Final AgResults Evaluation Design: Kenya On-Farm Storage Pilot

Submitted to:

Department for International Development (DFID)
Abercrombie House,
Eaglesham Road
East Kilbride, Glasgow G75 8EA

Prepared by:

Abt Associates
4550 Montgomery Avenue
Suite 800 North
Bethesda, MD 20814

27 June 2014

Table of Contents

Foreword iii

1. Setting for the AgResults pilot 5
1.1 The post-harvest loss problem in Kenya 5
1.2 The AgResults pilot objectives and theory of change 6
1.3 Implementation considerations 8
1.3.1 Technologies 8
1.3.2 Geography 9
1.3.3 Maize storage issues and potential solutions 11
1.3.4 Typology of farmers 12
1.3.5 Gender issues and potential implications for OFS pilot impact 12
1.4 Hypothesized program implementation considerations 13

2. Evaluation questions and the planned research methods to address them 14

3. Evaluation approach for each evaluation question 16
3.1 Evaluation Question 1: What has been AgResults' impact on private sector engagement in the development and uptake of on-farm storage solutions? 16
3.1.1 Hypothesized baseline scenario 17
3.1.2 Hypothesized pilot impacts: endline scenario 19
3.1.3 Method 21
3.1.4 Data 22
3.1.5 Qualitative data analysis 25
3.2 Evaluation Questions 2 and 3: What has been AgResults' impact on smallholders' uptake of on-farm storage solutions? What has been AgResults' impact on smallholders' income? 25
3.2.1 Short interrupted time-series design 26
3.2.2 Model specifications for the estimation of the overall impact of the AgResults pilot 32
3.2.3 Differential impact of the Agresults Pilot on subgroups of smallholders 36
3.2.4 Statistical power analysis and sample size requirements 36
3.2.5 Data 39
3.3 Evaluation Question 4: What has been AgResults' impact on poor consumers' demand for derivative food products? 40
3.4 Evaluation Question 5: What evidence exists that the effects of the AgResults pilots will be sustainable in the medium to long term? 40
3.5 Evaluation Question 6: What is the evidence on the scale of any effect on private sector investment and uptake and on the cost-effectiveness of AgResults as an approach? 41
3.6 Evaluation Question 7: What lessons can be learnt about best practices in the design and implementation of AgResults? 42

4. Evaluation implementation 43
4.1 Initial qualitative assessment – Phase 1 44

4.2 Initial qualitative assessment – Phase 2 45
4.3 Evaluation design workshop #1 46
4.4 Evaluation design workshop #2 46
4.5 Smallholder survey instrument pretest 46
4.6 Baseline data collection—quantitative and qualitative 47
4.7 Ongoing qualitative assessment 47
4.8 Intermediate quantitative data collection for ITS .... **Error! Bookmark not defined.**
4.9 Endline data collection 47

References 48

Appendix A: Data needs from pilot managers and verifiers 50

Appendix B: Pilot implementer & OFS provider survey 51

Appendix C: Short survey for community-level respondents (CDAs, AAEOs, Chiefs) 54

Appendix D: Key informant interview for maize and storage sector specialists ... 61

Appendix E: Survey for OFS distributors 62

Appendix F: Information needed from farmer survey 71

Appendix G: Qualitative Farmer Questionnaire 72

Appendix H: Process analysis template 75

Appendix I: Stakeholders met during IQA Phase 2 76

Foreword

AgResults is a $110 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. It is funded by the governments of Australia, Canada, the United Kingdom, the United States, and the Bill & Melinda Gates Foundation, and managed through a Financial Intermediary Fund operated by the World Bank. By using pull mechanisms, AgResults extends beyond traditional aid measures to promote the adoption of innovative technologies with high-yield development impact. AgResults will provide economic incentives to private sector actors in smallholder agriculture to develop and ensure the uptake of innovative technologies with the potential to yield high development impacts. It will help overcome market failures impeding the establishment of sustainable commercial markets for such technologies, or goods produced by means of them, and thereby achieve substantial and sustained development impacts, manifested in improved food security and food safety, increased smallholder incomes, and better health and nutrition. It will call upon the ingenuity and drive of the private sector to identify and execute the most effective and efficient strategies to achieve development outcomes.

In Kenya, AgResults is funding an on-farm storage pilot that stimulates improved food security through the widespread adoption of enhanced on-farm grain storage solutions for smallholder farmers in the Rift Valley and Eastern Province of Kenya. The pilot is designed to demonstrate a successful model for developing low-cost storage solutions for smallholder farmers by offering cash prize payments to private sector companies based on the volume of low-cost storage capacity sold within a given timeframe. The AgResults evaluation runs from 2013 to 2018, while the Kenya pilot will run from July 2014 through November 2017.

AgResults program team comprises a Steering Committee, a Secretariat, a Trustee, country-specific pilot implementers, and an external evaluator. The Steering Committee oversees the implementation of AgResults and is comprised of the five donor agencies and the Trustee. The Steering Committee is responsible for strategic oversight of the initiative, including endorsement of key management decisions, approval of concepts and business plans for proposed pilots, and the monitoring of pilots and the initiative as a whole. The Secretariat is responsible for implementation of the AgResults initiative and reports to the Steering Committee. In order to fulfil its role effectively, the Secretariat develops a close working relationship with the Trustee and ongoing external evaluator. Core functions include appointment and management of pilot implementation and verification agents, sourcing new pilots and communicating results. As Trustee for AgResults, the World Bank provides an agreed set of financial intermediary services that include receiving funds, holding funds, investing funds, and transferring them to recipients or other agencies for implementation as directed by the Secretariat on behalf of the Steering Committee. Agribusiness Systems International (ASI), a wholly controlled support organization of ACDI/VOCA, serves as Pilot Manager for the Kenya pilot. As Pilot Manager, ASI is managing overall implementation of the pilot. This includes marketing, promoting, and managing the pre-qualification process to identify potential implementers; coordinating with international organizations and relevant government ministries; coordinating reporting by implementers on progress towards targets; and generating lessons learnt for dissemination to the broader stakeholder community.

The Steering Committee appointed Abt Associates Inc. to serve as the External Impact Evaluator for the AgResults pilots, including the Nigeria Aflasafe pilot. Abt's role is to determine on a rigorous scientific basis if the pull mechanisms achieve their objectives – to measure whether the mechanisms produce private sector behaviours and social outcomes different from, and better than, what would have happened in the absence of the mechanism introduced by the pilot initiatives. We will also report our assessment of the sustainability of the results produced in the private market once the pilot incentives are removed. In our role as the External Impact Evaluator, Abt will define the overall evaluation framework for the AgResults Initiative and an impact analysis strategy for each pilot. We will also implement and analyze field surveys based on established best practices, conduct qualitative market analyses, and communicate evaluation findings to the Steering Committee and wider audiences as needed. Our role will be vital to the AgResults' learning agenda of understanding the potential of private sector involvement in the development and spread of agricultural innovation. This report presents Abt's evaluation design for the Kenya pilot.

1. Setting for the AgResults pilot

1.1 The post-harvest loss problem in Kenya

Post-harvest losses (PHL) of grain are high in Sub-Saharan Africa (SSA), ranging between an estimated 10 and 20 percent of crop value and reaching as high as US$4 billion on an annual basis (World Bank 2011). In Kenya, a study by the International Maize and Wheat Improvement Center **(**CIMMYT; cited in Dahlberg 2012) found that traditional farm-level storage of maize led to losses of about 25 percent of the volume, mainly due to weevils and larger grain borer (LGB). For the large majority of smallholders, most PHL entail losing grain stored for household consumption. The prospect of grain loss during storage also drives economic losses: farmers tend to sell maize quickly after harvest when prices are depressed due to abundant supply, rather than waiting for prices to improve. While farmers still keep some maize for their own consumption, many end up buying maize back from the market when they exhaust that supply, usually at higher prices than they received when selling the maize they grew at harvest time. On-farm storage (OFS) that prevents losses, therefore, has the potential to reduce both physical loss of stored grain and economic losses for farmers.

Furthermore, during our field visits farmers frequently cited concern over the pesticide dust they currently use to mitigate pest infestation. Many are not sure whether they are using it properly (and indeed, some apply too little, at the wrong times of day, or apply the pesticide too infrequently for it to be effective). Since they primarily use the pesticide on maize that they store at home (the maize that they will use to feed their family), they are worried about its potential health effects and would prefer not to use if they do not have to.

Despite these high losses and the aversion to pesticide use, there is limited use of improved on-farm storage technologies that are available in Kenya. A need also exists to develop better on-farm storage technologies that control damage by the LGB, which afflicts maize crops in Eastern Kenya in particular. Even though farmers recognize that they lose a significant amount of grain (also to untimely rain, theft and rodents), they tend to view losses as a reality of farming. This reflects a lack of awareness of available storage technologies and of the economic benefits they could yield.

Furthermore, farmers tend to be risk-averse and face constraints to adopting on-farm storage technologies with relatively high upfront costs, cash constraints, and uncertain future benefits. Komen et al. (2010) found, in a survey of farmers in Kenya’s Uasin Gishu and Trans Nzoia counties, that 72 percent of the respondents reported that uncertain returns to storage because of future price unpredictability were a major storage problem. While the study did not focus on available improved storage technologies, 35 percent of farmers cited limited working capital as a barrier even to constructing traditional storage facilities such as cribs to store maize. These factors, and the cash constraints that compel farmers to buy early, create enormous challenges to the private sector for entering the market for on-farm storage in Kenya. The awareness gap and risk aversion among the potential demand pool (smallholder farmers) imply that entry into the on-farm storage market in Kenya will require significant upfront investment as well as intense and sustained marketing activities to persuade farmers of the benefit of the product.

Other than the demand side constraints, the supply of suitable post-harvest storage technologies is limited because of lack of distribution networks and resulting high cost of supplying these technologies.

