bred specifically for 'last mile' type areas, such as drought-prone regions.

The review notes seven specific models of seed distribution: commodity traders; community-based seed producers; agro-dealers; village-based advisors; seed company agents; supply-chain facilitated technological access; and integrated services via social enterprises. Much of the experience remains either of limited duration or context (still could be considered pilots) or the literature has outstanding questions of reach, volume, or sustainability. No single model stands out as an achievable solution. If anything, the models may raise more questions on what truly gets smallholders to use routinely new varieties or quality seed. Is it distance to access inputs? Training needed to fully utilize new seed? Reducing the risk for the smallholder through smaller packs and crop insurance? Innovations in finance, transportation, or distribution networks?

Many in this field look at the success of Coca Cola in reaching the last mile and wonder what is limiting seed from reaching the most remote markets. Here the review presents business innovations used by various enterprises and companies and suggests their possible adoption and inclusion into programming. Bundling services partially works for One Acre Fund (although not at scale for legumes) ; piggy-backing off existing distribution networks helped d.light reach rural customers; heavy investment and time put Unilever's products on shelves across SSA; Coca Cola's informal distribution network and willingness to change, based on appropriate business responsiveness feedback loops in rural areas, has seen the beverage reach lips of consumers in the most remote areas.

The review concludes with a look at the models and questions what is really needed to make them more effective. Most of the experiences are still in pilot stages or lack a sufficient evaluation base to truly note their effectiveness. While certain innovations such as repackaging seed into smaller packs have shown promise across almost all models, there still exist questions as to the effectiveness and sustainability of most models. Reach is seldom noted—are the smallholders benefiting from programs living close to town, along major thoroughfares, or in extremely remote areas? Are there viable models to extend to producers beyond that? And do these models incorporate business-based feedback loops to understand smallholders, or simply note a lack of training or lack of access to finance as the primary adoption roadblocks? Most models feature training, but is that what is required? Smallholders in PROFIT+'s scheme purchased seed without the introduction of credit schemes—what does that signal about the reliance on an assumed lack of access to credit? Coca Cola has embraced informal market approaches, and social enterprises have adopted innovation from for-profit companies. Maybe most important is how smallholders view risk. Understanding the risk profile of rainfed producers and providing farmers with risk management options is paramount to effectively distributing seed—programming for the last mile must implicitly understand this and build it into every intervention.

Overall, this review is an effective starting point for understanding what models exist to move seed but notes that no single model has the proverbial nut cracked. It also highlights key gaps in the literature that can provide a learning agenda for programs and pilots going forward.

I. Introduction

For the past fifteen years, many donors have increased their investments in varietal and seed technology development and other agricultural input innovations. Similarly, donors and implementers alike have recognized that results of the research and technology development efforts are still not reaching farmers for reasons that include issues of access, availability, and quality, among other factors. Therefore, the last 5-10 years have seen numerous donors and implementers (private sector and non-profit actors) actively test and implement various delivery models, as well as strengthen potential delivery systems, with a focus on the access issue of farmer adoption.

A lot of this input delivery investment has been focused on maize seed (especially hybrids), fertilizer dissemination and distribution channels. Significant questions have emerged within the broader implementing community to understand better the technology distribution and dissemination experience to date, as well as the relevance and opportunities that may exist for other technologies to move through those channels. In addition, these experiences (models/channels) need to be understood in their context – their reach, the volumes moved, their replication, the supporting or inhibiting enabling environment, the incentives for the key actors, and the characteristics of the products moved.

Grain legumes play a key role in many rainfed smallholder production systems. Grain legumes are important for household nutrition, risk diversification with farm management, and crop rotation. Grain legume seed does differ in many ways from maize seed. While in some markets, hybrid maize has gained significant ground among hectares under production; grain legume seeds are self-pollinated; that is the resulting seed will produce plants identical to its parents and can be easily resown. Self-pollinated crops are traditionally produced in African systems from seed saved by the producers or from seed routinely purchased in local markets. Informal seed systems spread self-pollinated crops through the purchase and planting of grain by neighbors or other producers [or 'seed' grain which has had some selection, sorting, cleaning, and careful handling for a small seed premium—referred to as 'potential seed' (Sperling and McGuire 2010).] In addition, some grain legume seed can be less stable between multiple seasons than hybrid maize seed – seed not sold one season may lose significant quality and germination if carried over and sold for a subsequent season. Legumes also may require tighter environmental controls in handling and storage, such as soybean and groundnut. These factors, among others, have been partially addressed by pilot distribution and dissemination models, but need to be scrutinized further. Identifying relevant models from outside of the limited experience with legume seed to date, will hopefully help direct future efforts to assist in getting more quality legume seed to those producers who rely upon the crops in their production systems.

This literature review examines the research and experience regarding technology distribution and dissemination with an emphasis on how quality seed (of a range of crops, but especially maize) and other inputs or small-scale technologies reach farmers, particularly those models reaching farmers 'at the last mile'. Our focus has been on Africa, although examples which may have relevant learnings for the African context have been drawn from elsewhere.

II. Methodology

While there is a surfeit of literature on maize seed distribution and value chains, many of the underlying experience is of short duration, often still what might be considered a pilot experience. There appears to be less written on programs and models for other—especially legume and non-maize cereals—seed input supply programs. This review includes innovative practices of delivery found from non-agricultural models to assess potential game-changers and draws on the documents, reports, white and grey papers, slides, reviews, articles, book excerpts, and critiques that exist. The review attempts to examine such literature, as it exists, for other development professionals, yet also notes where trustworthy or tested information has been missing. More weight has been given to those documents with well-noted sources, and independent evaluations and reviews, including those that examined programs across a longer period than initial launch of programs. The basic questions of this literature review were developed after initial research and refined over consultation for emerging themes. The review cannot possibly incorporate all literature on seed input and adoption but has been designed for professionals already familiar with the challenges and knowledge surrounding work with smallholders.

The review identified 7 categories of technology dissemination models described in Section III:

1. Commodity traders
2. Community-based seed producers
3. Agro-dealers
4. Village based advisors and Private Input Service Providers
5. Seed company agents
6. Supply chain facilitated technology access
7. Integrated Service via Social Enterprise[1]

Several common themes emerged and are discussed in further detail in Section IV. These themes are:

- Delivery models inclusive of extension
- Bundling and piggybacking
- Product/market fit – small packs
- Marketing and market segmentation
- Access to credit
- Risk
- Scalability and Replication

III. Technology Delivery Models

Numerous models exist in the input supply sector, and not all are focused on delivery specifically of legume or cereal seed, let alone seed in general. Examination of these models and their general methods has been necessary to understand what has already been done or what is currently on-going within the context of SSA. While these models focus extensively on sub-Saharan Africa (SSA), at times outside models or specifics are included to highlight certain practices or insights that may be beneficial towards gaining a clearer understanding of seed input systems.

[1] The review was not able to locate multi-sector rural enterprises, possibly selling seed, but also other commodities, such as food staples or fuel.

Commodity traders

The majority of smallholder farmers buys and sells at least some of their production through the local market system. Fifty-one percent of all seed moves through these markets, including 65% of all legume seed (McGuire & Sperling, 2016). The movement of seed through these local markets, directly by smallholder sellers or via commodity traders (i.e. including specialized seed/grain handlers) dwarfs the rest of the models, but to understand this system, the formal system needs to be contrasted.

Sperling et al (2013), using Louwaars' definitions, describe the formal system as:

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.

But the informal markets, which characterize the majority of SSA markets, especially those in which smallholders routinely buy, are quite different. Sperling et al, 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 seed and grain, and
- Highly dynamic

According to one six-nation study, over 90% of the seed smallholders sow is accessed from the informal sector, with 51% coming from informal markets. Fifty-five percent of all seed-linked interactions are based off cash transfers (neighbors and markets), and the informal markets, as key points of seed transactions, are highly persistent, even in the face of well-developed formal markets (McGuire and Sperling, 2016). Sperling et al, again notes that in Kenya and Malawi, nations with strong agro-dealer networks, smallholders still source 27.8% of their maize seed from local markets, compared to 20.3% of maize seed from formal dealers (Sperling et al. 2013). The informal market is dynamic and resilient, rebounding from currency crises in Zimbabwe and the civil war in Rwanda, yet remains slightly connected at best to integrated seed system linkages.

According to the available literature, there has been little in the way of programmatic attempts to leverage the market 'middleman' for technology dissemination. Alternative models and channels have been pursued by actors wishing to increase smallholder access to technology, including quality seed; these are discussed in the subsequent detail.

Community-based seed producers

The second most common model throughout sub-Saharan Africa (SSA) is that of community-based seed producers and/or local seed businesses (LSBs). Community-based seed producers are associations of

smallholder farmers organized and trained to produce quality seeds. In this model, local farmers organize themselves into groups or communities to multiply selected varieties of seeds. The focus is most often on newer varieties, and the seed producers themselves maintain certain standards of quality (these standards may not be certified, but they are higher than those in the informal market). Community-based seed producers are often organized and trained within a value chain development project where quality seed availability has been identified as a constraint by the implementing organization. The project most often provides complementary demand for the quality seed initially produced by the community-based seed producers, either directly or through demand development with the broader community of producers engaged in the program. The community-based seed producers are typically the lead farmers and early adopters of technology within the communities, as seed production is a more technically demanding type of agricultural production.

These groups, and associated local seed businesses, are highly dynamic, but are not found in all communities and have their share of potential challenges, including production of new varieties that may not yet be in demand within the local communities or set up to sell into communities without a strong commercial seed demand. The investment in seed production is higher than grain production and the community-based seed producers often prefer to produce based on contractual relationships due to the market and investment risks; for programs, for local seed businesses, or for institutional buyers. Very few analyses exist on the economics of these community-based operations (Sperling et al. 2013.)

