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Pull Mechanisms for Overcoming Market Failures in the Agriculture Sector

Initial lessons learned with case illustrations from AgResults' Kenya pilot

After the food crises of 2007-2008 and the growing realization that donor resources were not nearly adequate to meet agricultural development challenges, the AgResults initiative was launched at the June 2012 G20 Summit in Los Cabos, Mexico as an innovation to boost private sector engagement in meeting these challenges. With funding and leadership of several donors—Australia, the Bill & Melinda Gates Foundation, Canada, United Kingdom, and United States—and the World Bank as its trustee, the AgResults initiative uses results-based incentives or "pull mechanisms" to harness the resources and creativity of the private sector to drive agricultural innovation, research, and delivery for smallholder farmers in developing countries. AgResults is now a $122 million initiative comprised of seven pilot projects that incentivize the private sector to develop and deliver innovative products to smallholder farmers in settings where markets for agricultural inputs, services, and outputs are underdeveloped or nonexistent. Each pilot provides financial incentives to the private sector actors only after they achieve predefined results, with the ultimate objective of overcoming market failures impeding the establishment of sustainable markets for developmentally beneficial agricultural innovations serving smallholder farmers.

Pull mechanisms are results-based approaches to development that incentivize private sector actors ("solvers") through prizes to achieve a set of results, paying the solvers only if those results are achieved. Through the $122 million multi-donor AgResults initiative, donors are testing the use of pull mechanisms to engage the private sector in providing agriculture technology solutions to smallholder farmers sustainability, so their engagement in the market continues after the donor support ends. Drawing on early lessons from the AgResults experience to date and the AgResults Kenya On-Farm Storage pilot in particular, this brief provides guidance for development practitioners interested in incorporating pull mechanisms in their own work. It draws on the evaluator's initial qualitative assessments in each pilot country, which involved interviews with actors in the agricultural sector, key government representatives, and the pilot design and implementation teams. This brief also draws from structured interviews conducted in June 2016 with key AgResults stakeholders to synthesize their collective thoughts on lessons learned thus far. These 13 interviewees included the in-country pilot managers in Kenya and Zambia and representatives from the Secretariat and the Steering Committee.

Key Lessons on Designing Pull Mechanisms

- A starting premise is that pull mechanisms aiming to develop a sustainable market for a technology are best designed for development problems that can be resolved by large scale adoption of a technology that has already been proven in the field or requires only some tailoring.
- The solvers should see a clear business case for engaging in the market for the technology. Also, the users of the technology—smallholders—should realize an economic benefit from adopting the technology.
- The outcomes that trigger payments should be easily measurable, verifiable in a cost-effective manner, and in the manageable interest of the solvers.
- Finally, and critically, a robust theory of change must clearly articulate how the solvers, motivated by the incentive structure, will address the key constraints limiting the development of a market for the technology.

First, the brief provides a definition of pull mechanisms, followed by an explanation of how pull mechanisms can address market failures in agricultural value chains as applied in AgResults, using Kenya as an example. We then discuss the key elements of a pull mechanism with examples from the Kenya pilot.

The key elements of pull mechanisms include:

- A development problem to be addressed
- The technology solution
- The "solvers" or private sector actors whom the pull mechanism incentivizes
- An incentive structure, which includes the predefined outcomes and prizes
- A verification protocol
- A theory of change that ties together all the elements
- Ongoing monitoring and evaluation, to inform on-going adaptation

This brief suggests circumstances when pull mechanisms are most likely to be effective as a development tool for the practitioner wanting to develop a market for agricultural technologies that benefit smallholders. It also draws on AgResults' experience to date to suggest some initial lessons, several of which point to the value of incorporating what we know about the behavior of economic agents in agricultural markets and the underlying causes of market failure. For example:

- A starting premise is that pull mechanisms aiming to develop a sustainable market for a technology are best designed for development problems that can be resolved by large scale adoption of a technology that has already been proven in the field or requires only some tailoring.
- The solvers should see a clear business case for engaging in the market for the technology. Also, the users of the technology—smallholders—should realize an economic benefit from adopting the technology.
- The outcomes that trigger payments should be easily measurable, verifiable in a cost-effective manner, and in the manageable interest of the solvers.
- Finally, and critically, a robust theory of change must clearly articulate how the solvers, motivated by the incentive structure, will address the key constraints limiting the development of a market for the technology.

The initial lessons also suggest that pull mechanisms are more likely to succeed when there is only a single binding constraint limiting market development, and not a multitude of constraints (unless other interventions are directly and simultaneously addressing those other constraints). Avoiding a multitude of constraints makes it more likely that the "nudge" to solver behavior provided by the incentives can induce the private sector to engage and that a functioning market will emerge. Synthesizing these lessons, this brief presents the critical steps in designing the technical elements of a pull mechanism and in supporting on-going adaptation throughout implementation.

What are Pull Mechanisms?