The AgResults on-farm storage pilot in Kenya aims to address the market failure for on-farm storage by providing an incentive (in the form of a performance-based grant) to providers of improved storage technologies who can develop and sell sufficient storage volume to smallholder farmers over a three-year period. The technologies marketed by these providers must meet minimum efficacy standards, including LGB resistance for storage sold in the Eastern counties. Otherwise, the pilot is largely technology-agnostic: any type of container (e.g., hermetic bags, metal silos, plastic containers) is eligible as long as firms show that it prevents the loss of maize (or other stored crop) due to pests over a reasonable storage period (four to six months) and as long as the sale of the specific technologies can be easily verified. For example, a poly bag with a cache of chemical mix would be effective but would not qualify for this pilot because given its widespread use, it will virtually be impossible to track its sale by a specific company.

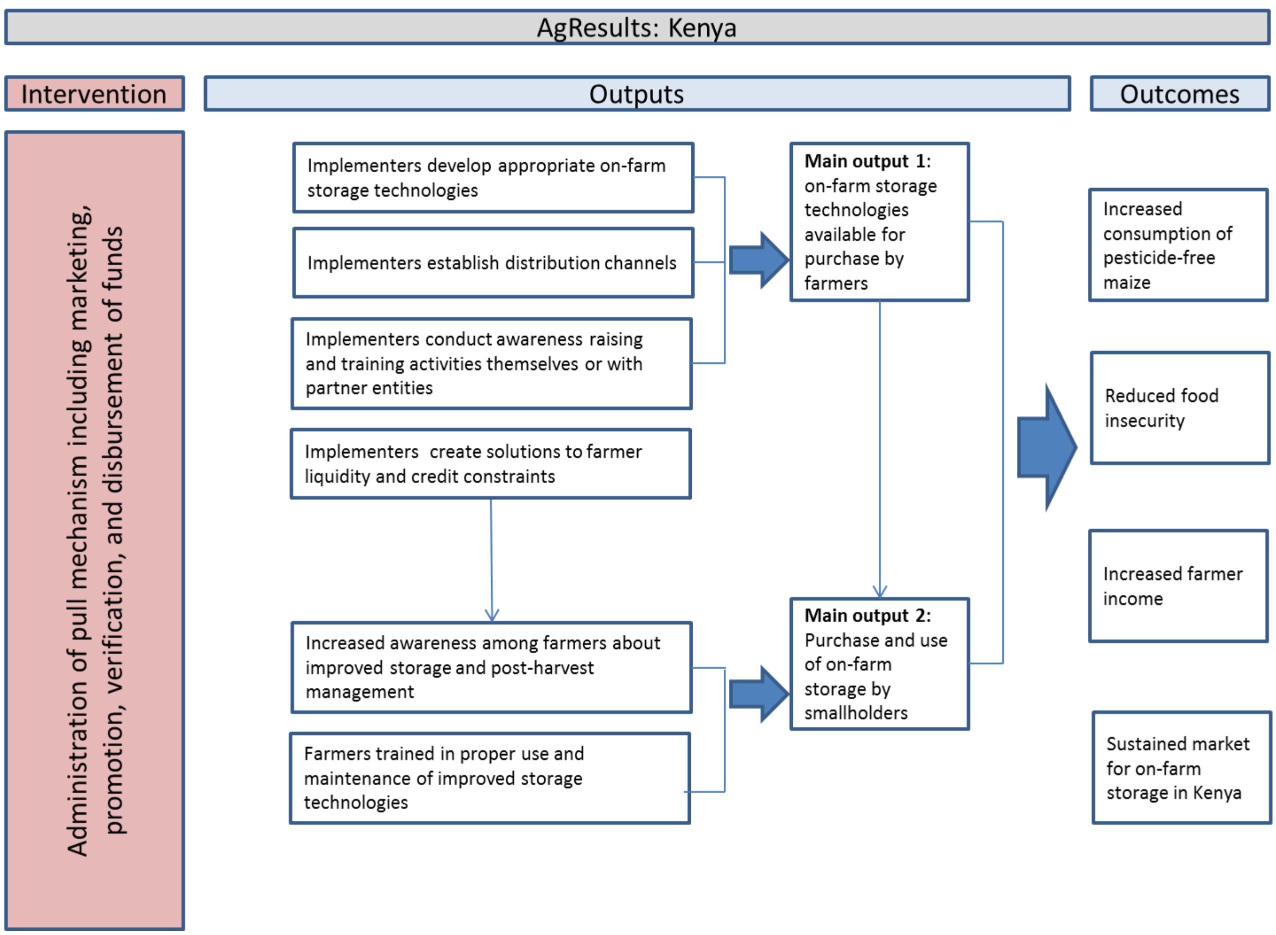
If the private sector is able to overcome the challenges described above (e.g., supply-chain bottlenecks, lack of awareness, cash constraints, low working capital, or access to credit) and create an effective market for on-farm storage in Kenya, there is potential for many smallholders' current post-harvest problems to be significantly reduced. However, on-farm storage does not address several other major post-harvest problems. First, one major source of loss is mould (including aflatoxins) due to inadequate drying before storing. Farmers cite unpredictable rainfall around the time of harvest, as well as a lack of moisture meters or testing equipment, as barriers to sufficient drying. All storage technologies in the pilot will require improved post-harvest management, including proper drying to be effective. Second, and perhaps more challenging to the adoption of storage among smallholders, is the fact that farmers who do not have a source of off-farm income or another cash crop (e.g., coffee, tea, or sugar cane) often must sell their maize at harvest time to pay school fees, loans, and other expenses. In other words, lack of storage is not the only (or even the primary) driver of early maize sale among many farmers, and the economic case for these farmers to purchase storage is less clear. Therefore, while the AgResults pilot may improve the market for and awareness of on-farm storage, there are other post-harvest loss issues that also affect farmers but will not be addressed by the pilot.

1.2 The AgResults pilot objectives and theory of change

The AgResults on-farm storage pilot offers incentives for private sector investment in the market to provide on-farm storage solutions for maize in Kenya. The objective is improve smallholder farmers' (defined as farmers with less than 5 hectares of land) access to and utilization of economically and technologically appropriate on-farm storage solutions, allowing them to realize the economic benefits of storing maize after harvest rather than selling it and buying it back later (at higher prices) due to a lack of storage options. By motivating the supply of high-quality on-farm storage, the pilot seeks to mitigate this sell-low, buy-high reality and the high rate of product loss in storage that is currently endemic to Kenya and Sub-Saharan Africa. The pilot design is tailored to the needs of each of the locations where it will be implemented. In the Rift Valley, the focus is on the replication, distribution, and sale of existing technologies for maize storage. In the Eastern counties, the focus is on developing and distributing smallholder-appropriate storage solutions that mitigate losses from LGB.

The pilot is intended to motivate private sector investment in the market for on-farm storage solutions by offering performance-based grant money to firms in proportion to the amount of technically appropriate storage which they sell. The theory of change, depicted in Figure 1, is that the performance-based grant mechanism will spur implementers to engage in development, distribution, financing, and awareness-creation activities that lead to a robust market for on-farm storage in Kenya. The creation of this market is intended to stimulate purchase of storage technologies by smallholder farmers and ultimately to lead to farmer-level impacts such as increased consumption of pesticide-free maize, increased income, and reduced food insecurity. Minimum sales requirements are intended to ensure that storage providers enter the market in sufficient numbers and volume to support the creation of a dynamic on-farm storage industry that will be sustained after the end of the pilot. While storage providers have the autonomy to develop whatever distribution networks they feel are appropriate, it is expected that many will recruit existing agro-dealers—located on average within 8 km of farmers—to serve as retail outlets (Dahlberg 2012).

Figure 1. AgResults theory of change



There are two implementation areas for the pilot—the Rift Valley and Eastern regions. The Rift Valley is characterized as relatively well-off and is responsible for well over half of Kenya's maize production on a yearly basis. Commercially oriented production is typical among large, medium, and small-scale farmers. Mechanized production and use of improved inputs is common, and there are credit facilities available to lend to farmers who qualify.

In the Rift Valley, the first five implementers to sell 21,000 metric tons (MT) of useful life adjusted storage capacity[1] will be eligible for a US$750,000 performance-based grant. Then, all implementers that reach a 21,000 MT useful life adjusted storage threshold by the end of the pilot period will share in a US$1,000,000 grant that will be allocated proportionally based on the capacity that each implementer sold. In the Eastern counties, all implementers that reach a 21,000 MT useful life adjusted storage threshold for LGB-resistant technologies will receive a share of a single US$3,000,000 performance-based grant in proportion to the capacity that each implementer sold.

1.3 Implementation considerations

1.3.1 Technologies

The AgResults on-farm storage pilot is technology agnostic such that it will promote any technology that meets the following minimum requirements (adapted from the AgResults Kenya On-Farm Storage Pilot Pull Mechanism Request for Applications):

- Maximum storage capacity of 540 kg per unit;
- Reasonably easy for smallholders to use;
- Suitable for storing crops for individual consumption;
- Prevents insects and other pests from damaging the stored grain within two weeks of the crop being placed in the container (i.e., the pests should die before they can multiply and cause significant crop losses);
- Prevents increased infestation of pests from outside the container during a reasonable storage life of the crop (estimated to be four to six months);
- Does not cause any adverse effects on the quality of the stored crop;
- In the Eastern counties, prevents or retards LGB infestation;
- Sales can be easily verified as occurring from the specific company.

Given these requirements, several main types of potential storage solutions are likely to be included in the pilot. As described in the AgResults On-Farm Storage Business Case and the Request for Applications, these include:

Hermetic bags, which are airtight bags that suffocate any living organisms, including storage pests, within a matter of weeks and prevent them from damaging the grain after that. Several firms that have expressed interest in becoming pilot implementers trade in such technologies, including GrainPro, Purdue Improved Crop Storage (PICS) bags (developed by Purdue University and distributed in Kenya through Bell Industries), Vestergaard, and AtoZ. The majority of these bags rely solely on a hermetic seal to kill pests, while some (such as Vestergaard) also include a pesticide dust component. The bags are generally not rodent-proof and may be vulnerable to LGB as well. Most hermetic bags have a useful life of two to three

---

[1] The useful life adjusted threshold is calculated separately for each technology based on the storage capacity of the technology and its assumed useful life.

years. While there is a range in the price of bags, most cost at most several hundred Kenyan shillings (KES).