As well, these groups may be comprised of female farmers, youth, or other specific groups; often programs will use associations created for a different mandate to identify and build upon for local seed producers. They sometimes can reach (as they are co-located) the more geographically remote producers but need support with risk management, ongoing seed quality, production, and handling capability, and complementary market development.

Local seed businesses are similar in that they are locally-based and focus on the specific seed needs of their community. LSBs can also serve niche markets that are underserved by larger seed companies, and their proximity to farmers may allow them to charge less for their varieties. They meet varied standards, sometimes certified and sometimes not, depending on the specific regulatory framework. Some programs working within this model focus on integrated seed sector development (ISSD) and support LSBs and seed producers to improving the quality of seed and work towards varied levels of certifications (Subedi, 2015).

These informal sector groups and small businesses are found throughout communities in SSA, with seed groups more common in remote areas and LSBs in somewhat larger communities, though this is not strict (Katabalwa, 2015). CEDO notes that youth and women are important targets for involving in the market, but then lacks further information on whether the program specifically sells to women and/or youth. In fact, CEDO notes that after program introduction, men seem to take increased interest in the traditional female-dominated sector of bean agriculture. This observation lacks further information but may be an unintended side-effect of programming (i.e. males sidelining women). Involvement in the multiplication and sales side may be one of the best ways to begin to involve women or other marginalized groups more heavily in the seed market. CEDO, an organization focused on working with community-based seed producers, notes that in Uganda, beans are typically seen as women's crops, and several production groups are formed of only women (Katabalwa, 2015).

Much like the general informal market, LSBs and seed production organizations are highly adaptable to changes with a larger focus on quality that one may not find at the individual farmer level. Most LSBs and community-based seed producers do not become direct distributors of seeds but rather sell into differing distribution models. CEDO, in their review of the program running since 2000, states that

organizations have adopted 85% of high-yield bean varietals, and from 2006 to 2011 they have seen an increase in bean cultivation per farm from 4.46 acres to 7.6 acres (2015).

Another LSB model exists in Ethiopia. A recent preparatory study for a seed system security assessment conducted in the country found that there are 275 Seed Producer Organizations supported by the ISSD program. The study states that the Ethiopian smallholder market is still relying on up to 90% farmer saved seed, farmer to farmer 'seed' grain sales, and cooperative or NGO based seed multiplication and distribution systems.[2] The LSBs that are members of the Seed Producer Organizations were found to produce approximately 10% of the national seed supply, which accounts for only about 3-6% of the seed planted by farmers (the rest covered by the saved seed, farmer to farmer 'seed' grain sales, etc.).

Agro-dealers

Agro-dealers are entrepreneurs with fixed (brick and mortar retail) stores in towns and villages providing a range of agricultural inputs for sale. Dissemination of inputs and information is the focus of these models. IFDC made a significant investment in developing agro-dealers through identification, training, start-up and working capital, and made linkages with varied suppliers more than a decade ago in various SSA countries. Other donors and implementers have since built upon that early work, working with the same agro-dealers, expanding the numbers, and other slight variations of the agro-dealer model as a means of improving technology access to smallholder farmers outside of the large markets and market centers-- even replicating the model outside of SSA. In many of these countries, the agro-dealer model may not be as robust as informal markets and may be affected by issues of the model design: scalability, sustainability, trust, and value chain connectivity.

Kenya and Malawi are two countries that now have extensive established agro-dealer networks, and this service a large population of smallholders. Many programs developing and growing agro-dealer networks, begin with a focus on the supply-side and the agro-dealer itself, with less integrated work on complementary demand development. The model focuses on local shops or agricultural supply stockists who seek to expand their offerings to the community, but who typically lack the knowledge of improved inputs and techniques. These stockists are trained—through varied modules on business and agricultural techniques and inputs—to provide greater service delivery to their customers. Certified as agro-dealers, they are then linked to larger agricultural input supply firms who supply initial stock. Typically, these outlays are covered by credit guarantees, as the agro-dealers may be initially unable to afford the necessary stock. The agro-dealers carry product from multiple suppliers who may or may not have set margin agreements in their distribution agreements. The agro-dealers carry the inventory with the suppliers after the business relationship is established with some track record. Some models elect for agro-dealers to then repackage inputs to more affordable smaller units for the community based on their local knowledge, while other suppliers simply supply ready-made smaller units. The agro-dealer then incites demand in his or her community through dissemination of knowledge, connecting farmers to information and innovation in the agricultural sector (Rockefeller, 2011).

Results have been positive, according to Rockefeller when evaluating CNFA's agro-dealer program, in Malawi, Kenya, and Uganda. Between 1997 to 2004: average distance to nearest dealer declined for smallholders from 8 km to 4 km; $900,000 worth of agricultural inputs and seeds had moved into the smallholder realm; and the default rate on credit guarantees was found to be less than one percent (2011). AGRA itself, with programs in 16 African nations, has trained 14,098 agro-dealers who have sold 376,315 MT of seed (Kapran, 2015).

[2] Bright Development Management Consultancy Service. Preparatory Work (Input) for the Upcoming Ethiopia Seed System Security Assessment. Prepared for CRS. July 2016

However, Future Agricultures notes the challenges to this model: extremely remote communities may not have a small supply store with whom to partner; restocking inventory in remote areas may be difficult and expensive, as is maintaining quality control; labeling and understanding of seed and other inputs is incredibly important, and can result in ill-will if improperly done; agro-dealers may be the only member of the store trained, yet many are not involved in day-to-day operations (2012). In an impact assessment for agro-dealer support in Mozambique, IFDC further found that most of their most successful agro-dealers were those located very close to major towns (2015). Stimulating demand from the supply side has proven difficult for multiple programs, as Mercy Corps has noted from agro-dealer work in Timor (Godhino, et al, 2015). AGRA has found its agro-dealers have a challenging time keeping stock due to lack of consistent capital and therefore miss out on customers during sowing season (Future Agricultures, 2012). Furthermore, Odame notes that only 10% of agro-dealer inputs is devoted to seed, and an overwhelming number of that is maize seed (2014). CNFA found that three years after a Kenyan agro-dealer program cessation, some agro-dealers retained their relationships with wholesalers-- yet a currency crisis precipitated an eventual collapse of the model; without the crisis, speculation could see the model as ongoing past program completion.

Further research is necessary to understand better how agro-dealers make their incomes. Do they sell mainly subsidized or unsubsidized inputs? Agricultural chemicals and horticultural supplies? Veterinarian supplies? How much comes from seed specifically, and within that how much comes from hybrid maize and vegetable seed only? These questions should be addressed as a baseline prior to program start and re-evaluated after program completion to gauge the possible change.

Reach

CNFA was extremely detailed in the geographic descriptors of its area of work, and—when compared to other models—segmented the population of agro-dealers by several divisors: gender, occupation, age, years in business, education level, and more. Less detailed was the segmentation of agro-dealer customers. However, from 2001 to 2004, according to the Rockefeller evaluation, only 322 agro-dealers had been trained—the sample size is not incredibly representative of a large group (2011).

AGRA's efforts did result in positive outcomes, more so for those farmers based in rainfall heavy areas. Since heavy rainfall areas in Malawi, Uganda, and Kenya tend to be where the majority of the population is found, the question remains how well the program was at reaching those remote smallholders at the last mile (Future Agricultures, 2012).

The trend of the lack of information on the specifics of smallholder customers will be repeated in the literature throughout the models—smallholders are noted as simply smallholders, with little descriptor as to their current distances to towns, agro-dealers, production centers, and other potentially impact-changing places. This is a challenge for those evaluating such programs due to dissimilar comparisons: An agro-dealer program based close to Nairobi benefits from positive externalities that may not be mentioned, vis-à-vis a program based outside Lodwar, which may suffer from not only poor agricultural conditions, but lack of infrastructure, government investment, and stability.

Note on literature

AGRA has run agro-dealers program in Kenya, Malawi, and Tanzania, and has conducted evaluation on the three countries. While much of the program, especially in Malawi, focused on maize seed and inputs such as fertilizer, the general body of knowledge is considered robust in this literature review. CNFA and Mercy Corps have run similar programs and supplement the body of knowledge. Further

study remains on the dissemination of other crop seeds through this model, and whether the improvements buoyed by agro-dealers can be transferred.

Village Based Advisors (VBAs)

Another model to stimulate demand-led approaches to technology distribution is that of the Village-Based Adviser (VBA) or Private Service Provider (PSP), VBA models rely on a trusted community member to disseminate knowledge, sell inputs or other products, and increase connection to technology, credit, or information for farmers. The model can reach even those communities without established stores or markets, but success is highly dependent upon the VBA him-or-herself. Under some of these programs, the model focuses on identifying a lead farmer to serve as the VBA. In other models, including Savings and Internal Lending Communities (SILC) + PSP programming of Catholic Relief Services or CNFA's work in Senegal, the VBA may be a youth, a woman, a retired professional, or other trusted and engaged community member.

When VBAs are trusted farmers, elected typically by a local farmers' association, they are trained by Ministries of Agriculture or similar organizations on technical skills. They reside in their local villages and provide valuable training to smallholders on the use of modern inputs and innovations, and generate income based off sales of inputs and potential services. For most models, VBAs generate initial interest and facilitate learning at demonstration plots. Since the VBA is localized, the model presents a method for reaching the most remote areas, working with community-trusted farmers, and increasing distribution of seed inputs outside of typical maize (Seward, 2015).

The VBA model also presents interesting opportunities to engage youth, women, and marginalized groups as VBAs, the latter groups often ignored in government distribution or extension schemes. This should be an avenue of approach for programming looking to strengthen these groups' participation in seed markets.

In addition, the VBA model may increase demand by bringing community profiling and engagement to the equation. Taking the concerns and needs of the community, VBAs may make purchases and learn new techniques to potentially increase harvest yields or ease technology adoption. However, in the majority of some VBA models where lead farmers are not the focus, the VBA's purchases may revolve around products and technologies other than agricultural, with seed being a small percentage of purchase. This role may be played by many actors and could be a good entry point for those who lack access to land and other employment such as youth, women, or other marginalized groups.