Pull mechanisms are among the incentive-based approaches to development such as prizes and advance market commitments (AMCs) that pay value-chain actors who pursue the incentivized goal only after predefined results are achieved. Thus far, most prize-based approaches have been used to encourage innovation creating new technologies, recognizing that socially beneficial technologies are by nature a public good and underprovided (Masters 2003 and Masters and Delbecq 2008). These prizes are usually structured as a winner-take- all grand reward such as the X Prize, first awarded in 2004, which sponsors high-profile competitions to encourage technological breakthroughs "for the benefit of humanity." While the focus of these prizes has been to develop technologies, Michael Kremer has argued for using AMCs that not only spur development of innovative technology, but also include a market test to ensure that the technology is adopted. For example, the AMC for developing a pneumococcal vaccine pays winners only after the vaccines are purchased by countries where targeted beneficiaries live. However, the AMC does not specifically focus on developing a market for the vaccine or engaging the private sector. In 2008, William Masters proposed a proportional (rather than winner-take-all) prize to encourage not just one, but many, private sector actors to develop technological innovations to address predefined agriculture development challenges such as increasing yields. This approach emphasizes innovation in breakthrough technologies and encourages private sector engagement with some focus on adoption, but includes nearly no focus on developing a market for the innovations. Overall, these approaches that combine innovation and adoption do not recognize that technology development and dissemination are typically domains of different types of organizations.

In contrast, AgResults technology adoption pilots have the explicit aim of not only encouraging adoption by smallholder farmers, but developing a functioning and sustainable market that will provide the technology to these farmers. Therefore, AgResults pull mechanisms focus on socially beneficial technologies that are usually further along in their development. AgResults provides payments (or incentives) to targeted market players (or "solvers") after and only if they achieve the pre-specified outcomes of developing or marketing innovative agricultural products or services.

The payments are designed to alter the risk-reward payoff to market players, motivating investments that address the underlying market failures that limit the development and adoption of beneficial technologies.

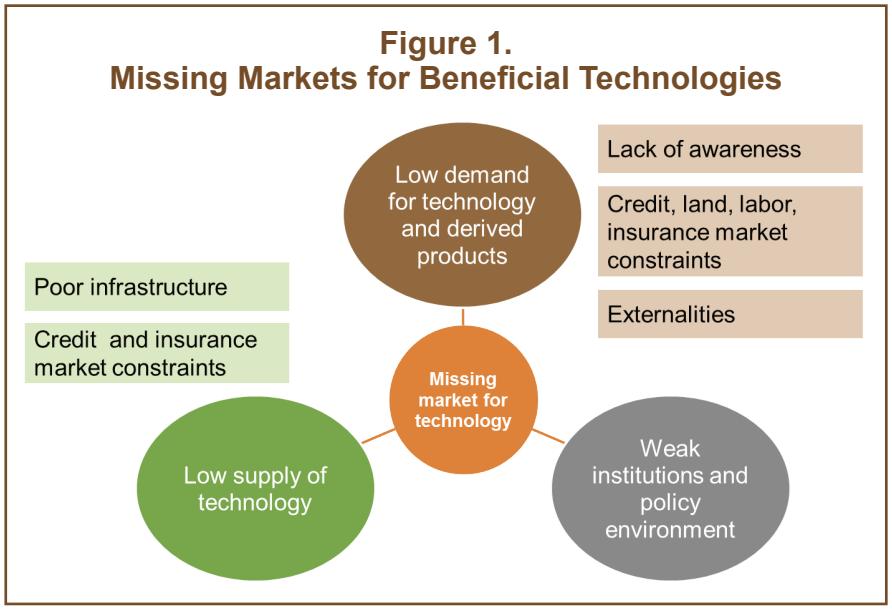
As such, pull mechanisms, if successful, can significantly leverage donor funds by engaging the private sector to substantially and sustainably increase their investment in food security and agricultural development. Without relinquishing resources up front, the sponsor has a chance to engage more than one innovator at a time, thereby theoretically increasing the chances of success, especially if there is a good-sized pool of potential solvers. By directly engaging with the private sector, this approach also avoids crowding out the private sector, which often happens with grants that use subsidies or provide technologies for free. Pull mechanisms also offer the appealing advantage of removing a donor's risk of contracting with a sole innovator who may not succeed—yet who could use up all the donor's resources in the attempt. Pull mechanisms in this context are seen as a possible complement or even alternative to traditional donor-funded development approaches that seek to "push" promising technologies out to beneficiaries through grants or contracts that pay in advance for recipients' efforts. In the next section, we discuss how pull mechanisms can work to address market failures in the agriculture sector, which is how they are used in AgResults.

Overall, pull mechanisms may offer significant value for money by incentivizing private sector investment to address the development problem. The investment by the private sector in a pull mechanism can go above and beyond usual private sector partnerships since it puts private sector actors in a competition to win. Cost-effectiveness can also come from paying only if the results are achieved and not otherwise. Finally, insofar as pull mechanisms address the underlying market failures and create a functioning market, the results are likely to continue well beyond the availability of the pull prize, implying a greater overall cost-effectiveness. The AgResults initiative is using rigorous evaluation to measure the cost-effectiveness of pull mechanisms and test this hypothesis. If we find them to be cost-effective, pull mechanisms can be a strong candidate for being mainstreamed into the "toolkit" of approaches for economic development (when the conditions are ripe for their application).

How Can Pull Mechanisms Address Market Failures in Developing Countries' Agricultural Sector?

Many underlying constraints can lead to low demand and low supply of an agricultural technology, particularly among smallholders and poor consumers. Low demand for a technology may result from limited awareness about the technology, or difficulty in accessing, paying for, or implementing the technology, particularly by smallholder farmers who are likely the final intended beneficiaries. Perceived risk of using the technology can also limit demand. On the supply side, the costs and risks of investing in developing appropriate products or services for smallholder farmers may be too high. Even if the product is developed, low expressed demand, poor infrastructure, or high distribution costs to reach smallholders may limit the supply. These problems are often accentuated by a weak enabling environment. Overall, a reinforcing cycle of low demand and low supply can lead to a "chicken and egg" problem that inhibits the emergence of a viable and sustainable market for a socially beneficial technology. These conditions lead to a missing or underdeveloped market for the technology or, in other words, a market failure in the provision of the technology (see Figure 1).