Tests of the PICS bag technology in Benin, Burkina Faso, and Ghana have shown it to be effective against major storage pests in maize stored for 6.5 months, suffocating 95-100 percent of insects and preventing infestation by any new insects (Baoua et al. 2014). Similarly, Baoua et al. (2013) found that both PICS bags and GrainPro's SuperGrain bags prevented pest damage to stored cowpeas over a four-month period, with both bags offering the same reduction in oxygen levels and temperature inside the bag over time. While both of these bags are available in Kenya, GrainPro has the highest usage primarily for coffee.

Flexible, durable bulk bags, such as GrainPro's Cocoon, which are used as an outer container in which multiple bags can be stored. This technology has already been in use in Kenya, largely for higher value crops such as coffee, and may be sold in modified form (with storage capacity below the 540 kg limit) as part of AgResults. Pricing and useful life are not yet available for this technology.

Metal drums or metal silos, which are made by local artisans who have been trained by CIMMYT and/or Catholic Relief Services (CRS), the latter of which introduced this technology in Kenya in 2000. Metal silos were developed and first disseminated in Latin America by the Swiss Agency for Development and Cooperation. They are usually custom-made by local artisans following the CIMMYT quality paratmeters, and they range in capacity from 5 kg to much larger. They are effective against rodents and insects, including LGB, and do not require the use of pesticides. To be effective, they require a rubber band seal as well as a candle that is lit inside the container to eliminate oxygen at the time of closing. If properly maintained, metal silos can have a useful life of 20 years or more. They are significantly more expensive than hermetic bags (starting at about KES 6000), and in the past they have generally been sold with significant subsidies from CIMMYT or CRS. Tests of the metal silo conducted in Kenya by CIMMYT found that, with or without the addition of pesticides, the technology was effective at preventing losses for six months (CIMMYT 2011).

Plastic containers originally developed as water tanks, such as those made by Kentainers, are also being adapted as grain storage technologies. They are effective against all pests and do not require the use of pesticides. They are relatively expensive at around US$50 per container, though they are large (350 kg capacity) and have a useful life of at least 20 years.

1.3.2 Geography

The pilot's target counties are split between the Rift Valley and Eastern regions. Each region has its own performance-based grant structure as described in Section 1.2. Rift Valley is characterized as relatively well to do and is responsible for well over half of Kenya's maize production on a yearly basis. Commercially oriented production is common and among large, medium and small-scale farmers. Eastern province is a poorer region and suffers from inconsistent rainfall, drought, poor soils and small and fragmented landholdings, such that maize yields are only about 40% of the national average (Government of Kenya 2011) p.17. Eastern province is generally considered to have poor agroecological conditions for maize and several extension and projects are working to reduce maize area planted in favor of other crops like sorghum. Most maize producing operations are conducted manually or with animal draught power, and the use of improved inputs is limited by limited availability and lack of credit for their acquisition.

The Rift Valley target counties where sales will be counted under the pilot are:

- Uasin Gishu
- Trans Nzoia
- Nandi
- Nakuru
- Laikipia
- Baringo
- Bomet
- Kericho
- Trans Mara

In the Eastern region, the target counties are:

- Meru
- Embu
- Makueni
- Kitui
- Machakos

The maize production and storage situations vary among these counties, likely making some areas more attractive to implementers than others. First and foremost are the differences in production between different counties: farmers in Rift Valley are generally larger and more advanced in their production methods. The Eastern region is poorer and suffers from inconsistent rainfall, drought, poor soil, and small and fragmented landholdings, such that maize yields are only about 40 percent of the national average (Government of Kenya 2011, 17). The Eastern region is generally considered to have poor agro-ecological conditions for maize, and several extensions and projects are underway to reduce the areas used for maize in favour of other crops such as sorghum. Most maize-producing operations are conducted manually or with draught animal power, and the use of improved inputs is limited by limited availability and lack of credit for their acquisition. Maize production, marketing, and utilization in Kenya
Maize is the major food staple in Kenya, with consumption averaging 80 kg per capita and accounting for one-third of calories (Dahlberg 2012). Although the pilot incentive is structured to reward on-farm storage for grains, generally, it is expected that the AgResults pilot will mostly focus on storage for maize.

Smallholders dominate maize production in the country, though primarily at a subsistence level. More than 98 percent of small farmers grow maize, but only 2 percent of them are responsible for more than half of the maize marketed by smallholders. The remaining 98 percent of the smallholders either sell no maize or small only small amounts, and most rural producers are net buyers of maize (Kirimi, et al. 2011).

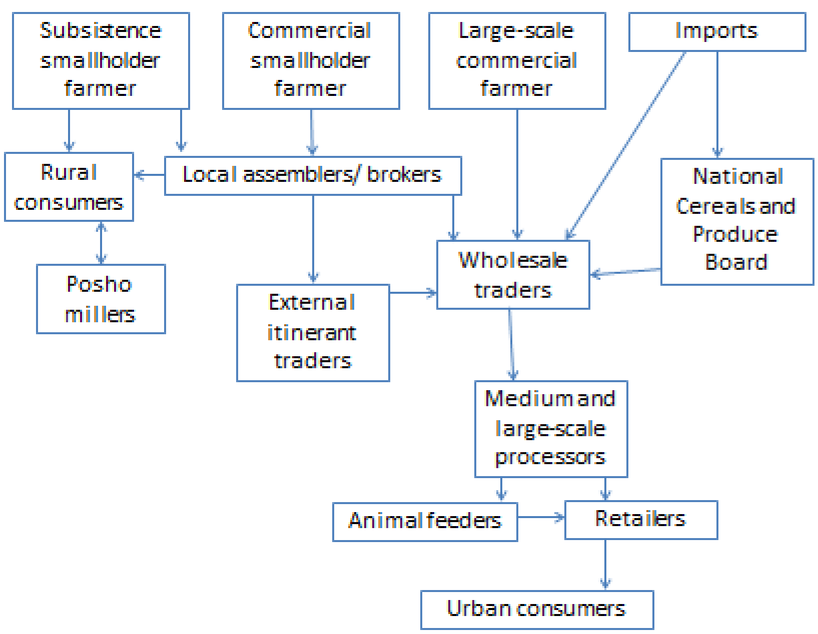
Following production, farmers harvest, shell, and dry the maize, which is then stored. Farmers usually sell maize to local traders, and the market is considered to be competitive. Local traders either hold the maize for selling it to local consumers or may sell it to larger traders, who sell it to processors. During times of local shortfalls in maize supply, the larger traders import maize into the area (often from Uganda or Tanzania), and local traders sell that to local consumers.

Kirimi et al. (2011) provide a succinct description of the maize marketing chain in a normal year:

> In a normal or good year, domestic production from small- and large-scale farmers forms the major source of domestic supply. Smallholder maize sales go largely to small-scale assemblers or brokers, who collect and bulk for onward sale to large wholesalers. Large-scale millers are the next major link in the chain, buying grain primarily from the large wholesalers, the NCPB [National Cereals and Produce Board], and from smaller traders. The large millers sell mainly to a decentralized system of informal retailers (street kiosks, dukas, multipurpose retail shops, and traditional retail markets) and to a lesser extent to the more high-end consumers who shop at supermarkets. Posho millers who operate in retail markets are important players in some areas. Consumers buy grain and pay a fee to custom-mill their grain into posho meal. This option provides the means to produce maize meal relatively inexpensively and is preferred by the urban poor and most rural households, especially in western parts of the country (ix).

Figure 2 provides a graphical depiction of the maize marketing chain.

Figure 2. Kenya maize marketing chain (adapted from Kirimi et al. 2011)



1.3.3 Maize storage issues and potential solutions

Storage is seen as a major challenge due to high losses throughout the pilot area. Currently, the predominant storage method is to use polypropylene bags to store maize, either on the cob or shelled, that has been mixed with pesticides. The bags are kept in cribs, barns, or houses to protect against theft. Nonetheless, there are a variety of storage options available, including the polypropylene, sisal, or jute bags, traditional granaries, hermetically sealed bags, metal and plastic tubs and silos, and off-farm storage in community-level cereal banks, the government maize parastatal (NCPB) storage facilities, and several private storage ventures including warehouse receipt systems (WRS). Both government and non-government organization (NGO) initiatives are working to improve storage options for farmers, and there is a significant investment in promoting metal silos, in particular, by training local artisans who can produce and market them at the community level.

1.3.4 Typology of farmers

In addition to the regional differences between farmers in Rift Valley and Eastern counties, qualitative research reveals two distinct types of maize farmers in Kenya. The first type are highly financially constrained: they have little or no ability (or access credit) to purchase improved storage technologies, and they are less likely to have off-farm income or an alternative source of agricultural income. They usually have fewer land holdings, as is the case among many farmers in the Eastern counties. They tend to sell their maize immediately after harvest, in large part due to household financial obligations. They are also likely to face a "lean" period of maize consumption between harvests. This stems from their inability to store enough maize to sustain them through the next season because they have to sell some to meet their financial obligations.

The other type of farmers are less constrained. They may have more land, access to credit, off-farm sources of income, or an alternative cash crop that they can sell instead of maize (or some combination of these). They also tend to sell maize soon after harvest, but their sale is more closely linked to storage constraints—they sell quickly at lower prices because waiting and selling later instead would cause losses from insects, mould, and rats. However, given the right conditions (i.e., access to storage and awareness of the benefits of storing longer), these farmers do have the potential to use improved on-farm storage to increase their incomes by selling maize after the harvest at higher prices.

1.3.5 Gender issues and potential implications for OFS pilot impact

There are differences in households' access to and control over resources depending whether a male household head is present. Female-headed households are common in Kenya. While *de facto* female-headed households often receive support from outside, such as remittances from husbands, other family members, or grown children, *de jure* female-headed households are less common, but do not as frequently have access to outside sources of support and are perceived to be disadvantaged and poorer. Furthermore, although the 2010 Constitution granted women the right to inherit land, this relatively recent law has not yet had a significant impact, and in reality virtually all land is still titled to men.