Difficulties have arisen in the model. Training has not been standardized, and often, the VBA simply procures inputs without the prerequisite training for their use. Many VBA's rely on government extension services to interest people in modern seed (Audio Transcript, 2014)

However, this method may work well for remote villages that have experience with cooperatives or village committees, as the VBA can connect them to a grouping of seed producers with whom they may not had prior contacted. However, ensuring that demand for new varietals and quality seed is promoted to communities that don't share this interest may be difficult. VBAs may have to see the benefit of quality seed for themselves, then try to stimulate demand on the ground-level. Both the VBA and the community stand to benefit from the relationship, provided there is continued access, interest, and trust between the parties.

CLUSA has pursued a VBA model in Zambia, Mozambique, and is currently working to replicate the dissemination model in Senegal. Their VBA model utilizes an individual who represents community interests in procuring inputs and ensuring knowledge is disseminated within the community. This community elected individual represents the community in purchasing and interactions with trusted input companies and/or agricultural agents.

CLUSA's work in this model has been ongoing in Senegal, and they report that VBAs also began to speak in terms of community and mission as opposed to amounts sold (CLUSA, 2016). Furthermore, the VBA model does not tie villages to one agricultural supplier but allows them to access a number of pre-verified companies who work with CLUSA. Since the VBA is essentially a representative of a cooperative with guaranteed loans, input suppliers have been more likely to sell at a discount, and the VBA can buy in bulk (CLUSA, 2016).

Within CLUSA's literature, they note that the 3,260 communities in Zambia served by VBAs have experienced a 50% reduction in input costs and 50% increase in yields. Further, 14 Zambian agricultural firms have integrated VBA into their business plans, while FSPs have lent nearly US$16 million to 367,692 institutions financing purchase of modern inputs through VBAs. These are major changes across a six year period, though CLUSA's VBA model built upon the successes of prior projects (Zambia, 2016)

CLUSA's VBA model notes 247 active PSPs, with over 600 in training in Senegal, and over one million customers served in Zambia. However, despite USAID evaluations, there is little beyond the locales where programs are taking place. The consistent lack of specific information on reach—who, what, where—is frustrating across models since they cannot be truly categorized on their ability to reach the last mile.

CLUSA's focus in Zambia and Mozambique have had a focus on maize seed, with only secondary focus on development of legume or other cereal seeds.

CLUSA's literature rarely segments exactly the smallholder populations involved. Working with USAID produced solid evaluations, but—as is the same with most models—knowing the segments of population (gender, age, education) is hard to find (Evaluation, 2014). CLUSA's initial program in Senegal is still ongoing.

There is a dearth of literature regarding critiques of the VBA program, yet challenges to extend reach to the last mile would be like those facing many smallholders. If the VBA has a poor harvest on her demo plot or is not trusted in the community, farmers may not engage; free distributions may upset the market that allows the VBA to continue their work; supplying the VBAs with necessary inputs may be extremely difficult in remote areas—as they are just as likely to run out of stock as those in the agro-dealer approach. However, this method has produced remarkable results: USAID in a compendium report reviewing VBAs under FIPS noted adoption rates of root crops in Kenya as high as 85%, with the average rate between 30-60% per village, across a timeframe from 2006 to 2010; this study evaluated not only the sales of produce, but also on-farm consumption (Compendium Report, 2012). It should be noted that beneficiaries of this root crop FIPS-program were required to repay initial investment on crops either through cash payment or "passing on" cuttings to neighboring farmers, raising an interesting question on whether adoption occurred because of VBA assistance, or simply neighbor-to-neighbor exchange—especially when one farmer has already demonstrated increased production on his or her farm (2012).

FIPS VBA model worked in the Singida and Dodoma regions of Tanzania, mainly in communities of smallholder farms characterized by poor soil and growing conditions, where majority of the population lived below the poverty line and was found to be food-insecure. Due to the 4 VBA associations FIPS helped create, 1,010kg of dolichos lablab (a legume) was distributed, though the literature does not note whether this distribution was a sale, a giveaway, or a loan. According to an evaluation by Sibuga, yields increased by 30% (accounting for all crops, not only legumes), leading to further promotion of the model. Farmers reported adopting Dolichos, harvest 5kg of seeds from the initial 50g seed bag and are harvesting the crop on an acre of land. As this was a five-year project, there needs to be further evaluation of whether farmers are still engaged with VBAs to buy more seed or continue to innovate, or are simply saving seed for reuse (Seward, 2015).

The VBA model works on an extremely local level for communities, establishing trust and knowledge with engaged members of the village. VBAs' results in increasing farmer knowledge and access may have to do with specific inputs or certain circumstances, but it does seem that this model is one to further explore.

Reach

Again, the literature is light here on the actual reach of the VBA program; FIPS operates in multiple districts in Kenya and Tanzania, in both populous districts and more remote districts. In Dodoma and Singida, majority of farmers are food-insecure and use late-maturing crops on poor soils susceptible to drought. These farmers numbered 367,000, though not all could be possibly served by 354 VBAs; only 80,000 farmers were listed as beneficiaries. Yet, again, there is little disaggregation of these numbers. How many women farmers? How many are based in towns or in small communities? In the larger FIPS program, the numbers rise to nearly 400,000 households assisted by 800 VBAs, yet some districts may have but one VBA—is it possible to serve the entire district by oneself, and how connected is this VBA to input suppliers? The profile of the VBA is the most informative—young, local, low-education level, and self-employed—but that still lacks specification (Priest, 2012). FIPS does work in several inputs—maize, fertilizer, sweet potato, cassava, and others—but without more specific information, it is difficult to gauge the effectiveness across geography and population.

Note on literature

FIPS is an extension of agriculture programs in Western Kenya began in 1990. As such it has an extensive body of results. With these reviews, evaluations, and critiques, FIPS literature is seen as reliable and tested, though as always, research after the program's end can show whether lasting effects were achieved or simply relied on the VBA model while supported under FIPS.

Seed company agents

Agent models rely on companies acting as a wholesaler to an agent who is trained on new varieties and techniques, and then sells to the community for a commission. If needed, the company will sometimes provide a line of credit to the agent, though not all models do so. The model is like both agro-dealers and VBAs, yet challenges of using this model to generate returns on non-maize seed are still extant. Investments in capital or developing specific varietals may be too high for the producing company, inputs may not be available, the agent may not disseminate information well, and some companies practice predatory policies that harm the smallholder. However, this model may be an effective method for larger seed producers to reach the last mile, as the agents travel and work in this arena.

The agent model dovetails with the agro-dealer and VBA models, and CARE's experience touched on aspects of nearly every other model at varied points in time. Agents were identified and trained by individual companies (with assistance from the NGO) and given exclusive credit lines; these newly trained agents worked with agro-dealers (or were agro-dealers themselves) to travel to communities, disseminate information, and sell new varieties and inputs. The agents are then formed into business membership organizations (BMOs) that enjoy even higher purchasing power from the company. By project end, CARE's evaluation shows that 70 agents had moved US$28,571 worth of agricultural inputs, and that 58 agents had permanent credit lines with the partnering company, Red Star (2005). 46,800 farming households experienced increased access to inputs, yet it is unclear in the literature if this also includes the 31,000 households who received relief packages (2005). This occurred in Zimbabwe during a massive financial crisis, when many companies were unwilling to invest in rural agriculture, and smallholders suffered weak purchasing power. The agent model continues with three more large companies getting involved, and a larger focus on setting up BMOs and agent organizations (CARE, 2005).

The agent model shows positive evidence, especially considering the difficult operating environment in Zimbabwe during 2003-2004, but challenges still arise: predatory practices from companies may harm smallholders, agents may not be able to supply inputs due to disturbances in the economy or agricultural sector (such as currency crises or droughts), farmers may not see the inputs as improvement, and free distributions from government and NGO programs can hamper success (2005). A major drought in the intervention zone during 2002 in Zimbabwe also negatively affected the program; however, a major drought would be likely to adversely affect any model (Annual Report, 2002).

Agent models are interesting takes on the prior two models, more connected to the private sector than VBAs, but also more mobile and flexible, moving directly within communities unlike agro-dealers.

Reach

It is important to note that both Zambia and Zimbabwe have large, highly professionalized seed companies that already serve large commercial producers; adjusting their methods to focus on agents supported by these companies is made possible by their prior establishment. Yet in countries without these professionalized seed companies, this model may not be practical. As well, agents cannot make a yearly living based off their agent status alone, much like VBAs. As well, last mile communities may simply be too remote to have reasonable access and support from this model as logistical costs remain high in delivering the seed in the village sized volumes.

Note on literature

CARE has been involved in the agent model since 2002 and has produced numerous documents, including a training manual for agents. Their literature has a few gaps in knowledge, and evaluations could be more robust, but overall CARE's documentation may represent the best study of the Agent model, though the program only ran from 2002-2005: more information is clearly required for a thorough examination.

Supply chain facilitated technology access

Outgrower schemes and contract farming have long been present in SSA. Companies contract with farmers to produce and—in many models—provide the necessary agronomic inputs. Smalley (2013) notes that outgrowing can cause landlessness, indebtedness, exploitation, and technology-suppression, when companies are unscrupulous and community leaders act in pure self-interest. Beyond this, smallholders in remote areas are unlikely to benefit from this approach, as the transaction costs for doing business in remote areas are often too high for companies to bear. Even in communities located close to major towns, outgrowing faces numerous challenges: low margins, active competition (side-selling), and low barriers to entry and exit for traders.