Figure 1.
Missing Markets for Beneficial Technologies



Pull mechanisms offer incentives to their solvers that temporarily offset these unfavorable demand and supply conditions. Through results-based prizes that reduce the cost of entry into these markets, pull mechanisms effectively increase the likelihood of the solver achieving a minimum return on investment. Consequently, these prizes create incentives for private sector actors to develop systems for procurement, value addition, distribution, and promotion of innovative technologies, thus creating—if successful—a functioning (and sustainable) market for the technology.

The AgResults Kenya On-Farm Storage pilot demonstrates how this looks in practice. In Kenya prior to the pilot, as in many developing countries, as much as a quarter of smallholder farmers' production of staple grains was lost after harvest to problems such as pests and mold. Improved storage devices that could reduce post-harvest losses, such as hermetically sealed bags and metal or plastic silos, have been developed (see pictures on page 5). However, smallholder farmers' low levels of awareness of these storage products and the large investment required to raise awareness and set up distribution systems were barriers that kept suppliers from refining these products for smallholders and marketing them. Instead, suppliers often relied on development agencies as their primary buyers because these agencies could be counted on to make large orders, conduct farmer awareness creation and trainings on how to use the products, and then distribute them for free or on a subsidized basis.

Even though some development partners had been working on promoting smallholder adoption of improved on-farm storage solutions for more than a decade, at the start of the AgResults pilot in 2015, fewer than 12 percent of Kenya's smallholder farmers in the main grain growing areas were aware of the existence of improved on-farm storage technologies, and less than 4 percent were actually using them.

AgResults' Kenya On-Farm Storage pilot energized commercial suppliers of on-farm storage products to compete with each other to tailor and distribute these products to smallholders. The suppliers were motivated by an attractive incentive structure with prizes proportional to their performance in achieving predefined sales goals (see Figure 2). At the end of Year 3 of the four-year project, in response to the incentives, there are now nine suppliers selling storage products to farmers under AgResults with total sales of 146,436 MT of improved storage capacity for smallholders (based on sales of 704,776 storage units). At least 70 percent of these storage products are estimated to be in the hands of smallholders (verification of the proportion of total sales going to smallholders was ongoing at the time this brief was written). Although the final evaluation has not yet been conducted and there is more to be learned, monitoring data suggest that the pilot is addressing a key market failure. Companies are using several strategies to market to smallholders, such as using sales and marketing staff in the region to connect with the smallholders and understand their needs, and nurturing connections with local cooperatives and farmers groups to increase exposure to farmers (Deloitte, 2017). There is evidence of competition among companies that is giving agrodealers and farmers many options for purchasing hermetic storage for the first time. There is also evidence of efforts by companies that go beyond what is rewarded by the pilot. For example, the companies are coming together informally in a working group to discuss the standards for hermetic storage.

In the next section, this brief further explores the necessary elements of a pull mechanism that enable it to address market failures in agriculture value chains.

In Kenya, there is emerging evidence that competition among companies is giving farmers many new options for on-farm storage.

Metal Storage Silo—adapted for smaller capacity for use by smallholder farmer

Hermetic Storage Bag—Several companies are promoting different types of hermetic storage in Kenya, incentivized by the AgResults pilot incentives

Plastic Storage Silo—adapted for smaller capacity for use by smallholder farmer

Figure 2. Kenya AgResults Pilot at a Glance

Geography

14 **Counties** in the Rift Valley and Eastern regions of Kenya

Pilot Timeframe

May 2015-December 2019

Technology

Improved on-farm storage devices

Targeted Beneficiaries

Smallholder farmers

Number of Implementers

- **2015** — 4 original solvers joined
- **2016** — 4 new solvers joined
- **2017** — 1 new solver joined
- 2 more interested

Prize Structure

Rift Valley Mid Point:
first 5 implementers to reach 21,000MT sales receive $750,000 each

Rift Valley End Point:
all implementers to reach 21,000MT sales share $1,000,000 proportionally to capacity sold

Eastern Region End Point:
all implementers to reach 21,000MT sales share $3,000,000 proportionally to capacity sold

Results to Date

146,436MT of improved storage space created for smallholders

What Are the Key Elements of a Pull Mechanism?

As we gain more experience with pull mechanisms through AgResults, we are seeing that these mechanisms need to incorporate a number of technical elements (see Mitchell et al., 2014 on designing broader prizes). Many of these essential elements were identified at the beginning of AgResults, but have come into sharper focus over time. Below we discuss each of the major technical elements in turn, illustrated with details from the Kenya pilot.

DEVELOPMENT PROBLEM

A **development problem** that is recognized as socially significant with a technological solution that has the potential to address it

KENYA

Post-harvest losses of grains due to pests, particularly large grain borer

TECHNOLOGICAL SOLUTION

A **technological solution** with potential to have a significant impact on the development problem if adopted at scale

KENYA

Improved on-farm storage solutions such as hermetically sealed bags, metal and plastic silos

SOLVERS

"**Solvers**," i.e., pre-identified private sector actors who will be incentivized to invest in developing a market for the technology

KENYA

Manufacturers and distributors of improved on-farm storage

INCENTIVE STRUCTURE

An **incentive structure** including a targeted outcome, parameters to qualify the outcome including a means of verification, and reward prize structure for achievement of the outcome

KENYA

Outcome: Sales of improved on-farm storage to smallholders

Parameters: Storage must be technically effective, there is a maximum capacity for storage, retail prices must be at or above cost, credit must be resolved for sales to count, only sales in major grain growing areas count. In Eastern region, storage must be proven to be protective against large grain borer.