There are also traditional gender roles guiding participation in maize production, harvest and post-harvest, and utilization activities in Kenya. In terms of production, men typically are responsible for heavy labour such as land preparation and women are responsible for planting and weeding (except in the case of Muslim households). Both men and women take part in harvesting, while women are responsible for post-harvest activities such as drying, shucking, and shelling of maize. Men are usually in charge of sales of large amounts of the maize harvest (e.g., wholesale sales to traders), while women take care of any retail sales of maize (e.g., informal sales at the local market). Women are responsible for preparation of maize for consumption, including milling and cooking. In households without male adults, the traditionally male tasks must either be completed by females or children, or hired out (which is difficult for low-resource households). Thus, female headed households, particularly those that have no adult sending remittances or contributions from elsewhere, are particularly constrained in their ability to produce maize and other food staples.

These gender differences in access to and control over resources, and household roles in maize activities, have several potential implications for the impact of the OFS pilot on women. First, gender roles and different access to resources may limit women's (and women-headed households') access to improved OFS. Their more home-based roles and responsibilities may make them less likely to be exposed to information about the OFS options, they may have more difficulty obtaining credit to purchase them, and they may have more difficulty in accessing the storage solutions from distributors such as agro-dealers.

Second, women and women-headed households may face more difficulty in learning how to use the OFS solutions properly, which may affect the benefits of these storage solutions at the household level. This possibility is particularly noteworthy considering that women are traditionally responsible for post-harvest and storage activities, but men often represent households in organizations and transactions, and often, as "head of household" are the persons targeted for educational campaigns (e.g., on using the OFS solutions). In such cases, either the men will need to take over management of the stored maize, or they will need to convey information on how to use the OFS solutions to women.

Finally, there are potential inequalities in the distribution of costs and benefits of the new storage solutions. Given that the OFS solutions are expected to improve the durability of maize that is stored and allow for its storage without pesticide, it is likely that benefits to the household (including women) will be positive. OFS solutions should lead to increased availability of maize for consumption over much of the year (i.e., increasing and smoothing out the consumption). On the other hand, the costs of the storage include not only the purchase price but also the labour costs involved in utilizing the storage. If utilization of the storage adds to the responsibilities of females (e.g., additional steps required to prepare the grain for storage), then this could have a negative effect on household women.

The impact evaluation will collect gender-specific data to allow these (and other) potential impacts to be evaluated. The quantitative baseline survey will collect data on households' structure, including gender of the household head, who is responsible for utilization of the storage solutions, and who participates in pilot-related activities, such as training on utilization of the improved storage. The qualitative data collection will also investigate potential gender-differentiated impact, delving into whether there are any shifts in household roles and responsibilities related to use of the storage, how OFS adopters were exposed to and trained in use of the storage, and perceptions on the effectiveness of these awareness and training efforts, as well as perceptions on the effectiveness of the storage itself.

1.4 Hypothesized program implementation considerations

Given the context and design of the pilot as described above, strategic responses from potential implementers and smallholders suggest that the program implementation may entail the following actions that would affect pilot outcomes:

- Implementers may have a natural proclivity to focus their marketing and sales efforts on farmers who are less-constrained, as described in Section 1.3.4. Ultimately, this may mean that farmers who are relatively better-off among the smallholder farmers (farmers with less than 5 hectares of land), will participate in the pilot, thereby limiting the pilot's benefits to the nation's smallest farmers and their families.

- Implementers, even those who are already operating in Kenya, are likely to look for partner organizations or local governments with on-the-ground networks, established farmer relationships, and platforms for training to help them with the time- and resource-intensive task of raising awareness about their products. This approach has already been used with some success by PICS and CIMMYT in Kenya. Therefore, the geographic spread of market penetration may be closely linked to the presence of third-party partners that implementers can leverage for awareness creation.
- The longstanding tendency of farmers to sell maize immediately after harvest may be a particularly difficult practice to change, even for larger farmers who can afford to wait for better prices. In addition to farmer financial constraints and storage concerns, this tendency is at least partly due to trading patterns: farmers often sell to itinerant traders who arrive at their farms shortly after harvest. Given that these entrenched patterns may take time to change, the income effect of the pilot may lag other outcomes.
- A significant percentage of farmers' current perception of the benefits of improved storage is primarily limited to the elimination of the need for pesticides, which they perceive to be harmful. They are interested in keeping pesticide-free maize for consumption, but as there is no market premium paid for pesticide-free maize, farmers may prefer to use improved storage only for the maize they intend to consume. They may continue to use other storage options and pesticides on maize they intend to sell.

These potential interactions—and others that we may not have captured here—imply that the evaluation must collect extensive information on factors that may lead to the success or failure of the pilot in affecting farmers' storage uptake and use. The rest of this document describes Abt's proposed approach to assessing whether the AgResults pilot achieved its intended impacts and why—and if not, why not. The next section lists the evaluation questions we will address and summarizes the analytic methods—qualitative, quantitative, mixed—we will use to address each question. Section 3 presents details of the evaluation approach to be used with each question. Section 4 concludes with the timeline of the evaluation.

2. Evaluation questions and the planned research methods to address them

As noted above, the on-farm storage pilot provides incentives for private sector investment in the market for on-farm storage solutions for maize in Kenya. The objective is to improve smallholder farmers' access to and utilization of economically and technologically appropriate on-farm storage solutions, allowing them to realize the economic benefits of storing maize after harvest rather than selling and buying back later (at higher prices) and improved food security through reduced physical losses of grain and increased consumption of pesticide-free grain.

The AgResults evaluation will assess whether the program has met its objectives and be guided by the following six questions out of the seven evaluation questions in the overall evaluation framework (Evaluation Question 4 is not relevant for this pilot):

1. What has been the impact of the AgResults project/pilot on private sector involvement in the development and uptake of on-farm storage?

2. What has been the impact of the AgResults project/pilot on smallholders' uptake of on-farm storage?
3. What has been the impact of the AgResults project/pilot on smallholders' incomes?
4. What is the impact of the AgResults pilot on consumers' demand for derivative products? *[not relevant for Kenya pilot]*
5. What evidence exists that the AgResults pilot is scalable and that its effect will be sustainable in the medium to long term?
6. What is the evidence on the scale of any effect on private sector investment and uptake and on the cost-effectiveness of AgResults as an approach?
7. What lessons can be learnt about best practices in the design and implementation of agricultural pull mechanisms?

We will also address, within each of the questions, whether the pilot's impact has had any gender-differentiated effects, and analyse the determinants of any such effects that are identified. Questions 1, 5, 6, and 7 are related to the pilot's impact on the market. To provide evidence for the pilot's impact on the market or private sector engagement, the evaluation must contrast markets that are subject to the pilot pull mechanism with other markets that are not. Small numbers of market participants and multiple levels of interaction make it difficult to measure these consequences in a large sample-based quantitative evaluation. Therefore, we will assess the market-level questions on the agenda (questions 1, 5, 6 and 7) using primarily qualitative methods—specifically a structure, conduct, and performance (SCP) framework. We will use quantitative (statistics based) methods to assess the pilot's impact on smallholder awareness, adoption, and use of on-farm storage solutions and subsequent effects on income (questions 2 and 3). Mixed methods will also play a role in addressing most of the questions—for example, we will use qualitative methods to help understand in depth the outcomes of the quantitative impact analyses of questions 2 and 3.

The qualitative and quantitative research activities will be coordinated. We will collect data for the qualitative research using a mix of key informant interviews and small-sample surveys. The survey questionnaires will consist of a mix of structured and semi-structured interview questions. We will collect data from farmers, improved on-farm storage suppliers, and distributors (both AgResults implementers and any suppliers of on-farm storage who are not).We will also interview diverse market actors including farmers, intermediaries, processors and retailers, consumers, and agro-input suppliers, as well as other sector specialists who have expertise on the topics of inquiry.

We will employ "best practices" to ensure the robustness of our qualitative methods. Qualitative activities are frequently assumed to have only descriptive utility and assertions of their robustness are often dismissed on the basis that qualitative researchers can "create" data to confirm their hypotheses. It is thus critical to follow proper research processes and document them so that the validity of the research results can be assured. Best practices in qualitative research include using "naïve" questioning approaches (rather than "leading" questions, which introduce bias), triangulation of data sources (for example, seeking information from multiple levels of the marketing chain to obtain diverse explanations of phenomena), and the careful documentation of the evidence supporting results (Yin 2003). Much like quantitative research, the validity of qualitative research is also bolstered by leading with theory-based models (such as the SCP framework), as well as actively seeking out disconfirming evidence rather than confirming (much as statistical hypothesis testing can only result in the rejection or failure to reject a null hypothesis rather than "acceptance" of the hypothesis).

We will collect data for the quantitative research using household-level smallholder surveys conducted at the baseline, the endline, and several intermediate points. We will interview the same farmers at each stage to capture changes in farmer-level intermediate and final outcomes. In the next section, we present our evaluation approach for the specific evaluation questions posed.

3. Evaluation approach for each evaluation question

3.1 Evaluation Question 1: What has been AgResults' impact on private sector engagement in the development and uptake of on-farm storage solutions?

Our evaluation of the AgResults pilot's impact on private sector engagement in the market will (1) analyse whether the pilot intervention enabled the emergence of a market for OFS solutions for maize, (2) document the structure of the market and the strategies of firms in the market, and (3) evaluate whether the pilot structure had a gender-differentiated effect on participation in the market or the accrual of gains from such participation.

We will measure the pilot's impact on private sector engagement using qualitative methods. Baseline data will be collected in June 2014, and endline data will be collected in 2017. We will use the baseline data collection to document the market for OFS for maize before the initiation of the pilot intervention, and we will structure data collection on the basis of the structure, conduct, and performance analysis (or shortly SCP framework, which is discussed below), which, when applied to Kenya's maize markets during a rapid appraisal, gave rise to hypotheses about the pre-intervention market. We will use the endline data collection to test hypotheses, detailed below (and to be updated on the basis of baseline results), about the impact of the pilot on the OFS market.

We will use the SCP framework to analyse the effects of the AgResults pilot on the market for on-farm maize storage. The use of SCP as an evaluation tool was pioneered by John Holtzman of Abt Associates (Holtzman 2003). Its qualitative and theory-based approach to causality facilitates the definition and testing of hypotheses regarding the impact of an intervention on a market in contexts where small numbers of market participants and multiple levels of interaction make quantitative evaluation inappropriate.