The outgrower model, also called contract farming, provides a larger producer or wholesaler company with the total crop production it needs from smallholder farms. The company typically provides all the inputs that smallholders need to produce a crop to a certain agreed-upon quality that the company will buy at the end of the season (sometime during the harvest period.) This model requires several essential points to function properly: production, timeliness, quality, and trust (Legge et al, 2006). The model works most successfully when there is limited competition in the off-take market or the commodity market is somehow regulated, such as cotton concessions that have existed in some countries. Few of these models have been implemented in the legume sector, but IFAD has worked with

Ugandan smallholders on modern sunflower varieties. Outgrower relationships considered a stable income for some smallholders, especially when SSA governments dismantle crop governing bodies, as the buyer for their crop is guaranteed. Smalley identified there are some positive spillover effects from this model into the community such as greater technology and an increased ability for women to negotiate their own labor (Smalley, 2013).

However, there is a volume of literature that notes smallholders rarely benefit from these models, and the poorest farmers are often left out of these schemes or forced into unprofitable production (Smalley, 2013). Often, the smallest farms are left out of outgrowing models, food insecurity may increase, and local elites can capture the majority of business. Legge et al, note that companies tend to move away from smallholders and may renegotiate contracts to the detriment of the poor (2006). Beyond this, even in the Ugandan case, adoption of new seeds within this model was limited, and reach into the most remote areas is hampered by extremely high transaction costs (Case Study, 2007).

Yet Bolwig et al, relate that the larger global trend of organic farming and "fair trade," may mean this model begins to see resurgence in demand, influenced by the end consumer who will require a more benevolent company (2009). Yet, this is a very specific market—often with exportable crop choices and typified by single large buyers—and no successful example can be found for a more competitive, functioning domestic grain markets.

Finally, a note on the pigeon pea in Mozambique—what was once a completely ignored crop (so much so that FAO and AGRA did not list it on their respective production reports in the 2000s). It is now the third-most important crop for smallholders. Pigeon pea received little attention until demand rose in India, underlining the difficulty in predicting any potential gamechanger in which an enterprise may invest. Now, many smallholders grow the pigeon pea, many in a form of outgrowing for pigeon pea seed providers. This relationship works in smallholders' favor due to the difficulty in mechanizing and intensifying production; for most companies, it is more profitable to take delivery from outgrowing smallholders than invest in potentially less effective large farms. However, this is a unique example of a specific legume—outgrowing works well for both smallholder and purchasing company in this occasion, but may not in other cases (Walker, et al, 2015).

Outgrowing may initially hook smallholders with a stable income, free inputs, and guaranteed prices, but Smalley and others point out that the model affords too much power to the companies and rarely benefits the smallholder. This model may be different for non-cash crops, especially with a focus on higher-producing legumes or cereals, but would need to focus on likely small, regional companies with tight margins, which may still not enter the market due to transaction costs at the last mile (Smalley, 2013; Chibwana, et al, 2012).

Reach

The reach of outgrowing and contract farming tends to be greater than specific programs, likely due to its simple set up; IFAD claims 206,943 farmers have been reached with their program. But again, further information on these smallholders is missing—the literature reports that the majority of sunflower is grown in Uganda's northern and eastern regions, where the majority of Uganda's poor also live, but no further breakdown is given.

Walker et al (2015) are more specific with numbers, but they are examining an entire nation's pigeon pea production. They do note that majority of these smallholders farm on less than one hectare and 68% of pigeon pea for export comes from ten districts in Zambezia province, yet further segmenting information is missing. Are most pigeon pea growers women? Are those reached by outgrowing

schemes located near roads and towns? These questions are left unanswered in the literature, dimming the lessons learned from this model.

Note on literature

Contract farming has an abundance of literature, mostly noting its negative effect on smallholders. The related concept of outgrowing is gaining literature, most of which is similar to that of contract farming. However, if trends towards organic farming continue, where traceability is a critical market demand, in the coming years there should be a number of interesting pieces on how outgrowing has or has not worked within this system.

Chibwana's piece is largely an excoriation of the voucher system in Malawi but contains interesting points on contract farming and the reluctance of small businesses to enter a comparatively difficult market.

Integrated Service via Social Enterprise

One Acre Fund, Cheetah Development, and Babban Gona are examples of social enterprises offering integrated fee for service models to producers, largely focused on inputs and production support including agronomic extension, mechanization services, and similar. These models are still new, with One Acre Fund the oldest, starting in 2006. These organizations have received significant investment and funding from donors to cover some of their costs, with the fees generated from farmers not covering the costs of delivering the services. In 2015, One Acre Fund had achieved a repayment rate of 78.5%; very impressive, but not yet fully self-sustaining. One Acre Fund may have the most experience and the highest recovery rate of the examples considered.

As of May 2016, One Acre Fund actively served 400,000 farmer families in Kenya, Rwanda, Burundi, Tanzania, Uganda and Malawi[3] with repayment rates of the micro-loans as high as 97%.[4] In evaluating a number of social enterprises involved in health and agriculture in Western Kenya, Griffin-EL et al (2014) note:

> Most of the social enterprises, in order to achieve a social objective, either seek a long-term partial subsidy from a government, donor or NGO source in order to sustain a business that would not otherwise be viable; or they purposely reduce financial surpluses by paying above-market premiums or guaranteed prices to suppliers (fair trade), paying above-market wage rates to employees, and restraining business margins within fixed limits. Some social enterprises are receiving subsidized products from public agencies, driving down the cost of services that would otherwise be expensive for the economically disadvantaged communities.

Griffin-EL et al noted that one specific agricultural social enterprise distributed financial surpluses to customers by including them as co-owners of franchises where possible, and two other agricultural social enterprises acted simply as for-profit companies with innovative solutions to agricultural challenges. Nearly every health-oriented social enterprise operated with guarantees from either the government or outside NGOs, which simply notes their business models fall more generally inside the above stated definition.

[3] One Acre Fund now serves 400,000 smallholder farmers. www.newz.ug. Retrieved September 25, 2016.
[4] Caluag, Maria. One Acre Fund: Solution for Farmers. www.borgenmagazine.com. Retrieved September 25, 2016.

However, there are limitations and challenges such as cooperation with governments, mistrust from smallholders, and difficulties in collaboration amongst other enterprises. Griffin-EL et al noted that programs which worked in Western Kenya may not be appropriate for the arid northern regions (2014).

If smallholders have access to these programs, they have hit a 'jackpot': what remains to be seen is how long-term and expansive these enterprises can remain. One Acre Fund, a social enterprise lauded in the development world, started in 2006 and has seen increased growth near every year; KickStart began in 2005; and Kilimo Salama in 2011. Note that many of these enterprises began after 2000 (Griffin-EL et al, 2014), which is a longer history than some of the other programs and models, considered above. As they continue to evolve, it will be interesting to see how they expand further and further into the last mile.

IV. Common Themes

Models aimed at changing the nature of smallholder agriculture in SSA will likely face similar challenges and themes, even those most dissimilar. Obvious challenges such as infrastructure, low government services, and poor agricultural zones can affect any model reaching into remote areas. The literature review noted several common themes, both in the literature documenting the theory of input and technology distribution/delivery models, as well as, the experience within the models noted above. These common themes include common approaches or activities (such as including agronomic extension and information dissemination), the identification of common gaps critical in supportive services (such as access to credit), and a common lack of customer segmentation and market strategy. Following is a summary of the common themes identified in the review process.

Delivery models inclusive of extension

Knowledge transfer, agronomic extension, training, and demonstration plots targeting farmers, the proposed technology adopters, all figure across the models to some extent. While this literature review looked at the issue of access and delivery and not at adoption, all the models included the need for information and demonstration as critical components to be tied with distribution and delivery to encourage or ensure sustained adoption. The information accompanying the product is most often referred to as extension, training, or knowledge and isn't specifically put within the context of marketing or market development. Marketing and market segmentation is therefore considered in a separate theme below; but it isn't a clear differentiation. Often it is the extension and training components that are the most subsidized by donor or funding partner during the model initiation; and the lighter, lower cost touch (or lower financial capacity to invest) of the commercial seed companies with their agents, and the small-scale seed producers could be a limiting factor for reach and expansion.

Every model features dissemination of knowledge, often with little evidence to show that this education has changed adoption. Models rely on knowledge gleaned from VBAs or agro-dealers, centralized farm field schools, or demonstration plots—all models have a method to demonstrate to either smallholders or disseminators themselves that their products work. CEDO's Uganda findings mention that information dissemination combined with the distribution channel development is important, but then state that the observed increase in biofortified bean production was accomplished on a crop that requires little complicated training (2015). The Rockefeller Foundation's evaluation of the agro-dealer model for CNFA notes the importance of training and education for agro-dealers, and that agro-dealers need to provide information and knowledge to their customers, but presents little evidence that dissemination caused increases in sales of inputs; in fact, they note that average distances in model

districts in Kenya from farmers to dealers decreased from 8 to 4 km. Expanding the geographic reach and number of agro-dealers with increase in retail density is incredibly important, yet, the literature does not examine whether the increase in access for farmers may have actually accounted for the positive results (2011). FIPS' support for VBA training comes from two unverified reviews—increases in yields are not shown to be connected to training (Seward, 2015). Further, FIPS notes—in a fertilizer promotion scheme—that demonstration plots were effective for showing farmers the benefits of input adoption but did not mention further training as necessary (Blackie and Albright, 2005). This leads to the question whether the focus on farmer-training is viable, effective, and necessary—or simply an assumed piece of the puzzle.