Prize structure: Geographically differentiated. For solvers competing in Rift Valley region, threshold prize for first five companies reaching a specified level of sales, then end-of-pilot prize from fixed prize pool proportional to market share. In Eastern region, end-of-pilot prize from fixed pool proportional to market share

THEORY OF CHANGE

A **theory of change** that reflects the causal logic by which the incentive structure will motivate solvers to develop a sustainable and well-performing market for the technological solution, as well as how the pull mechanism's outcomes will have a significant impact on the development problem

KENYA

Pull mechanism incentive will motivate firms to invest in development of demand generation and distribution systems for improved on-farm storage, increasing the availability and uptake of storage by smallholders, thereby reducing post-harvest losses and improving food security

VERIFICATION PROTOCOL

A **verification protocol** that is based on outcomes that can be measured cost-effectively, is not subject to manipulation, and does not place a burden that excludes certain types of solvers

KENYA

Large sample survey of smallholders to estimate adoption

M&E FRAMEWORK

Monitoring and evaluation framework that provides continuous learning to adapt pull mechanism and generates lessons on the design and implementation of pull mechanisms.

KENYA

The external evaluator is using an interrupted time series design to assess the impact of the pilot on smallholder welfare, and is using qualitative analysis to understand the development of a market for improve on-farm storage solutions

Pull mechanisms must be grounded in a clear **development problem**—a socially meaningful problem that the pull mechanism is intended to address—and a **solution** that has the potential to address the problem if it is brought to scale. The pull mechanism can then be designed to address the key market failures that have precluded the emergence of a market for this socially beneficial solution.[1] The solution can be a specific technology already tested and proven, or it can be a technology or practice that requires further tailoring to be adapted to smallholder needs and the specific development problem. In the latter case the pull mechanism can incentivize investment in the refinement of the technology itself. Development problems that do not yet have viable technological solutions are best addressed through innovation-oriented pull mechanisms or other non-pull approaches.

A key element of a pull mechanism is the **solver**—private sector actor—who is incentivized to achieve the predefined outcomes. Because the solvers are the main agents of change in a pull mechanism investing their creativity and capital to address the development problem, they must have an underlying interest in the market for the solution. Therefore, the choice of solvers is intrinsically tied to the choice of the development problem and its solution. This choice is underpinned by a clear theory of change that demonstrates the solvers' path to scale up the solution to address the problem and the underlying market failures (as discussed below). Furthermore, it is important to ensure that there is a sufficient pool of such solvers who have an underlying interest in the market and the capacity to invest at the scale needed for the market to reach a critical mass.

The **incentive structure** includes the predefined ***outcomes*** that will trigger payout, the ***parameters*** against which those outcomes are judged, and the ***prize structure***. It is critical to the pull mechanism that the outcomes are clear, measurable, and verifiable without vulnerability to tampering by solvers, while also being in the manageable interest of the solvers. Furthermore, outcomes should be such that achieving them advances the resolution of the development problem. One outcome that is commonly used in AgResults' pilots is the level of sales of the targeted technological solution by solvers (see table on next page).

Parameters against which outcomes are, for example, technical specifications to ensure a technology's suitability to smallholder farmers, and/or market terms under which sales would qualify for reward to promote investments that lead to sustainable market systems.

The ***prize structure*** includes the size, type, and frequency of payments that are triggered once the verified outcomes are achieved. Prize structures differ in the types of competition they induce between solvers, the degree of risk they place on solvers, and the types of market structure that they promote. Prize structures range from winner-takes-all to payment per unit of outcome achieved (see table). AgResults prize structures typically eschew winner-take-all awards that are not suitable for developing markets with multiple actors; instead they tend to rely on prize structures featuring multiple awards such as proportional prizes, milestone prizes, and per-unit prizes (similar to AMCs).

Underpinning the above key elements is the final important element of the pull mechanism—a clear **theory of change** that articulates the expected causal linkages between the pull mechanism incentive structure, the solvers' expected investments and activities in response to the incentive structure, the expected development of a market for the target technological solution because of the solvers' investment, and realization of a meaningful impact on the development problem. The theory of change should also recognize the external factors that might impact the causal linkages, positively or negatively, which necessitates a clear understanding of the current enabling environment, such as policies and regulations, and any expected changes to it in the future.

[1]Masters (2005) has argued for pull mechanisms that are more solution agnostic and focused on development problems with the specific intent to spur innovations that lead to new solutions. The focus of this brief is scaling up the adoption of socially beneficial solutions that exist by using pull mechanisms to remove barriers to adoption.

A **verification protocol** also must be incorporated into the pull mechanism design process. Verification typically involves a third-party verifier, to transparently and defensibly verify that the solvers achieved the outcomes as laid out in the initial requirements.

A final and important element of a pull mechanism is a robust monitoring and evaluation framework (see Conrad et al, 2017 for an evaluation framework for prizes). For AgResults, engaging an external evaluator from the start enabled the design of rigorous impact evaluations for the initiative. The evaluator's initial qualitative assessments of the pilot plans and context and the ongoing review of pilots' progress have informed pilot adaptations and ongoing learning from implementation. The next section presents the initial lessons from the AgResults pilots that draw on, in part, the external evaluator's ongoing learning.