The SCP paradigm is a product of the Industrial Organization school of economics (Caves 1987, Scherer and Ross 1990). This framework depicts how the underlying conditions in a market influence the market's structure, which in turn influences individual firms' conduct in the market (such as decisions to invest in new market segments, or technological and organizational decisions). Individual firms' decisions, at an aggregate level, lead to market performance outcomes of interest such as the adequacy of a product's supply in terms of volume and quality, prices, returns to investors, and responsiveness to consumer demand.

Building on the basic SCP framework, Sutton (1992) examined how endogenous and exogenous sunk cost investments influenced industry structure. This approach, which we will apply in the current analysis, recognized that firm strategic conduct is a direct response to market conditions, and that aggregation of the outcomes of firm strategic behaviour gives rise to market structure.

Thus, while the overall paradigm is referred to as SCP, the specific analytical model actually reflects a causal flow from situation to strategy to structure to performance (SSSP).

The underlying, or "basic" conditions of a market are fixed in the short to medium term and include characteristics of supply and demand of a product and its market, and the institutional environment. Supply and demand conditions include cost structures, seasonality of demand and supply, income distribution, and buyers' and suppliers' responses to changes in prices and income (elasticities). The characteristics of a market include the prevalence of information costs and asymmetry and asset specificity, which increase transaction costs and risk. The institutional environment includes both formal (legal) and informal (cultural) controls on behaviour, and is critical to establishing behavioural norms that reduce transaction costs and the risks that potential buyers and suppliers in the market are exposed to. Together, these conditions define the incentives and create interdependencies that shape individuals' and firms' decisions regarding whether and how to engage in the market (North 1990).

Individuals' and firms' strategic behaviour reflect their attempts to pursue profit and utility objectives given the constraints imposed by underlying conditions. Strategic behaviour includes such decisions as whether to invest in production facilities or a new venture, pricing and service delivery decisions, whether to register a company rather than continue as an informal entrepreneur, and the choice of institutional arrangements between market actors such as the choice of contract structure.

A market's structure is shaped by the aggregate decisions of many individual firms. Structural elements include the numbers of buyers and sellers in the market, the characteristics of production and value creation (such as the technological packages that dominate), the degree and types of product differentiation, and barriers to entry. Such structural features tend to evolve over the medium to long term, and as such are represented among the basic conditions that influence firms' strategic behaviour.

The performance of a market can be understood in many ways, but the main elements of interest for the AgResults pilot markets include whether a commercially viable market for on-farm maize storage solutions emerges as a result of the pilot interventions. In the case of the pilot markets, under-investment or no investment in on-farm storage leads to no or substandard products and services being generated. In performance terms, this leads to a "missing" or "failed" market.

3.1.1 Hypothesized baseline scenario

This SCP scenario is derived from an Initial Qualitative Assessment (IQA) conducted in September 2013 to gather data on the pilot context and inform the design of the evaluation protocol. The baseline scenario is referred to as "hypothetical" because much of it is projected on the basis of partial information; we will test these hypotheses in the course of the baseline data collection and will report results in a baseline report.

Situation

Contextual factors and institutional environment	• Geographic dispersion of farmers • Limited reach of extension • Insecure environment—grain theft is an issue • High pest pressure—weevils and LGB (in Eastern Province)

	• Aflatoxin prevalence in Eastern Province
Demand conditions	• Farmers recognize the storage problem and want to address it but lack awareness of most alternatives • Small volumes to store—at average cultivated area of 1.5 acres, assuming 50 percent is devoted to maize, and assuming yields of 5 bags/acre, the average household will have less than 4 bags to store (360 kg) • Households need continued access to stored grain for consumption • Poverty and low liquidity limit ability to purchase relatively more expensive storage solutions and encourage adherence to use of technically sub-optimal but affordable and familiar storage methods • Traditional gender roles imply females will be responsible for maintenance of maize in enhanced storage; but they have less access to resources (including finance, extension, etc.) that will enable them to learn about, obtain, and utilize it • Maize tends to be sold soon after harvest due to – Liquidity constraints (need for cash) – Concerns about aflatoxins and pest damage
Supply conditions	• The market is considered highly risky for commercial entry due to lack of established demand for technically appropriate storage solutions and lack of established commercial distribution channels • Technically appropriate storage solutions (both on and off-farm) are available or being developed • Several off-farm solutions of varying viability are available for small farmers such as NCPB, warehouse receipts, and private storage on fee-for-service basis • Public sector (national extension), NGOs, and donor-funded projects target storage losses

Strategy

Farmers	• Traditional farmers adhere to default, familiar, low-cost storage solutions; in particular, they use polypropylene gunny sacks, which are stored inside the house or traditional outdoor cribs (particularly for maize on cob) despite the risk of high PHL • Some "progressive" farmers have on-farm solutions that are economical and effective • Farmers sell maize after harvest to compensate for technical storage constraints and for cash • Farmers purchase maize as needed after stores are depleted • NCPB is used by some farmers but generally oriented to larger farmers due to volume requirements. This option is also riskier due to aflatoxin testing. It is generally not considered a viable solution for small-scale farmers.
Storage solution providers	• Local investment in storage solutions is limited due to lack of effective demand, with exception of emerging cadre of metal silo manufacturers trained by NGOs and other organizations

	• External suppliers work through organizational channels (e.g., NGOs) to supply storage to clients, with organizations taking strong mediating and leadership role • Private traders offer storage on fee basis—permit withdrawals for household consumption—farmers either bring grain individually or in group batches if needed to economize on transport • Storage firms in the market – Only two commercial storage firms exist in market—GrainPro and Bell Industries (selling PICS bags)—but they have limited local presence – Increasing but limited number of independent artisans are trained to fabricate metal silos • There are incipient warehouse receipts programs (both public with NCPB and public/private supported by the Alliance for Green Revolution in Africa (AGRA) and the East African Gran Council (EAGC))
Agro-input dealers	• Focus on established market with established clientele • Take a cost or quality approach to development of clientele and sales strategy – Low-cost suppliers purchase through intermediaries and cannot assure quality of supplies – Quality-oriented suppliers purchase through authorized dealers in order to ensure quality, cultivate reputation for quality with clients • Focus on established markets for both seeds and chemicals (e.g., fertilizers, pesticides) • Limited, low-risk experimentation with new products (including storage) is carried out by quality-oriented dealers

Structure

- Market is dominated by reliance on technically inappropriate polypropylene gunny sack available through non-specialized market vendors
- NGOs and other projects promote the use of improved storage solutions and facilitate their supply and acquisition, but have had limited success
- There are no established commercial markets for technically appropriate on-farm storage solutions

Performance

- There is no commercial supply of affordable, technically appropriate storage solutions to small farmers

3.1.2 Hypothesized pilot impacts: Endline scenario

The AgResults pilot intervention seeks to alter the conditions underlying the lack of a market for storage solutions appropriate to the needs of small farmers, stimulating investment in the market to the point where adequate supply channels and volume of sales will exist for the market to be self-sustaining by the end of the intervention.

Situation

Pilot intervention will	• Mitigate risk of commercial investment in the market by providing a guaranteed return to suppliers who meet a minimum threshold • Provide ongoing incentives for investment by rewarding farmers shares of a monetary price proportional to the amount of storage that they sell

Strategy

Storage suppliers	• Invest in market for small-scale on-farm storage – Produce or source technically qualifying storage – Distribute storage to farmers, most likely via agro-input dealers, hardware stores, and farmer organizations – Promote storage to smallholder farmers, provide training and technical assistance, and assist farmers in acquisition of units through provision or linkages to credit suppliers • Structure relationships with agro-dealers and hardware stores to reduce risk they face and reward them for investing in market
Agro-input dealers	• Supply on-farm storage to small-scale producers in accordance with incentives provided by storage suppliers • Quality-oriented agro-dealers are more likely to participate than cost-oriented dealers
Farmers	• Their investment in storage will be influenced by: - Volume of production (Lower levels of production lead to less expenditure on storage despite overall benefit-cost ratio) - Aflatoxins (reduces incentive to store) - Price differential expected between harvest/sale and purchase of maize - LGB (reduces incentive to store unless controlled by chemical treatment or storage modality) - Liquidity and credit constraints (opportunity cost of sales, need for quick cash, difficulty obtaining funds to make capital investments in storage) (Jones, Alexander et al. 2011) - Availability of/access to alternative storage options such as community-level and private storage (e.g., by posho mills, WRS) • Gender differences in access to and control over incomes will likely lead to distinct rates and patterns of uptake of enhanced OFS – Differences in access to and control over incomes and productive resources – Women's home-oriented roles and responsibilities may make them less likely to be exposed to information about the OFS options – Women may have more difficulty obtaining credit to purchase OFS – There may be shifts in gender roles regarding storage if household members decide to have those who have received training (which, as previously discussed, training may fall disproportionately to men) be responsible for their use.

	– Households in which men are trained on storage but women utilize it may have poorer results than those in which the person who will utilize storage is trained—this may limit repeat purchases and storage effectiveness. – There is also potential for dynamic shifts in roles and responsibilities for storage if introduction of any new OFS makes participation in storage more attractive for different household members.

Structure

- Commercial market channels for small-scale on-farm storage develop alongside non-profit and traditional (bagged) storage channels already in existence

Performance

- Private sector sources of on-farm storage emerge that meet smallholder farmers' quality and cost requirements

3.1.3 Method

3.1.4 Our evaluation approach for the first evaluation question will be organized around the SCP framework. The preliminary SCP framework, based on a qualitative assessment during the protocol design phase, will be the source of hypotheses to be tested regarding the baseline status of the market and the anticipated impact of the pilot on the market. We will adjust hypotheses for the endline survey on the basis of baseline results, major developments in the market that might affect pilot impact (such as the entry of new players or policy changes), and any unanticipated adjustments to pilot implementation that might take place. As part of our hypothesis testing, we will identify and explore counterfactuals from private sector actors who act in the same market in the pilot's geographic area of intervention but who are not participants in the pilot intervention, as well as private sector actors who operate in similar markets outside of the pilot's area of intervention. The

SCP analysis will include an "embedded" gender analysis to investigate potential gender-differentiated impact of the pilot on access to the OFS market, and utilization of OFS among households. The gender analysis will also explore whether there are any shifts in gender differentials in how potential OFS adopters were exposed to and trained in use of the storage, and perceptions on the effectiveness of these awareness and training efforts, as well as perceptions on the effectiveness of the storage itself. Specific gender-oriented hypotheses, data to address them, and gender-relevant questions that will be addressed are integrated into the overall SCP analysis and discussed at key points in the remainder of the question's protocol description.