Agents, VBAs, agro-dealers, and contracted farmers are also targets of training, often occurring at farm field schools or other demonstration areas. The question of geography and locality become central here. Outgrowers typically locate a production center near the majority of their contracted smallholders, and so companies offering training are likely to experience similar growing patterns, ecology, climate, and soil makeup (Legge et al, 2006). Yet agents, VBAs, and agro-dealers are likely to be educated at centralized locations that may not match local growing conditions; indeed, both Odame and Future Agricultures note the difficulty of ensuring that agro-dealer training translates into effective dissemination to smallholders, especially when the bulk of sales fall outside the received training (Odame, 2014; Future Agricultures, 2012). It may not be enough to simply train disseminators, rather future follow-up and continued training may be necessary to reinforce the information to be disseminated and to ensure that disseminators are continuing to provide effective, localized knowledge. Indeed, the majority of the literature does not note the length of time of training for the varied disseminators—an interesting question would be the results of disseminators trained for six weeks versus six months or other timeframes, and evaluation of the effectiveness across time and season in these cases.

What is not clear is the cost effectiveness and sustainability of the intensity of training and extension. Could demonstration plots be more effective than training? Graf et al (2015), posits that farmers may doubt that demonstration is practical, or matches their circumstances, or that they themselves are able to reproduce such results. Since depression and poverty are linked, there are connections to be made that would support the latter within a psychological context. However, Miller et al (2014), simply point to the fact that new varietals, even ones that are demonstrably high-performing in demo plots, do not always result in improved yields; they cite conservation agriculture practices that produced both 10% higher production in 23 cases (across SSA) and 10% lower yields in at least six cases. Smallholders, especially those at the last mile, may not be able to afford even that small marginal loss.

Graf et al identify that not all training is created equal, nor operates in the same environment. Training in competitive environments where farmers have many marketing options may be too high a cost for supply chain facilitated extension. Companies and even many programs are not always interested in carrying the cost of broad sector improvement, when they need financial returns (such as the ability to secure the complete harvest.) Side-selling by farmers is often cited as a risk or potential cost where more training is needed, instead of a symptom that the model may not be correct in that market. In monopolistic environments or those supply chains where traceability is compensated along the chain, especially those seeking certain certifications like Khyati Foods' organic label, training is a prerequisite—this could increase the effectiveness of benevolent outgrowing models. And for those models that deliver on production enhancing technology, training will be required, though there is no guarantee that it will result in adoption.

No single model or evaluation proved conclusively that training and improved outcomes were correlated. Retail density was mentioned in a few cases that were specifically considering training alongside other

adoption factors. The cost of high touch extension and training could limit the replicability of the model as well. These correlated themes are discussed from different perspectives below.

Bundling and Piggybacking

Bundling combines several goods and/or services that customers seek into one package. This method moves away from specific individual purchases, which may be costlier individually and deemed unnecessary in the smallholders' consideration and provides them at minimal cost due to aggregation. Bundling is well known in the private sector—for example, purchasing a laptop that comes with pre-installed software bundled into the price.

Piggybacking is where distribution and retail channels that are successful in moving a good or service (or bundle) are leveraged to move another or newer technology, essentially using the already created distribution and logistics networks. Traditionally in the seed sector, newer varietal developments may be released, distributed, marketed, and sold through the same, established channels as previous technologies. But piggybacking can also be more diverse, such as the PICS bag distributor in Niger who leveraged his cellphone recharge card business model and channel to move PICS bags to smallholders.[5]

These aren't definitive definitions, but at least some of the models move more than one product or service, bundled or piggybacked for a variety of reasons.

The social enterprises and agro-dealer models all move bundled products, offering at times seed, fertilizer, information and/or demonstration, agrochemicals, and maybe even production credit or mechanization services. The VBA models are still emerging, but many are launched around more specific products, perhaps bundled with information, but not often with a diverse offering of products and services, particularly as the model is launched in a geography.

Utilizing existing distribution networks and aggregates of many smallholders, the costs of providing micro-credit, crop insurance, and inputs decreases; resulting in the best cases in profitability for those upstream. Kilimo Salama, a social enterprise, initially offered crop insurance alongside their micro-credit loans from 2009 to 2011, selling 23,000 contracts. When they began bundling the insurance into the loan, sales rose to 74,000 in 2012, and to over 180,000 in 2013. Farmers can now no longer purchase Kilimo Salama's products directly, but, through a pilot system with local traders: farmers receive a voucher in purchased seed bags that covers their seed if there is no rain in three weeks post-purchase. Smallholders are covered for failures by the fee for the bag, which includes the insurance. Sales of these bags grew from 0 to 200,000 in a year. One Acre Fund follows a similar pattern, bundling a mandatory 4% fee to cover insurance built into their loans. Smallholders who may never have purchased individualized risk insurance are covered by default when accessing these programs (Graf et al, 2015).

One Acre Fund continues with a holistic bundle that it has offered in Kenya; a bundle bought on credit with a 100% repayment rate. The bundle includes certified quality inputs, delivery at time of planting, training, flexible repayment terms, and crop and death insurance. Farmers were found to be willing to pay 25% more for this bundle than that paid to traditional input traders (Graf et al, 2015). Other methods of bundling can group together non-similar technology, such as d.light's bundling of LPG gas canisters with solar lights: farmers making the initial purchase of the gas canister also pay for the solar light, which takes advantage of an already extant distribution network, and allows the smallholder to purchase a discounted product that he or she may not have purchased otherwise (Neuwirth, 2011).

[5] Coulibaly, Jeanne; Stephen D'Alessandro, Theodore Nouhoheflin, Casimir Aitchedji, Maiyaki Damisa, Dieudonne Baributsa, and J. Lowenberg-DeBoer. Purdue Improved Cowpea Storage (PICS) Supply Chain Study. November 2012.

Bundling provides opportunities to introduce smallholders to new inputs and technology without increasing the initial cost.

The foundational framework for successfully selling to the large numbers of poor (the Base of the Pyramid, BoP), one that Polak and Warwick support consists of low prices, low margins, and a huge customer base. Simanis argues that the actual market penetration rate necessary to make these distribution networks is 30% or above, which is simply unworkable beyond a few instances (2012). Those instances took advantage of prior infrastructure (as in Manila Water's expansion to the poor) or distribution networks in rural areas (Unilever's Wheel detergent). The theory found in the literature is that piggybacking off of these existing distribution networks may be the key to low cost distribution and market penetration, but not one of the models noted in the previous section specifically starts from this point in practice. They either only reach those within an easy and convenient geography or they start from scratch to develop distribution into the more rural and marginalized communities. Inputs and agricultural technologies do generally experience more seasonality in demand than consumer goods and at times may be significantly bulkier (fertilizer and some seed.) But the literature doesn't provide much experience beyond the theory.

There is some practice regarding other aspects of distribution networks that can improve, and perhaps lower, the costs of, seed delivery. GPS mapping of transport and pickup routes can be implemented to avoid multiple trips; calendar coordination can ensure that arrival of small packages occurs when most people are at the market; identification of leaders of one community might help with identification of leaders at a nearby community (Webber, 2007).

Neuwirth discusses the realities of distribution networks and how they may be affected at a local level—lack of infrastructure, lack of aggregate demand, lack of inventory (2011). He argues that some distribution models may be more effective than other due to these challenges: hub-and-spoke models may tie in more with a VBA or PSP approach.

Neuwirth continues with a discussion of the benefits of "piggybacking" as regards d.light's entry into India. D.light attempted to enter the Indian market multiple times with limited success until "piggybacking" on the PSPs in gas delivery who would sell a 'bundle' of gas canister and a d.light product. The distribution network was already in place, and d.light did not have to create a logistics network from scratch. This lowered the price to enter and reach smallholders already seeking a certain product. It allowed partner firms to market their products together. If certain companies have already reached smallholders at the last mile, then "piggybacking" new inputs or services on these distribution networks may add to the effectiveness and penetration of the program (2011).

In a modern effort to ensure that development and consumer dollars are spent wisely, adopting the innovations of the private sector may make sense, since setting those networks and channels up from scratch takes both time and capital. Webber argues that there are a number of tools that can make entire sectors of agriculture more effective if approached from an agribusiness perspective: developing business plans, understanding the customer, market positioning, improving policy environments, and more. His longer work is well-researched, and worth the read to understand the application of business practices onto smallholder value chains (2007).

Product/Market fit – Small Packs and buying varieties versus seed

At least some of the models have focused on sizing the seed packages to the smallholder market. Small packs of seeds can be seen as the product/market fit for the smallholder market, the minimum viable product that allows for producer technology trial and adoption. By providing smaller amounts of seed at more affordable prices, the poorest farmers are still able to purchase and experiment without undue commitment. Farmers also get access to new varieties without investing in large volumes of seed purchase. Small packs simulate informal market selling, which can occur in a bulk basis; whatever volume one wishes to purchase. However, small packs do have a higher per unit cost; including increased packaging and handling costs. Many of the small packs were launched within programs with some subsidization.

Many models note the importance of allowing the farmer to experiment with new seeds (and especially new varieties) while not expending too much income, or pricing seed at a level that smallholders can afford. Smaller and smaller seed packs have made distribution and adoption of new seed possible, as points of sale can now be found on the back of a pick-up in a rural community. Prices reflect the much smaller amount of seed as opposed to even a 2kg bag (packs can come as small as 50-100g); PABRA has noted that farmers who start with a 100g sachet of seed have sometimes returned the following year for a 5kg package (Sperling and Boettiger, 2013). So, some farmers buy once- as they seek new varietal material. Some farmers re-buy and in larger quantity as they are interested in the certified seed aspect, that is, the added value of the seed quality. These seeds originate from a mixture of larger companies, smaller companies, national seed research groups, research organizations, and non-profit and social enterprises. FIPS uses Leldet, Ltd., a small seed company based in Nakuru, Kenya; Drylands Seed Ltd., a company working on distribution of drought tolerant varieties in arid northern Kenya, works closely with KALRO, the corporate body created by the state to research seed; some seed distributors are smallholders themselves who repackage seed from outgrowers or their own seed (AGRA, 2015; Mutisya et al, 2016; Mele & Guei, 2011). Drylands Seed Ltd. credits the tripling of sales of their seed from 2012 to 2014 to their breakdown of seeds into packages of 100g, 250g, 500g, and small assorted packs (Mutisya et al, 2016). Smallholders with internet access can even buy small packs direct from seed companies websites, some of whom offer courier services (PANNAR, 2016; Seeds for Africa, 2016).