Prize Structures Used in Pull Mechanisms

Type of prize	Suitability	Advantages	Disadvantages
Winner-takes-all: End-of-contest award with just one winner	Suitable when solvers are willing and able to take risks and invest, as they are placed in intense competition to achieve outcomes, with high uncertainty about receiving payment, suitable when the focus is on developing an innovation rather than developing a market, as just one award can leave a single solver at the end.	Limits the total amount of prize payout.	May not be suitable if solvers do not have resources ahead of time to invest with returns much later or if solvers are risk-averse.
Proportional: Payments are shared proportional to the relative performance of solvers	Suitable when outcomes can be measured in units attributable to individual solvers and the intent is to place solvers in competition, but not as intense as winner-takes-all. Solvers face less uncertainty about receiving payments, which are less dependent on the efforts of other solvers.	Increases likelihood of engaging multiple solvers for a longer period of time; solvers may face less competition and reduced investment risk—as all successful solvers earn some prize—without eliminating incentives to "win" since more successful solvers earn larger prizes.	A large payment can be made even if total quantity of outcome is low (which can be mitigated by setting parameters that establish a minimum threshold before the proportional payouts are made).
Milestone: Payments are made as a pre-defined milestone is reached	Suitable when the steps to achieving the final outcome are known. The level of competition among solvers is low, as all solvers who reach the milestone can get an award (the competition can be intensified by requiring that only the first few to reach the milestone receive the prize), implying much less uncertainty about receiving payments.	Allows periodic payment to solvers if they have a cash flow problem, and therefore increases the likelihood of engaging more solvers in the process.	Results in payment even if the final outcome is not achieved.
Prize per unit of outcome achieved: Payment is made per unit of outcome achieved (e.g., AMC is a payment per unit of sales)	Suitable when the intent is to keep the level of competition for the prize among solvers low to encourage multiple solvers to achieve the outcomes and to reduce the degree of risk they face in receiving payment.	If the per-unit price can be crafted to mimic the final price of the technology or the price premiums, then it can create the exact conditions for value chain actors to move toward a sustainable market (e.g., AMCs can be set at marginal cost of production for the vaccine).	Results in payment even if the final outcome is not achieved at the desired scale (which can be mitigated to some extent by providing minimum thresholds before per-unit payments are made).

Initial Lessons about Pull Mechanisms from AgResults

In this section, we offer initial lessons that can guide development agencies in deciding whether pull mechanisms are an appropriate tool for their agriculture development programs. These lessons draw from our AgResults experience and are illustrated with examples from the AgResults Kenya pilot. The lessons are focused on the technical aspects of the pull mechanism and do not include lessons on the management structures and coordination required at the country level, which are the focus of the AgResults Secretariat's lessons learned series.

Lessons about the choice of development problem, its technology solutions, and the solvers

The development problem should arise from a clear binding constraint causing the market failure that the private sector or targeted solvers can address.

The applicability of a pull mechanism to a development problem is heavily dependent on the reasons underlying the persistence of the problem over time. Specifically, there must be clearly identifiable causes of market failure that can be overcome if the private sector invests in the market. If the market failure results from multiple constraints, the pull mechanism may not be able to address all of them, at least not without making the pull mechanism difficult to understand and complex. AgResults experience indicates that pull mechanisms bring about a better early response when there is only one major binding constraint impeding development of a market. The emerging lesson is that there should be an overriding constraint that, if addressed, can unleash a market's potential.

Related to this is the consideration of other "push" approaches that support the pull mechanism (or potentially interfere with it). Pull mechanism sponsors may wish to consider including push mechanisms to address other underlying constraints. If the level of push funding becomes substantial, the project would become a push- pull hybrid.

AgResults' Kenya pilot tackles a development problem that early research suggests highly amenable to the influence of a pull mechanism.

Although potential technology solutions exist, private sector actors have not made large-scale investments in developing smallholder markets for their on-farm storage solutions. The constraints that have inhibited greater investment by the private sector include that the technologies needed tailoring to smallholders' technical and economic realities, smallholders were not aware of the technology's benefit, and large-scale distribution networks were costly to develop. The private sector actors needed a financial inducement to propel their entry into the market and did not face a multitude of constraints that would have limited their engagement despite incentives proposed under the pull mechanism.

The implementation context—including both the enabling environment and the market environment—should be conducive to a pull mechanism. Other programs should not be targeting the same development problem and promoting the solution in a way that interferes with market development.

The enabling environment—the government policies and rules—should be neutral or supportive to the pull mechanism's intentions. In particular, the enabling environment should not create distortions that undermine the development of the market. Such distortions include policies that favor competing or substitute products, and onerous regulations that inhibit private sector investment. It is also important that there not be other donor or government-funded activities addressing the same problem in way that can complicate the private sector's efforts and present additional constraints. For example, subsidized distribution of the target technology can undermine smallholders' willingness to pay for it, inhibiting development of a market.

In terms of market environment, there should be some existing market infrastructure that the solvers can leverage in developing the new market. Such market infrastructure includes the presence of distribution networks for similar products that can be extended to include the technology and the availability of other complementary services such as credit to enable the solvers to invest productively.