Data

We will obtain data on the structure of the market for on-farm maize storage solutions from several sources. Data on sales of storage solutions and their providence and destinations will be collected by project verifiers under the supervision of the AgResults Secretariat (a list of data needs is provided in Appendix A). The baseline and endline farmer surveys will provide data on the characteristics and activities of farmers investing in on-farm storage, while complementary qualitative surveys of farmers, detailed under Evaluation Question 2, will provide further insight into farmer participation in the market. Data from the verifier, results from the large-sample farmer survey, and small sample surveys of agro-input dealers will be used to estimate current and potential market flows for on-farm storage solutions. A lesser number of key informant interviews with those players will be used to determine how on-farm maize storage fits into their overall business strategies and their perceptions of market conditions and how those influence their strategies. Sector experts will be consulted to provide overarching insight into the market as well as for triangulation of results coming from the market actors. Data collection will also address gender-differentiated impacts of the pilot, delving into whether there are any shifts in household roles and responsibilities related to use of the storage, how OFS adopters were exposed to and trained in use of the storage, and perceptions on the effectiveness of these awareness and training efforts, as well as perceptions on the effectiveness of the storage itself.

We will record the large majority of the qualitative data (for this and other questions) using verbatim notes, and will request interviewees' consent to sound-record the interviews for later reference. The data will be entered into an online data collection platform such as Qualtrics in order to facilitate the standardization of results, and will be downloaded into Microsoft® Excel for cleaning and analysis.

Data collection will be organized around the following questions, which follow the logic of the SCP framework and respond to the hypotheses defined within that framework in its preliminary application to the market. The organizing logic of the inquiry will move from the most readily ascertained aspect of the market—its structure—to the firm strategies and conditions driving those and indications of market performance. The selection of respondents for data collection and interviews will also depend on the analysis of market structure, which will provide insight into the numbers and characteristics of actors in the market. Although there are no *a priori* hypotheses regarding gender differentials in the OFS market beyond those already detailed for farmer uptake, data on the gender of firms owners and respondents will be collected for each survey, and gender will be included in questions regarding value chain actors' clientele and factors driving their purchases.

Performance

- Does a commercially viable market for on-farm maize storage solutions exist?
- Is this market technologically and economically responsive to the needs of smallholder farmers?
- Is the OFS market accessible to the diversity of farmers who have use for it, such as women and cash-constrained farmers?
- How do uptake patterns differ among storage options on the basis of gender, farm characteristics, and implementer approaches?

Structure

- How is the value chain for on-farm maize storage structured in terms of major types of storage available, their volumes and market flows?
- How many private sector actors of different types participate in the market?
- What volumes are transacted by different types of actors?

Strategy

What drives the decision of whether and how to supply OFS for maize?	
What are storage providers' procurement strategies?	• From where do they source and how sourcing is organized? • What are their relationships with suppliers? • How do they manage quality control?
What are storage providers' and distributors distribution and merchandising strategies?	• Distribution channels • Relationships (use of contracts and terms of contract or exchange) • Provision of services to farmers and distributors (e.g., training, delivery, maintenance) • Pricing • Promotion
What factors underlie farmers' decisions of whether to buy OFS and which OFS technology to	• Exposure to and perceptions of different OFS technologies • Perceptions of and preferences among different sourcing options (e.g. agro-input dealer vs. farmer organization)

invest in?	• Gender-specific influences in farmer exposure, preferences, access, and strategies

Basic conditions

What are firms' perceptions of the following, and how do those perceptions influence their decisions and strategy around engaging in the on-farm storage market?	• Perception of supply conditions • Perception of demand conditions • Perception of transaction costs and risk inherent in acting in market • Perception of institutional environment and its implications for engagement • Perception of other activities in the market (such as NGO supply of storage) and how it affects commercial market prospects • Perception of economics/effectiveness of available storage solutions and market-driven distribution systems • Ability to realize conditions required for engagement in market to be successful
How do farmers' view storage issues and to what extent are they interested in improved OFS options?	• How do farmers' perceive the extent of their grain storage losses and to what degree do they consider it a problem to be addressed? • What motivates farmers to invest in OFS?

Data collection and entry will be undertaken by the Abt team's Agricultural Economist under supervision of the impact evaluation team's Qualitative Expert. Data will be entered into templates provided by the Qualitative Expert before transmission to her for analysis (see appendices A through G) . The Agricultural Economist will be trained by the Abt qualitative lead in the SCP model and appropriate data collection methods prior to implementation of baseline data collection activities. The timing of and logistical arrangements for data collection will be determined in conjunction with the Quantitative Expert so that synergies in implementation can be pursued and potential conflicts avoided. Our data collection will focus on characterizing the activities of three types of OFS market actors: OFS suppliers (AgResults implementers), their commercial distributors (such as agro-dealers), and farmers who are intended to be form the core clientele of the market. Interviews of the AgResults implementers (Appendix B) will characterize their operations and maize storage supply activities prior to participation in the pilot, and the investments they have made as a result of participation in the pilot. Interviews will also ascertain implementers' perspectives on market for OFS and their intentions regarding it, as well as inquire into their experiences participating in the pilot itself.

In order to identify commercial dealers to interview, the Agricultural Economist will conduct a brief, phone-based survey of community-level experts (such as County Directors of Agriculture (CDAs, formerly referred to as District Agricultural Officers or DAOs), Assistant Agriculture Extension Officers (AAEOs) who operate at the sub-county level, and local chiefs) in each of the implementation districts (Appendix C) to determine what maize storage options are available to farmers and the sources of these. The CDA and AAEO surveys will also provide insight into other non-market sources of maize storage (such as development projects and NGOs), representatives of which will be interviewed using the key informant interview (see Appendix D).

Market-based storage providers identified in the community-level survey will be combined with data from the implementers on their distribution channels, and a roster of agro-input distributors (which are anticipated to serve as commercial outlets for the OFS solutions) to obtain a roster of potential storage outlets to be drawn from for data collection. The members of the roster will be characterized based on their scale of operations, location, gender, and other major characteristics. We will also conduct structured surveys with representatives of each sub-group identified (such as independent agro-dealers and chain agro-dealers) in order to further characterize them and their participation in the market for OFS their OFS-market strategies and activities (e.g., pertaining to procurement and merchandising), and the reasons underlying them (Appendix E). Although the exact number of surveys and questionnaires to be conducted will be determined following the identification of market participants by the Agricultural Economist consultant, we will conduct this questionnaire with as many as 56 distributors across the implementation districts. Summary statistics drawn from the quantitative farmer survey will be utilized to help determine the structure of the market for OFS (Appendix F). Qualitative data will also be collected from farmers (Appendix G) and used to inform the hypothesis testing; farmer data collection is discussed in greater detail under Evaluation Questions 2 and 3.

Data will be collected through a mix of telephone and in-person interviews. Community experts will be interviewed by telephone in most cases, as will many distributors of on-farm storage; while farmer surveys and a subset of the other surveys will be conducted in person

3.1.5 Qualitative data analysis

We will analyse data on market structure using descriptive statistical methods. We will analyse data from key informant interviews using pattern analysis in which we will evaluate preliminary hypotheses on the basis of field results, ascertaining patterns and divergences among similar market actors with respect to those hypotheses. The analytic process and interactions with the Agricultural Economist who collected the data will facilitate an active search for disconfirming evidence and alternative explanations, and we will further investigate results that do not align with the hypotheses.

The Qualitative Expert will be responsible for data analysis and reporting of results; however, the nature of qualitative research implies that there will be substantial communication with the Agricultural Economist based in Kenya for the purpose of clarification of questions, elicitation of further insights, follow-up questions (as necessary), and vetting and review of research results.

3.2 Evaluation Questions 2 and 3: What has been AgResults' impact on smallholders' uptake of on-farm storage solutions? What has been AgResults' impact on smallholders' income?

The second and third evaluation questions stated above ask about the impact of the AgResults pilot on smallholder actions and outcomes. In particular, these questions pertain to the impact of the pilot on two primary outcome measures: smallholders' uptake of on-farm storage solutions and smallholders' income (which are referred to as "targeted" or "treated" outcome measures throughout this section). In addition, we will also examine the pilot's impact on smallholder's food security as measured by number of months the stored grain is available for own consumption (referred to hereon as food security). Furthermore, we plan to also assess the impact of the program on other outcomes such as smallholder's access to improved storage technologies, and smallholder's knowledge and attitude about other storage practices that are essential for successful use of the technology. For example, if farmers do not dry the grain properly, or do not clean the grain properly then the improved technologies will not be effective. While the impact of the pilot on these outcomes will be analysed using the same approach that will be used for the two primary outcomes (namely short interrupted time series methodology which is described in more detail below), the statistical power analysis and the determination of the sample size requirements focused on the two primary outcomes.

In what follows, by"impact" we mean the difference between results with the AgResults incentives present in the market—with whatever private sector supplier activities they bring—and what would have happened to the same smallholders without these factors present. Obviously, we cannot obtain data on the latter once the pilot begins in the target areas of Kenya. In this section, we describe how we will answer these questions in light of this challenge. The goal is to attribute technology adoption and income results to the AgResults pilot and other causal factors such as pre-existing market trends and shifts in agricultural inputs of other sorts. We begin with a description of the "short interrupted time series" approach for conducting this analysis, which is intended to pull apart influences on farmer outcomes to isolate the effect of the pilot intervention. Subsequent subsections give the detailed model for our planned statistical analysis and consider statistical power to detect impacts and the required sample sizes in the Rift Valley and Eastern Province.