Yet Sperling and Boettiger warn of too much reliance on small packs as the complete answer to increase non-maize seed adoption. They note that interest for small packs is segmented per crop, market penetration is still difficult for many companies, companies that invest in small packs make significant outlays in capital, and—due to relief sale—companies are more accustomed to selling in bulk (2013). While small packs can be scaled up for quick diffusion of modern varieties, much more research is needed on the parts of those who see small packs as the future. Companies need a sufficient profit margin to invest in the new technology to produce the packs, and nuanced and segmented understanding of the client base is necessary to deliver the right seeds in the right size at the right place. It is key to better understand farmers' rationale for purchase. Are they seeking new varieties foremost, or rather substantial amounts of certified/quality seed to cover most of their field? Are they buying because they have a once-off shortage (poor harvest or need to renew the quality of their degenerated stocks), or because they want to use high quality seed on a routine basis?

Farmer fear of new seeds is noted in the Dryland experience, yet they have embarked on a campaign of extension officers to inform farmers on the potential benefits of their drought-tolerant seeds (Kubania, 2014). And just as PICS recognizes its crop storage bags for the pollution they create, the question needs to be noted of the pollution in the generation and distribution and post-use of small packs (Foy, 2016).

Overall, small packages represent knowing the market, understanding who the customer is and what he or she can afford. The case of smallholders themselves repackaging seed, and reaching back to seed distributors, could be an interesting entry point into previously established informal seed distribution that featured farmers' prior recognition of the need for more flexible solutions.

Marketing and Market Segmentation

As noted above, most of the delivery models consider information and training as extension, and not as an integrated marketing or market development activity. That said, market development could be considered a desired outcome of information dissemination or extension activities, particularly for commercial actors and continued sustainability. Agronomic extension and training of producers assists adopters to capture the inherent potential value within the technology; critical for sustained adoption by customers. A specific focus on marketing requires market segmentation and targeting of customers (which could also affect product/market fit solutions, such as the appropriate size packs, or most appropriate opportunities to bundle.)

Marketing can enhance the knowledge and social aspect of a brand, increase interest, and maintain customers. Rural markets for private business are often left out of marketers' plans, and NGOs rarely consider the need for marketing, but both these delivery model actors (and the smallholders themselves) could benefit from integrating marketing into their models. Neuwirth notes good marketing is also incredibly targeted and knowledgeable about its audience (2011). Polak and Warwick discuss that marketing must be innovative and malleable in developing economies, as the restrictions on typical media methods are many. This is part of the targeting, understanding an audience and knowing what would drive them to purchase (or try out) a new varietal or quality of seed (Polak and Warwick, 2013).

Yet many models lacked specific information about its population segments to feed into targeting—nearly every model works with smallholder farmers, but that group is highly heterogeneous. Almost no single program working in any model broke down smallholders beyond the most basic age and gender. Few mentioned whether smallholders were living along a road, close to town, or in remote areas—which is incredibly important when considering how to effectively reach the last mile. The IFC notes this, relaying the following:

> A more sophisticated approach is to segment smallholders in a supply chain and apply different approaches based on the characteristics of the farmer and farm that can influence program goals…Farmer segmentation identifies the varying capacity levels and constraints of farmer suppliers to tailor a supply chain intervention that best meets their needs. Factors such as literacy, farming knowledge, and age should be considered…For example, while the average farm size may be reported as being two hectares some farms will be 0.5 hectares and others will be more than five hectares. The differences in land size could impact the selection of the most cost-effective machinery and agricultural practice (2013).

Even in the quote above, the distance that farmers live from towns is not mentioned. This is a serious error when left out. Segmenting farmers into different population groups— by age, gender, education, distance from town, main crop, occupation, and more—is a way to localize the program. Segmentation can and should be present in every model, and many note the bare bones of segmentation—typically in noting their approach to women and how many women will benefit from the program—but few dives deeply into segmentation. Segmentation is not the same as simple categorization, nor does it

stereotype smallholders, but helps target user groups more effectively, argues Polack and Warwick (2013).

This lack of segmentation is apparent when reviewing varied NGOs' targeting statements: "rural poor," "smallholders," "food insecure," or even "last mile." Businesses that have penetrated the rural markets have targeting statements such as, "rural, middle-income [for the area] married women," or, "Urban youth who drink beer, typically after sporting events." There is an easy-to-grasp difference between the specificity of private companies and larger organizations (Diaz, et al, 2007). This should be inherent within the seed sector where different varieties are demanded for different micro-climates, short season varieties for years of delayed rain and where farmers seeking new varieties may have a different profile from those seeking large amounts of quality seed. This does not necessarily mean that one method is better than the other; NGOs may have multiple programs that are much more targeted, and plenty of businesses working in developing economies simply note that the poor are their customers. Yet targeting specific population segments can increase effectiveness. For example, in Uganda, working with beans, especially at the farmer level, is viewed as women's work, and targeting women in this case makes the model function smoother (Katabalwa, 2015).

Program designers should conduct research prior to simply entering a community, and have that research inform the targeting of the model. Polak and Warwick warn that without correct targeting, any venture is bound to fail, since it will not reach its intended audience or consumer (2013).

Access to Credit

Much like training and dissemination, most models mention a lack of access to capital as a restricting factor in seed adoption. Throughout this literature review, varied challenges have been mentioned as restricting access for smallholders to "buy into" modern beans or cereals, to purchase and pursue new varietals. Access to capital can be added to that list, according to the literature. It is true that few lenders exist in the last mile, and those that do tend to lend, do so at outrageous rates or only offer trade finance, as oppose to production finance, requiring longer terms.

Smallholders suffer from a lack of collateral, and debt adds to their risk that already includes weather or other environmental disaster. The reasons expanding credit in rural communities are well known (climate instability, high transaction costs, lack of collateral, economic risks for both sides, lack of trust, lack of institutions) yet sustainable solutions are few (Hong and Hansen, 2016). Most models used aspects of financing wherein companies or the implementing organization provided goods (in-kind credit) at discount or they extended credit to buyers or some combination of the two. Small packs may be sold cheaply, but they are often heavily discounted against the cost of transport.

Polak and Warwick see the lack of capital as a challenge, but not insurmountable if products are designed to be "ruthlessly affordable," meaning priced so that customers can afford them, tied in with the marketing that lets customers know why they would want said product (2013). Yet their discussion comes from the point of view of benevolent Western capitalists; some companies that start with low prices until they capture the market and then raise the rent do exist (Smalley, 2013).

Integrated service packages of social enterprises most often include access to credit within their bundled offering. One Acre Fund offers a 10-month flexible repayment schedule; Juhudi Kilimo, a 2-month grace period; the Kenya Tea Development Agency deducts loan repayments from payments done upon delivery of produce. All these programs are aimed at understanding the reality of farmers' timelines and cashflow, which are erratic due to weather, credit, and harvest time. In seven programs that Graf et al evaluated, the six with a cash-flow tailored repayment scheme saw repayment rates of

95% and above; the seventh without a flexible scheme saw low rates that indicate schedules need be flexible (2015).

Furthermore, both grouping farmers and requiring initial payments increased the likelihood of loan repayment. One Acre Fund's 2-week grace period on repayment allows group members to cover defaults, which is in their best interest as a default of a single member makes the entire group ineligible for the loan in the next year. The enterprise also requires farmers to pay a symbolic amount to show willingness and commitment; this resulted in a 100% loan repayment rate in Kenya in 2014. Khyati Foods and Juhudi Kilimo both found that groups that are too large tend to fail; they broke larger groups into 30 farmers and found increased likelihood of repayment (Graf et al, 2015).

Yet, even where access to capital does exist, smallholders and input suppliers may prefer not to add the cost of capital and risk to their portfolio, so to speak. PROFIT+ literature in Zambia found that cash-on-hand is not a restraint to farmers' adoption of new agricultural technologies, including seeds. Despite a lack of capital provision in the program, 86% of input suppliers involved in PROFIT+ stated that the project was key to entering smallholder markets and remaining there post-program. Smallholders were found to be a viable customer group, albeit expensive, for input suppliers—they were willing to buy what inputs they needed. As well, input suppliers further stated that PROFIT+'s method of making the companies figure out their own distributing and marketing meant more sustainable connections were created (White, 2016). PROFIT+, similarly to so many of the other programs considered, did not segment the adopting farmers or provide significant profiling; so, their success may not have reached the most marginalized. Smallholders may also be reluctant to take on loans or credit that are risky—another point of risk diversification. They already carry environmental, weather, and market risk.

An exceedingly large amount of literature exists on the inaccessibility of credit for smallholders. Many of these pieces are well researched, but few focus on how farmers would react if credit were readily available, especially those smallholders at the last mile. The lack of access to credit is well understood, but how that access truly affects smallholders may be less so. PROFIT and PROFIT+ are some of the only examples that do not see access to credit as a critical barrier to input access and adoption, and they experienced similar results as other programs. While further research is necessary, this raises the intriguing question of whether credit is truly necessary for reaching those at the last mile.

Risk

Risk is a critical component of farmer adoption and impacts bundled products/services and distribution possibilities. Rainfed grain crops have extremely thin margins for all stakeholders of the value chain and therefore distribution and margins along input supply chains must also be very competitive.