In Kenya, the enabling environment has proven to be neutral to supportive of the pull mechanism. Specifically, there is adequate rule of law coupled with a meaningful but not burdensome regulatory environment to support private sector investment. Likewise, the market environment is also conducive to private sector investment in on-farm storage marketing efforts—for example, many of the pilot's solvers are leveraging the distribution networks that they have developed for other products. Although there has been, and continues to be, a significant degree of donor and government-funded activity to promote storage solutions for smallholder farmers, these efforts have had limited success and are not considered to directly undermine incentives to invest in developing smallholder markets for on-farm storage. Instead the inverse problem has been more prevalent—that is, some solvers have complained that the playing field is not level because several solvers currently benefit or have previously benefitted from donor funds to develop the storage solutions, or benefit from subsidized distribution. This issue, though valid, has not curtailed entry of diverse solvers in the Kenya context. Other programs are ongoing to address the problem, but these efforts are relatively small compared to AgResults.

The **technology solution** for which the market is being developed must be economically beneficial to the key value chain actors. The private sector players that the pull mechanism incentivizes—the **solvers**—must see a long-term business case and the ultimate consumers of the technology should see an economic benefit.

The private sector actors should have an underlying interest in the technology, with a solver who can be incentivized to participate in addressing the market failure. The business case for each value chain actor's engagement in the technology should be clearly articulated—particular attention should be paid to the business case of the solver who is incentivized and the smallholder farmers who are expected to have an inherent interest in adopting it. This is critical to ensuring that the market for the technology and any of its derivative products is sustained after the pilot. Early results have shown that pilots that promote technologies without a clear economic benefit struggle to take off because solvers are reluctant to engage.

In Kenya, an array of smallholder-suitable grain storage devices are available, which have the potential, if used in combination with appropriate post-harvest practices to ensure adequate drying and cleanliness of grain, to significantly reduce post-harvest losses of food staples such as grains and pulses. Because of their efficacy, the devices present a clear economic benefit to smallholders by reducing post-harvest loss, allowing them to purchase less grain for their own consumption in the months after harvest. These technologies include hermetically sealed metal or plastic silos and hermetically sealed plastic bags. If the smallholders eventually purchase these solutions, there is a clear business case for solvers to engage in this market even after the pilot's incentives end. The technology producers and distributors, many of whom became solvers, were enthusiastic from the start about the market potential of on- farm storage solutions because of the large potential demand.

The solvers must be adequate in number and have capacity to address the constraints limiting market development.

The choice of technology, the nature of market failures, and the intended final outcome of the pull mechanism all help the program sponsor identify the ideal private sector actor to incentivize as a solver. In choosing entities to serve as solvers, it is important to ensure that the chosen solver's engagement in the value chain can be made central to achieving the development impact. In other words, the solver must be well-placed to address the key constraints in the value chain of the technology or its derivative products. This might imply choosing solvers that have adequate financial standing and access to credit (particularly because pull mechanisms pay only after results are achieved). The pool of such solvers should be large enough to spur competition in the market and bring the market to a sustainable scale, with individual solvers having adequate technical, managerial, and financial capacity to successfully invest in the market and reach an efficient scale of operations.

The Kenya AgResults pilot encouraged participation from entities that could produce technically responsive storage solutions and articulate a plan to develop a market for them. The solver pool was relevant to the development impact as technology solutions needed tailoring, distribution networks needed to be developed, and adequate resources were needed to raise awareness among farmers. Manufacturers and distributors of the technologies could meet these needs directly or through partnerships with organizations that work with smallholders. The solver pool was also robust. A broad array of firms expressed interest in the pilot, including national and international firms active in markets for agricultural iinputs, pesticide-treated mosquito nets, agricultural produce (grains and pulses), and storage solutions specifically. The number of firms showing interest in the pilot, as well as the number that eventually applied to participate (9 by 2017) demonstrated a potential scale of operations that could reach the pilot's objectives of 172,000 MT of storage solutions being distributed to 480,000 smallholders by the pilot's end.

Lessons about defining the incentive structure—the outcomes, qualifying parameters, and prize

The outcome should be measurable and verifiable in a cost-effective way with adequate qualifying parameters to link the outcome to the development objective.

In defining the parameters of a measurable and verifiable predefined outcome, it is critical to strike a balance between a highly prescriptive approach that can inhibit private sector innovation and introduce burdensome costs, and an excessively laissez-faire approach that may lead solvers to develop the market in ways that undermine realization of the pull mechanism's development objectives. One way to do this is to set parameters on outcomes that mimic the characteristics of the market and product that the pull mechanism intends to promote. For example, the parameters can be set to reflect the geographic scope of the target market, the technical parameters of the

products being promoted, and the market conditions which are deemed to most likely to lead to establishment of sustainable production and distribution systems. A related lesson is that the seemingly simple option of mandating the desired outcome (e.g. the technology must be sold to smallholders) can impose excessive monitoring and verification requirements on either the solver or pilot management. This also highlights the fact that a pull mechanism, during its limited life, may not allow targeting of the poor or vulnerable population of ultimate interest, including women, without adding some complexity. In such a case, it is worth considering the likelihood of this population's eventually benefiting once the market is more fully developed.

The AgResults Kenya pilot used sales of on-farm storage technology to smallholder farmers as its predefined outcome. The pilot aimed to promote the development of a sustainable market for on-farm storage technologies for smallholder farm families to store staples for home consumption. Therefore, the parameters for storage and sales that counted towards the achievement of the predefined outcomes included the geography of the sales (grain producing areas were targeted so that storage wouldn't be sold to farmers to use for cash crops), the technical attributes of the storage (specifically a maximum capacity of 540 kg, which approximates the annual consumption requirements of a typical smallholder farming family), and the market conditions under which the storage was sold (storage must be sold at or above the distributor's cost, and any credit under which the storage was provided had to be resolved before the sale could be counted). At the same time, the parameters also specified that the storage had to be sold to smallholders, which required costly verification involving large-sample surveys of households.