3.2.1 Short interrupted time-series design

Randomized control trials (RCTs)—which split potential program participants into statistically equivalent groups through a lottery and provide the intervention to just one of those groups—are regarded as the gold standard for calculating impacts of programs. Due to the randomness of the split, an RCT results in the study's "treatment" and "control" groups being balanced on both observable and unobservable characteristics. Hence, their outcomes will differ only to the extent that the intervention has an impact on the treatment group; it is this outcome difference that reveals the intervention's effects.

When RCTs are not feasible, researchers utilize quasi-experimental designs (QEDs), which compare outcomes of program participants (the treatment group) to a counterfactual that represents their hypothetical outcome levels in the absence of the treatment. An RCT is not feasible for the on-farm storage pilot because implementers have a business incentive to market their technologies to all target areas for the pilot and to all farmers in those areas (through broad advertising and other means), leaving no potential for an equivalent "untreated" set of farmers to be drawn from that pool at random.

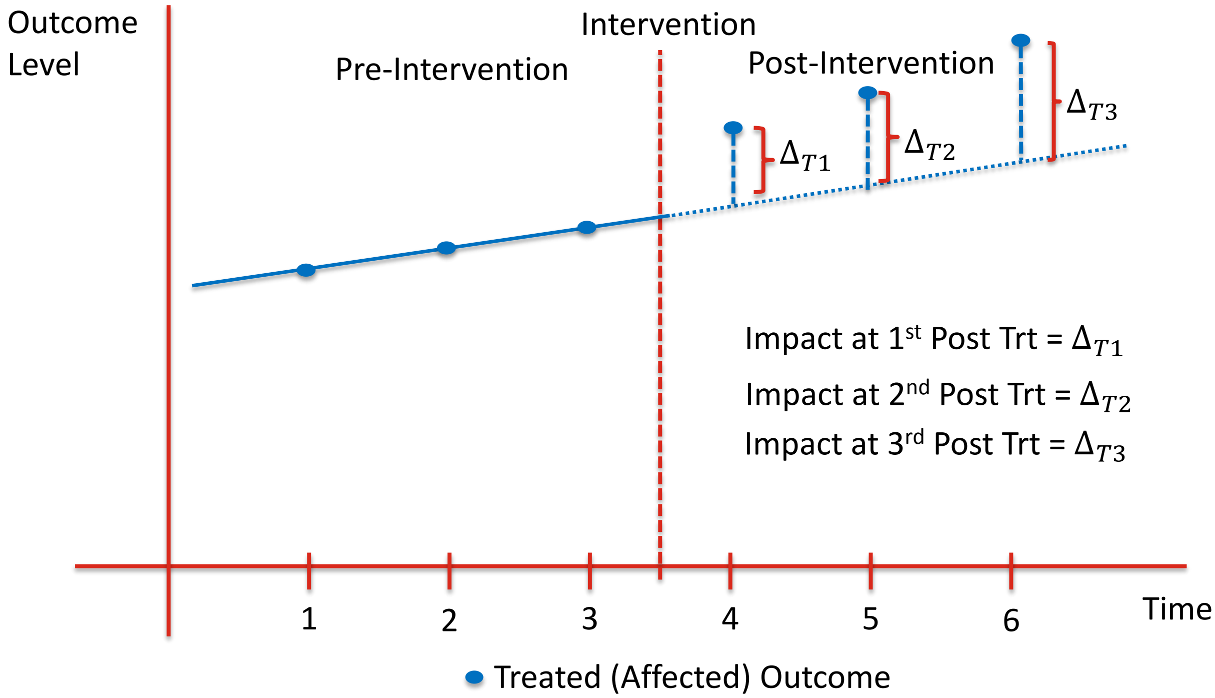
Selection of a quasi-experimental design option. The most commonly used QED entails comparing the outcomes of the treatment group to a group of units that has similar baseline characteristics to the treatment group members but is not exposed to the treatment—the so-called "comparison group". By minimizing the observable differences between the two groups, this method alleviates the bias in the treatment effect estimates that could arise due to the influence of other programs, interventions, or initiatives that may act as confounders.

The business case for AgResults proposed to estimate the effects of the pilot program by comparing two outcome measures—smallholders' uptake of on-farm storage and income—between a treatment group that consists of smallholders in areas targeted by the program and a comparison group that consists of smallholders in similar but untargeted areas. During our visit to the potential target areas in April 2014, we observed that this strategy may not be feasible due to (1) potentially substantial differences between targeted and untargeted areas and (2) the extensive effort that may be required at the onset of the evaluation to identify appropriate farmers to study in comparison sites.

As a result, we turned our attention to a QED that uses multiple pre-intervention data points to form the counterfactual, the short (or abbreviated) interrupted time-series (SITS) design. The SITS design measures the intervention impact as a departure from the expected levels of the outcome measure (in this case smallholders' uptake of on-farm solutions, smallholder income or food security) were the treatment not introduced (e.g., Shadish, Cook, and Campbell 2002; Bloom 2003). Specifically, this design entails (1) generating a counterfactual for the outcome measure, which represents the expected level of the outcome in the post-intervention period in the absence of the treatment and is constructed by projecting the trend in pre-intervention observations of the outcome measure, and (2) modelling the treatment effect as a deviation from this counterfactual.

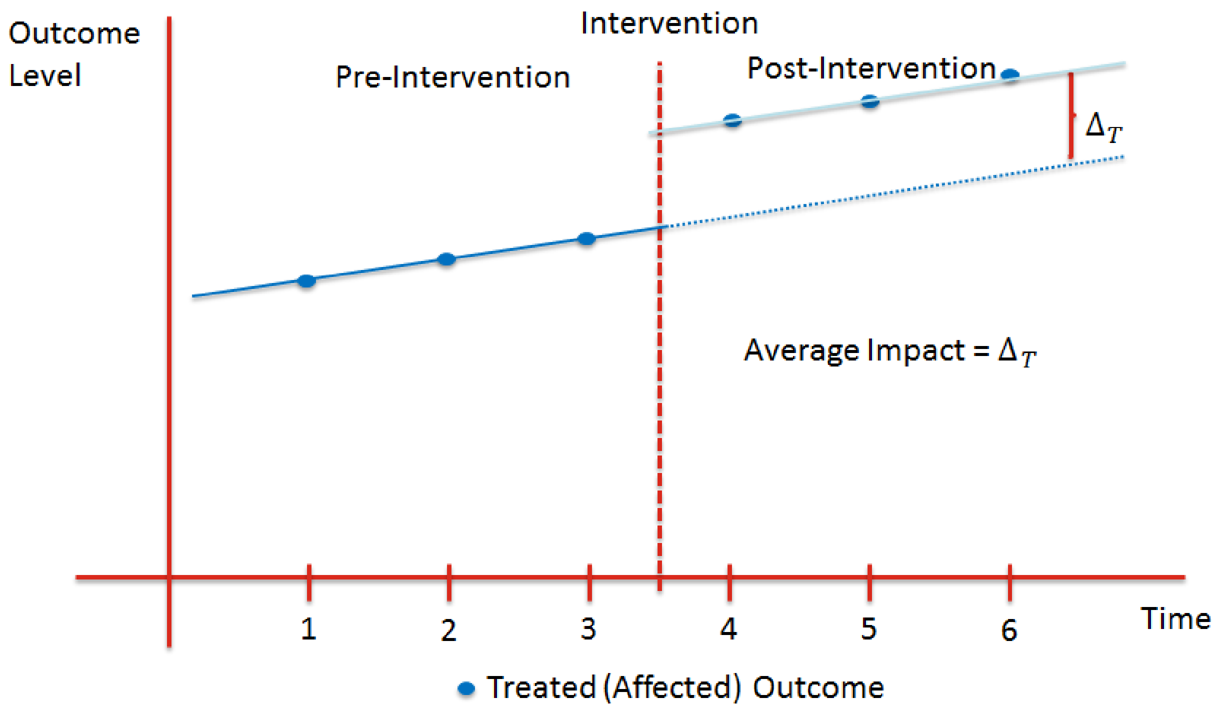
The short interrupted time-series approach. Figures 3a and 3b demonstrate a stylized application of the SITS approach for estimating the effect of a treatment on an targeted (or treated) outcome measure with a positive linear trend in the pre-intervention period. In these figures, the y-axis shows the average level of the outcome for the sample, and the x-axis represents the time points. There are three pre-intervention observations in this illustration (time=1, 2, and 3) and three post-intervention observations (time=4, 5, and 6) with the treatment introduced between the third and fourth time points. Pre-intervention time points will be collected through retrospective questions to farmers (on the baseline survey) about previous harvests and practices. The solid line in the pre-intervention period tracks outcomes prior to the pilot and captures the upward trend in the outcome measure. The counterfactual, which is represented by the dotted line, is obtained by extrapolating the pre-program trend information into the post-intervention period following the solid line upward to the right.

Figure 3a. Short interrupted time series with linear trend and year-specific impact estimates



The treatment effect in the first post-intervention period (t=4), represented by Δ_{T1}, equals the difference between the average outcome level at t=4 and the value of the counterfactual at that time period. Treatment effects at the second and third post-intervention periods are calculated in a similar manner. Alternatively, the average treatment effect across the three post-intervention time periods can be estimated by constructing a line through these time points based on the baseline trend (light blue solid line in Figure 3b) and calculating the difference between the intercept of this line and the intercept of the counterfactual line (denoted by Δ_T in Figure 3b).