Smallholders diversify crops and/or varieties as a part of a risk management strategy. Smallholders will often venture into crops where they have little knowledge or comparative advantage to ensure that, if their entire crop of maize is destroyed by disease, they still have a bean crop. Even NPR noted in an interview with an apple farmer in Lesotho that if the farmer had extra money he would not invest in apples, but in livestock because he needed to diversify his risk (Smith, 2016). Despite the creation of index-based insurance around the continent in the past decades, many smallholders lack crop insurance; those at the last mile are simply too remote, the transaction costs are too high, and the likelihood of failure too great for many insurance providers to target this population. Since these structures do not exist, smallholders practice ex-ante strategies to minimize risk: planting early-maturing and drought-resistant varieties if possible; accumulating savings, instead of spending on possible improvements; and reducing spending on farming. This leads to low adoption rates of new technologies and modern seed varieties, since farmers simply cannot take the risk of failure (Ameyaw and Harris, 2014).

The low investment involved in small packs helps but cannot take the place of credit default guarantees or insurance tools that allow smallholders the freedom to make changes. Unfortunately, climate change and the variabilities caused by it has a major negative effect on the poorest of smallholders, who are unable to adapt, nor depend on prior knowledge. Small shocks add up to eliminate any margin that smallholders produced. Mitigating this risk may be the most difficult aspect of any model, and programs across models should be designed with this mitigation in mind (Chuku and Okoye, 2009).

Scalability and Replication

Models have been identified for replicating the experience of success and scaling the reach and scope of the impact. Ag Partnership Council's "Crowd Sourced Lessons about Scaling Seed Systems," relays a major theme of scaling for seed systems:

> Heterogeneity in seed systems is critical to scaling strategies. Across different countries, regions and crops, the characteristics of seed systems are influenced by agro-climatic conditions, political and cultural factors, market access, policy frameworks, industry dynamics, donor involvement and institutional capacities. There are common constraints, and opportunities for learning, but interventions must be customized for context. Scaling inherently must strike a balance between designing for heterogeneity and coming up with approaches that work across larger markets (2013).

The piece continues with a number of recommendations from current thinkers and practitioners, but there are some salient points: Scalability may be on a case-by-case basis; product-specific subsidies or credit may be appropriate; investment, including major investment, may be necessary to help small and medium companies enter the market for seed.

With few programs conducting long-term post-program evaluation, the literature is bereft of longer discussions of sustainability. Many models (CLUSA, FIPS, CNFA) mention surveys completed within zero to two years after program completion, but it is not mentioned in what state the model exists. Many of these surveys are impact-oriented, and lack specific numbers of continued businesses, amount of seed or inputs moved, geographic reach, and adoption. Compounding this, many programs are still in their pilot or first stages, and so realistic potential to scale is hard to judge.

One critical component of scale involves reach; the breadth of technology access. Most literature simply points to smallholders as the recipients, and those trying to be reached, but lacks further explanation of how remote or isolated (or not) the farmers they are impacting actually are. All models mention the difficulty of reaching remote smallholders; yet there exist larger issues regarding how to meet the needs of the last mile. Gajigo and Lukoma ask the question of whether remote areas are simply remote because of distance or if they are remote because they happen to be in agriculturally unproductive areas; whether the areas have always been unproductive, or if they are unproductive because they haven't received inputs or been considered a viable production area. They note (with some potential controversy) that with specific infrastructure improvements, highly unproductive land in Asia and America was transformed into food exporting-acreage (2011). Finally, Blimpo et al, wraps the question around to the possible discrimination of marginalized groups or political decisions: these smallholders may suffer from a lack of infrastructure and lack of investment because they are in remote areas, or is that due to specific policies that marginalize these groups for political, tribal, ethnic, or other reasons (2012).

IFAD's Rural Poverty Report notes environmental factors—some agricultural areas are simply less productive, due to weather patterns, poor soils, or water issues—alongside still-present lack of investment in infrastructure to improve agricultural productivity (2011).

Across all the models, it appears that implementers are often very focused on replicability, even before substantive scaling within the original context and geography. As Boettiger et al, notes, "One size will never fit all." The majority of models work with local partners in a local context, which leads to difficulties when trying to scale beyond their area of impact. Boettiger et al, emphasizes that working with local partners and organizations builds trust, which is essential for success. As well, geographic, cultural, and environmental factors mean that certain solutions in the Upper East Region of Ghana may not match those along the coast of Kenya (2013).

Simanis makes a valid point regarding the investment required if operating at a village level: it is slow and capital intensive. Any program looking to promote adoption of new varieties and quality seed per village in a region needs to be prepared for significant expenditures, including shaping new teams for every expansion beyond the initial village or community. However, Simanis is writing from a private sector background, aimed at companies trying to penetrate the large rural poor market and his observations may not hold true for NGOs or social enterprises boosting the seed sector.

V. Lessons from Consumer Good models

The 'last mile' does generally have technology, goods, and services available for purchase; those areas are not entirely isolated or cut off from all access. Agricultural input delivery models may benefit from understanding and adopting the techniques of Coca Cola, SC Johnson, Unilever, and others. Piggybacking off their established networks could be a point of access for improving input delivery; copying their methods may lead to better targeting; and redesigning products with the end user in mind. The consumer product market offers insights into:

- piggybacking,
- investment in products design,
- patience and resources to develop deep distribution and retail networks,
- critical sales and customer feedback loops for learning and adaptation, and
- consumer segmentation.

Perhaps the most interesting "piggyback" solution has been the collaboration between Coca Cola's incredibly effective distribution network (relying on smaller bottle sizes, locally sourced ingredients to keep costs down, and franchises to eliminate lack of understanding of local context) and the Kit Yamoyo—a small medical kit fashioned to fit among the bottles of the Coca Cola crate. Shopkeepers receiving Coca Cola also receive these relatively inexpensive medical kits, whose price is kept low by piggy backing on Coca Cola's distribution network. Care was put into the Kit Yamoyo to ensure kits were easy to use and affordable for the end-customer, and the ColaLife Foundation ushered in the collaboration. Kits are sold at profit in larger markets in Zambia, while still subsidized in rural areas, due to purchasing power (The lowdown on Kit Yamoyo, 2013). This example demonstrates a powerful collaboration between a company and social enterprise, even if that enterprise is part of the Coca Cola family.

The reason why the kits are able to achieve significant reach is Coca Cola's ubiquitous advertising and several unique methods of distribution and marketing. By focusing on connecting Coca Cola with a love of soccer, the company understood the market. Selling Coca Cola in smaller bottles helped reduce costs, as did its franchise network of 160 bottling plants found in 56 countries across Africa. But Coca Cola also

reduced costs by allowing customers to drink Coca Cola in reusable bottles at the local store, thereby lowering costs even further. Coca Cola solved distribution problems by locating "zones," where it could deliver a truckload of bottles, which would then be further distributed by a small army of independent entrepreneurs who deliver the bottles to rural communities (Deloitte, 2010).

Unilever is another ubiquitous brand in SSA. To capture the market, they continued to develop products that Base of the Pyramid customers needed, such as margarine that does not need refrigeration, and combined that with extremely low-cost packaging. They then cooperated with extremely small-scale local retailers and utilized a large network of distributors that it has built over a number of years to reach nearly 80% of the population of SSA (Deloitte, 2010, & KPMG, 2014). The challenge here is the relative time and capital it took to establish these networks that typical seed input programs lack, and the focus on fast-moving consumer goods, which are in high volume, constant demand.

Simanis and Duke relate the challenge of SC Johnson and their effort to increase the use of malaria-treated bed nets. The company had to create consumer knowledge of product and generate demand, while keeping customer loyalty. When SC Johnson aimed to sell the nets in rural Ghana, they did the following:

> SC Johnson created a direct-sales model with coaches providing hands-on product demonstrations in homes and at gathering places in the community, thus building social support. Insect-control products were bundled with other items that consumers valued, such as air fresheners, which made sales more likely. In addition, buyers were given refillable containers, which reduced packaging costs. And subscription pricing, together with loyalty rewards, ensured that customers used products multiple times, thereby becoming more comfortable with the new product routines (2014).

The company had the benefit of prior failures and lessons, as well as the money to spend integrating new R&D with the business unit to ensure profitability. Yet they approached the problem by understanding their customer, educating him or her, creating a marketable product, and fostering brand loyalty. Maybe the most important takeaway from this model is the willingness to devote time to product re-design to ensure both adoption and continued usage.

Aggressive marketing improved Lafarge's cement production in Nigeria, where the company set up micro-kiosks inside stores to assist potential customers, and continually monitored their shelf space (Simanis and Duke, 2014). While this entry is primarily aimed at consumers with a slightly higher income than those at the last mile, it is worth noting that aggressive marketing tactics and promotion should be considered when aiming to introduce new products and innovations.

Establishing new market channels may take thinking outside the box, as Fan Milk did in West Africa. Recognizing the lack of cold-storage facilities in rural areas, Fan Milk sold both bicycles and products to vendors, who would then resell these items across communities. Fan Milk provides its 25,000 vendors with free bicycle repair and product training to sell products daily across Ghana, Ivory Coast, Nigeria, and Burkina Faso (Simanis and Duke, 2014). This provides employment to vendors who are positively motivated to reach new customers with a product that is recognizably in demand.

SABMiller moved into the last mile by making beer not with outsourced ingredients, but local cassava and sorghum in Mozambique and Uganda respectively. This allowed them to keep costs low to compete with their primary competitor, homemade brews. They also unleashed the power of their advertising to create an image of SABMiller beverages that consumers can recognize. And they have worked on pilot projects in establishing former bottle plant employees as one-truck distribution businesses, allowing them to reach markets outside of their initial entry points (Gunther, 2014). Lower costs, local buy-in,

and image-fulfillment are key takeaways from SABMiller, as well as the adaptability of both product and distribution network.

M-Kopa's foundation as a solar light company is modeled off the success of Safaricom's M-Pesa, another innovator that utilized nuanced understanding of the market and disbursed distribution networks. M-Kopa sees itself as a finance company that sells further installments to its customers, and controls subscriptions through SIM cards in the product. They found their most reliable customer to pay back the small loans on their lights were the rural poor; 93% repayment rates justified their expansion into rural areas. To continue capturing the market, before final repayment is made, M-Kopa offers more energy-saving (and therefore, cost saving) devices such as stoves, rainwater tanks, and bicycles. They target anyone with a mobile phone, casting a wide net (Faris, 2015).