Currently, there is discussion whether this requirement is redundant given the afore-mentioned parameters on the sales and also considering that the storage distributors did not have the capacity to track or document the identity of the final buyer of the storage, nor did they consider it to be in their business interest to develop that capacity.

The **prize structures** should take into account solver constraints and encourage participation and investment by diverse solvers.

The size of the payment should adequately reduce private sector risks and attract a large pool of solvers, while accounting for the trade-off with cost-effectiveness of the pull mechanism. Tepid interest among potential solvers in the early stages is an indication that the size of the prize is not adequate or that underlying assumptions in the theory of change must be revisited and redesign considered. At the same time, cost-effectiveness is a consideration, so the incentive has to balance the two elements. Phasing out of the incentives in a relatively brief span of time can address the cost-effectiveness issue, which can also promote sustainability and scale-up.

Solvers prefer and benefit from more frequent prize payments, as they have the option of re-investing those payments to enable more rapid growth (an important consideration given the prevalence of capital constraints in developing country economies), and also because they are more in line with private sector solvers' business cycles which typically operate on a seasonal or annual basis.

The duration of the prize—the number of years over which it is paid—should be as short as possible to offset the risk of solvers' becoming dependent on the prizes to enable ongoing participation in the market. Shorter duration prizes also have the benefit of leaving the pull mechanism less vulnerable to changes in the implementation context (for example as a result of policy changes or market developments) that might affect the viability or effectiveness of the prize, changes that are more likely to occur as prize duration extends. Phasing out of the incentives can address this issue and can also promote sustainability and scale-up.

The Kenya pilot presents an example of a relatively complex prize. Two separate prize structures were defined based on the geographic location of sales, with the Eastern Region prize requiring that the storage technologies be proven effective against the large-grain borer. The incentive structure also rewarded a limited number of solvers (five) for reaching an initial threshold of sales in the Rift Valley Region, then provided another large prize to be

shared proportionally among solvers based on their volume of sales at the end of the pilot. In terms of timing of the payouts, there is an early lesson suggesting the advantage of allowing periodic payouts after which the solvers start afresh in achieving their outcomes, rather than waiting for a single end-of-pilot prize payout. This would have allowed more entrants in the market, and reduced the first-mover advantage, in addition to solvers' cash-flow constraints. There is also some speculation that the Kenya pilot could have still achieved desired results with a smaller prize. It is too early to tell without the impact evaluation and final monitoring data, but at the same time the large prize may be the key reason that large private sector actors with the ability to solve the problem have entered the market. This circumstance suggests the wisdom of conducting a prospective cost-effectiveness analysis to determine the size of the prize, and also the qualifying parameters such as the minimum sales to qualify for the prize or the maximum capacity of the storage device.

Lesson about the theory of change

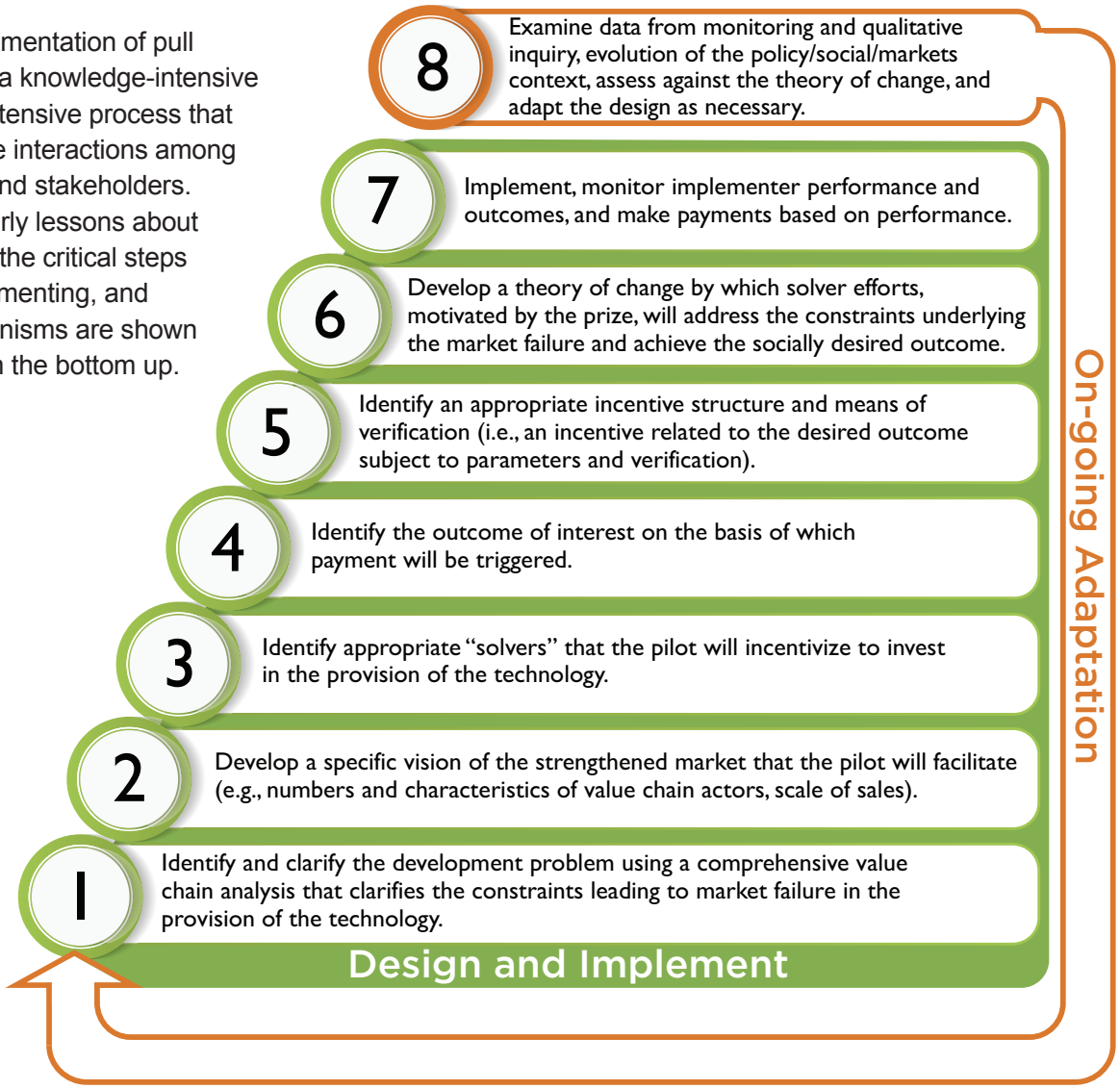
It is critical to carefully develop a theory of change based on a robust analysis of the value chain and implementation environment. This analysis must be updated as implementation nears.