We must note that the thing about seed is the product itself cannot really be changed- except to allow for more quality types. The process of certification can be changed—e.g. empowering local seed producer networks to support seed quality (with spot-check fines when this is not up to speed). The process of packaging and marketing can also be changed.

While this is not a comprehensive list of innovation, these examples represent companies that understand their market, have invested in their distribution chains, and have redesigned to match customer needs. These examples offer insights into inventory management, customer segmentation, distribution and retail reach, and product/market fit. There are many things particularly unique about agricultural technology and agricultural markets; but these consumer product successes offer many pertinent reflections for input delivery model pilots.

VI. Conclusions

Comparison across objective measures is incredibly difficult, if not impossible, due to the varied sizes of programs, different countries, different approaches, and lack of robust evidence that truly points to the model as creating specific impact. As well, while each model has some distinct features, many of the programs following them incorporate aspects of other models.

Many models show promise; experience is still mostly pilots

All models attempted to integrate new varietals and higher quality seed into the market, and no single model is the clear "winner." In addition, none of the models have a substantial amount of time experience beyond the period of donor support (except that of commodity traders and existing informal seed/grain markets). All meet challenges that are similar when working with smallholder farmers; all employ somewhat similar strategies, if the tactics are different. Education and information dissemination, credit extension, lowered investment costs, risk diversification, and strong partnerships with local companies and organizations are found in every model. In fact, many of the models bleed into each other at points—FIPS' VBAs in some areas began to set up their own input shops and make deals with wholesalers for inputs, which begins to look like the agro-dealer model. Depending on the point of view, every model is successful, yet no single model can claim it has solved the issue. Therefore, there needs to be a revisioning of how to address the issues, a revisioning that eschews the typical development solutions such as increased training, access to finance, empowering women (while only including a short throwaway gender aspect), engaging the population (which says little of 'how'), and dynamism. Small packages were already being distributed by smallholders in an informal market—innovations such as this, which are already working, should be capitalized on and paired with programs to increase access and adoption.

Understand what is needed

Many programs decry lack of finance in assisting smallholders, but the experience of major companies marketing in rural areas belies this point—there is money to purchase goods if the goods are valuable. Clearly, in some ways finance may be important, as many of the models and social enterprises utilize credit in serving smallholders. Yet, are farmers truly not buying quality seed, or does quality seed (or new varietals) not demonstrate enough value to outperform local traders' offers? Would risk insurance be a better solution rather than financing through credit? PROFIT+ offered no credit and still saw adoption; rethinking stereotypical ideas on the necessity of finance may be necessary to break through to the last mile.

This is a similar situation with training and dissemination of information. Is training needed? At what point and with what specific inputs? Many smallholders may lack formal education, but they have been farming for years—they can see clearly if a new input works or does not. Could there be a larger issue with what is offered, or how it is offered, rather than pat reliance on the idea that farmers are simply not trained? Often the approach is to put even more into training versus a realization that a lack of adoption may indicate other issues. (*The customer is never right in these circumstances – 'they' need more education, more information, and more behavior change. This is likely not the most effective perspective*.) More training is an easy solution to note, and easier to show on PowerPoint slides. Challenging these assumptions is absolutely necessary to reach the last mile. Training, access to finance, the idea that all programs must be scalable while still local—these have been the challenges to reach the last mile for decades, and still the problem persists. Truly understanding what is necessary to reach the last mile may take more of the same.

Incorporate informal market approaches

Coca Cola has little impetus to avoid informal networks—they are the distribution network with retail reach. Informal markets are dynamic and sustainable, yet seed models and programs seem to ignore this. The literature includes a study which documented the importance of commodity traders and existing commodity markets for moving seed among smallholder farmers. Yet not a single other model leveraged this existing network or market structure. Every model analyzed started from scratch in building distribution models. Building upon existing market structures and relationships would likely enhance reach and sustainability, as well as the time required to establish linkages.

No program notes reach

To even address the success of programs and models is difficult when they do not segment their population. How can a program be sure to reach the last mile if the question remains literally how far along the last mile were the pilot beneficiaries? The greatest takeaway may simply be that the closer presence of inputs allowed farmers to take advantage of modern seed—the halving of distance of agro-dealers form 8 km to 4 km saw an uptick of adoption. Perhaps models should focus on simply increasing availability through supply to meet demand in remote areas. Truly, to understand the success of the programs means that programs will have to be better at noting who they are serving—are inputs going to the furthest communities from the road? Are they being re-sold to traders? Do young farmers take advantage of them? More information is necessary, and programs do themselves a disservice by not noting it.

Adopting business-style approaches can be helpful

When trying to establish sustainable value chains through intervention, using tactics normally found in the business world can be helpful. Knowing the customer and marketing to him or her is important for product/market fit and ensuring the customer can capture the inherent potential value from the product. Segmentation and targeting can be very similar and may improve the effectiveness of programming. Enough literature has shown that giveaways are not valued nor used as effectively as purchased items; program designers should think in this cost-benefit mindset. Product promotions and samples are treated differently in a business context than 'giveaways' or relief handouts.

Designing products to be "ruthlessly affordable," means that those at the last mile can still purchase them, and that it would still be within a company's interest to sell to them. Businesses carefully examine their operations for ways to improve delivery and cut costs—this should be no difference when seeking to serve those at the last mile. Models need to examine routes, timelines, dates, personalities, and piggyback off existing infrastructure or distribution networks; and incorporate customer and business feedback loops.

This information, and the networks built up to support intervention, take time to develop—time that many programs built around specific funding timelines cannot afford. A change in how programs approach the issue is necessary; programs must be willing to spend the time and money that companies do. They must be allowed to fail at points, rework the issue, and attempt again, instead of simply reporting beneficiaries reached and then moving on to the next funding opportunity. Acknowledging the amount of time, it takes to create change is fundamental to Coca Cola and Unilever's success; it should be so with input delivery models.

Critically evaluate risk and how smallholders deal with it

Throughout the literature, the question of 'why farmers don't simply adopt new practices' weaves through the models. Even the poorest smallholder will invest in known positive outcomes, but new varieties often. Remain an unknown; rainfed smallholder farmers at the last mile are particularly risk averse. Specialization in production often does not occur because farmers are too wary of dependence on one source of income; it is a tacit risk management approach. Small packages are a good start, as the initial investment and effort are not too high, nor irreversible. Demonstration plots are good visible proof of concept, but smallholders also have to believe they can recreate the conditions of the demonstration plot. Bundling services into an affordable package with insurance is another useful approach; by increasing costs slightly, farmers are covered by insurance and decrease risk.

The difficulty programs face is how to lessen farmers' fear of failure. Insurance helps, as does an affordable, integrated package of services that support the adoption of modern seeds. This is not simply relying on improved information dissemination, or increased financing, but a basket of services that act to alleviate the pressure on smallholders.

Remaining questions after the literature review

The literature and experience are still limited, in reach and time of experience. There are outstanding questions regarding these interventions—questions regarding research, outcomes, interventions, and more.

- Programs could endeavor to develop the context better in regard to targeted populations. Simply satisfying beneficiary profiles with 'smallholder' does not give great insight into how well a model could work that is based immediately outside a large city or 500 miles from the nearest

crossroads. Who are the targets? Who is the population? Are these programs truly reaching the last mile? And can the last mile be reached? How to differentiate diverse types of 'last miles': geographically isolated; socially marginalized (poor); malnourished.

- How can programs better integrate the informal system into their distribution, planning, and adoption schemes? These informal systems are already working and need to be plumbed to discover why they are so resilient, and how to adopt their strategies into the promotion of adoption.
- Bundling is an excellent start to decrease risk. Sharing information and further collaboration between enterprises, companies, NGOs, and other entities is necessary, and all models should find ways to integrate risk diversification into the whole system.
- Does simple distance matter more than any other intervention? This question is a major one—are programs that see success more a factor of decreasing the distance traveled by smallholders than any other? This may require working with communities that are far from roads to isolate variables, to truly see if it is simply a problem of access, or if there is something more.
- The literature review focused on the issue of access and considered the models almost exclusively from the perspective of access. Issues of adoption are likely not only due to a lack of access or an inappropriate access model; access cannot be dissociated from the underlying value proposition and appropriateness of the technology or product to be delivered and that must also be central.

Annex I: Models Chart

Model	Programs	Countries	Impact	Inputs	Timelines
Informal market		All SSA nations		General seeds, inputs	
Community Based Seed Producers	General associations, CEDO	Majority of SSA nations	Some increase in adoption, though many organizations remain basic	General higher quality seeds, inputs	
Agro-dealers	AGRA, CNFA, IFDC	Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Tanzania, Uganda, Zambia	Positive results, though mainly for those located closer to large towns	General inputs, seeds (incl. maize seed)	1997-current
Village Based Advisors	FIPS	Kenya, Tanzania	Positive results, large numbers counted as beneficiaries, but specific impacts need research	Fertilizer and other inputs; cassava, dolichos, maize, sweet potato, general horticulture and agriculture crop seed	2010-2015
Agents	CARE	Zambia, Zimbabwe	Positive results, but limited; p	Maize seed, other crop seeds, general inputs, fertilizer	2000-2005
Outgrowers	IFAD, Varied agriculture companies	Malawi, Mozambique, Uganda	Mixed results—negative in Malawi, positive in Mozambique, generally positive in Uganda	Hybrid sunflower in Uganda, maize seed in Malawi, pigeon pea in Mozambique	Post-colonial to current

Private Service Providers	CLUSA	Mozambique, Senegal, Zambia	Generally positive results	General inputs & seeds	2014-current

ANNEX II: Bibliography

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