The theory of change needs to be mapped out on the basis of a detailed description of the current market condition and enabling environment. It should articulate how the solver's technology solution will address market constraints and lead to the final intended outcome. A value chain analysis underpins the development of this theory of change and is essential for all aspects of the pull mechanism design process—the identification of the development problem, its technological solution, the solvers, and design of the incentive structure. The value chain analysis must identify the major players in the value chain and their activities, motivations, and constraints as they relate to the provision of the technology or its derivative products. It must also describe the related flow of inputs, services, and products along the value chain, and major features of value chain organization and governance. The objective is to identify the key constraints to development of a market for the target technology (specifically as faced by the targeted solvers), to assess the potential profit (or "business case") for solvers, and identity the potential economic returns from smallholders' engaging with the technology. The value chain analysis requires interviews with key informants along the entire value chain including the potential solvers, smallholder farmers, and policy makers and other government officials who can shed light on the enabling environment. An agricultural economist or agribusiness expert paired with a value chain expert from the country with keen knowledge about the policy environment is essential to this process.

The Kenya pilot offers an example where a strong theory of change was developed based on a thorough value chain analysis, conducted in advance of the pilot and updated as pilot implementation approached and in response to emerging issues. The pilot's theory of change was based on a clear identification of the major factors contributing to post- harvest losses of grains, as well as those inhibiting the emergence of a market for improved post-harvest storage solutions. The analysis also examined the business case for the solvers to engage in the pilot, and the economic returns to smallholders. The critical junctures, or leverage points, where the pull mechanism could catalyze investments to resolve the critical market failures were identified based on that analysis. The Kenya pilot also offers an example of an implementation context that was largely favorable to establishment and implementation of a pull mechanism. Kenya has an active private sector-driven agricultural and agricultural-input industry, and its enabling environment is not considered onerous to private sector investors. At the same time, however, there is a large degree of donor and government-funded activity in grain storage markets, including free or subsidized distribution of storage products. This factor concerned some solvers, who felt that they were not playing on a level field, as other solvers had previously benefitted, or were currently benefitting, from public funding.

Critical Steps in the Development and Adaptation of Pull Mechanisms

Design and implementation of pull mechanisms is a knowledge-intensive and management-intensive process that requires constructive interactions among program sponsors and stakeholders. Drawing from the early lessons about the design process, the critical steps in developing, implementing, and adapting pull mechanisms are shown at right, starting from the bottom up.



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Contact

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AgResults is a $122 million multilateral initiative incentivizing and rewarding high-impact agricultural innovations that promote global food security, health, and nutrition through the design and implementation of pull mechanism pilots. The AgResults initiative is a partnership between the Australian Government, the Bill & Melinda Gates Foundation, the Government of Canada, the United Kingdom's Department for International Development, the United States Agency for International Development, and the World Bank.

Abt Associates is the external impact evaluator of AgResults. Abt Associates is using rigorous evaluation methods—both quantitative and qualitative—to determine whether the AgResults pilots' pull mechanisms achieve their objectives. These briefs summarize our lessons learned, which we are generating on the following topics

- **Suitability of a pull mechanism approach**, focusing on the key conditions under which pull mechanisms can be an effective development tool.
- **Pull mechanism design** and the primary elements to consider, such as the type of prize, choice of targeted solvers, and verification protocols.
- **Market impact** and how to maximize it for pilots that aim to create a market for agricultural technologies.
- **Development impact**, and how to maximize the expected impact on smallholder outcomes, and the interactions with market impact, including potential trade-offs.
- **Cost-effectiveness** of pull mechanism design in achieving development or market impact.
- **Sustainability**, focusing on the engagement of the private sector in technology provision and market development beyond the pilot.
- **Evaluating pull mechanisms**, focusing on methodological challenges and recommended approaches in conducting impact evaluations of pull mechanism pilots.

The contents of this brief do not necessarily reflect the views of the AgResults partners.

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