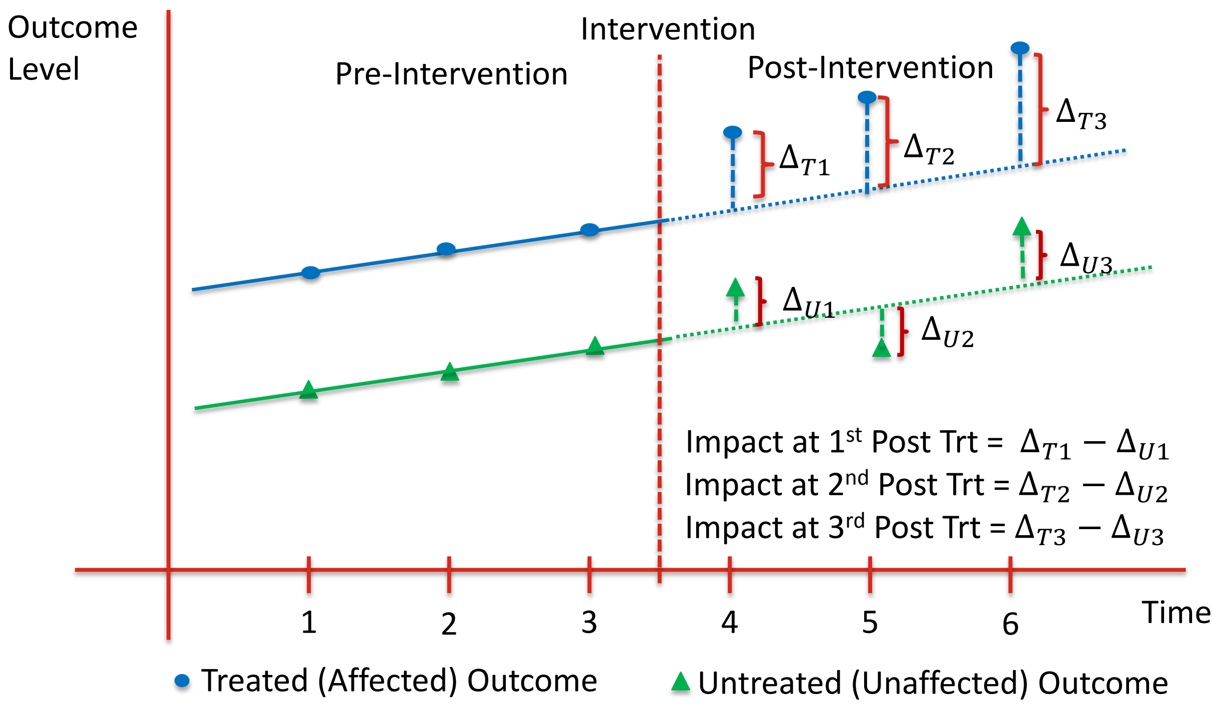
Figure 3b. Short interrupted time series with linear trend and average treatment effect estimate



It is important to note that while a SITS analysis accounts for secular trends in the outcome measure in the estimation of the treatment effect (which is demonstrated in more detail in the next section), it is subject to bias when other factors (i.e. confounders) that influence the outcomes of interest change simultaneously with the arrival of the focal intervention. For example, unusual changes in rainfall or pest burden that coincide with the roll-out of the treatment may be potential confounders as they may also push off their pre-existing trend lines. Unusually heavy rainfall during the first treatment year could increase the maize yield and consequently smallholders' income, a change that would be inaccurately interpreted as an effect of the pilot unless it is accounted for. Other government or NGO programs that are enacted in the post-treatment period and target the same outcome measures may also act as confounders. If the effect of such confounders on the outcome is in the same direction as the true treatment effect (which is assumed to be positive), not controlling for them would create an upward bias in the estimated effect of the pilot while confounders affecting the outcome in the opposite direction would lead to a downwardly-biased treatment effect estimate. The amount of bias is a direct function of the strength of the confounding influences and may be substantial.

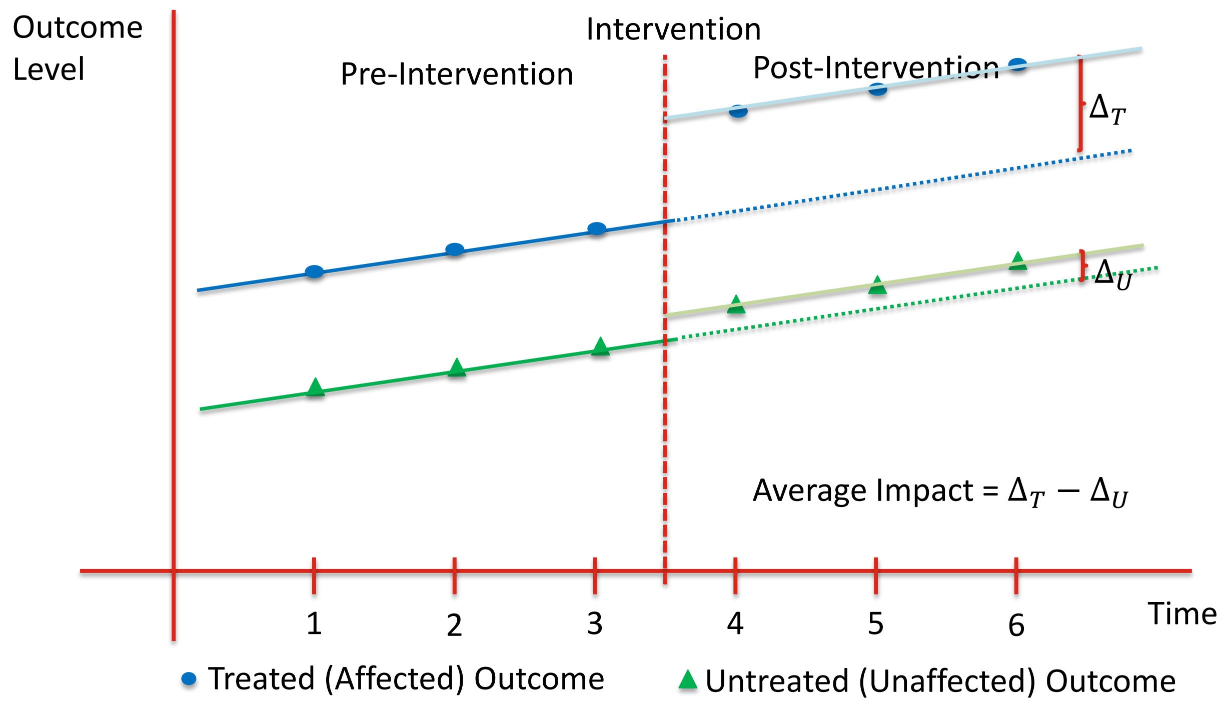
Fortunately, there are at least two ways the SITS analysis approach can be modified to alleviate bias due to these confounders. The first approach relies on an unaffected dependent variable to account for the confounding factors while the second approach employs unaffected units (i.e., areas and households) to control for the confounders. Each of these approaches are described in more detail below.

Figure 4a. Short interrupted time series with linear trend and an unaffected outcome to estimate year-specific impacts



Removal of bias using an unaffected or untreated outcome. This approach entails using a measure that is not specifically targeted by the program but influenced by the confounders in the same way as the targeted primary outcome measure. Specifically, this approach utilizes a measure that (1) is not targeted by the treatment, (2) follows a trend similar to the targeted outcome in the pre-intervention time period, and (3) is likely to be affected by the confounders in the same direction as the targeted outcomes. Such measures are called "non-equivalent dependent variables", or shortly "untreated", "untargeted" or "unaffected" outcomes (Shadish, Cook, and Campbell 2002; Coryn and Hobson 2011; Trochim and Donnelly 2007) . Figures 4a and 4b demonstrate how such a measure can be incorporated into the SITS analysis to control for confounders. Specifically, Figure 4a adds an unaffected outcome to the SITS framework, sample averages of which are represented by green triangles. Similar to the affected outcome, a baseline trend is constructed for the unaffected outcome (captured by the solid green line), which is then extrapolated into the post-intervention period to serve as its counterfactual (dotted green line).

Figure 4b. Short Interrupted Time Series with Linear Trend and an Unaffected Outcome to Estimate the Average Treatment Effect



In the absence of any confounders we expect the post-intervention observations of the unaffected outcome to be on the counterfactual line; therefore, any deviations from the counterfactual line are attributed to the confounding factors. That is, the term Δ_{U1} in Figure 4a represents the effect of the confounding factors on the unaffected outcome at the first post-intervention time point. In this stylized example, we assume the scales and the pre-intervention trends of the affected and unaffected outcomes are the same; therefore, the difference between the deviations of the affected and unaffected outcomes from their respective counterfactuals ($\Delta_{T1} - \Delta_{U1}$ for the first post-intervention observation, $\Delta_{T2} - \Delta_{U2}$ for the second post-intervention observation, etc.) yields a treatment effect estimate that is adjusted for (free of) the influence of confounders. Figure 4b shows how the unaffected outcome can be employed in the estimation of the average treatment effect across all post-intervention observations accounting for potential confounders.

We propose using *maize yield* as an unaffected outcome, as it satisfies the three conditions specified above. That is, we believe that maize yield per hectare may be used as an unaffected outcome measure for either of the two primary targeted outcomes (uptake of on farm storage and smallholders' income) as it (1) is not specifically targeted by the AgResults Pilot, (2) is expected to follow a similar trend to the tthree outcomes (which we hope to verify with extant data collected and maintained by Tegemeo Institute and the University of Washington), and (3) should be affected by at least some (if not all) of the same confounders. We vetted these assumptions with pilot implementers during the pilot launch workshop. The general conclusion was that yield may not be affected immediately but it is feasible that farmers may re-invest their increased incomes from pilot to improve their productivity. Another reason why the program could have an impact on yield is if the distributors also use the opportunity to raise awareness and increase adoption of other inputs. While all of these impacts are feasible, we believe these affects will be muted in the initial years of the pilot and are unlikely to materialize by the time we conduct our endline.

Removal of bias using a comparison group. The second and preferred approach to addressing confounding effects is through the use of a comparison group. In the current context, a comparison group would consist of areas and/or smallholders that (1) are not targeted or affected by the treatment, (2) have similar characteristics to treated areas and smallholders, and (3) are likely to be influenced by the confounders in the same way as the treated areas and smallholders. The way the comparison group is incorporated in the SITS design (which then is also called a comparative short interrupted time series or C-SITS) is very similar to the untreated outcome analysis as described above. Specifically, when estimating separate treatment effects at each post-intervention time point, the pre-intervention observations of the outcome measure are used to create a counterfactual trend (the green triangles in Figures 4a and 4b now capture the average outcome for the comparison group), which is extrapolated to the post-intervention period to serve as the counterfactual for the comparison group. Deviations from this counterfactual at each post-intervention observation are attributed to the confounders and are used to adjust the deviations of the outcome measure of the treated areas and smallholders from their counterfactual.

As discussed above, we think that the identification of a sufficient number of appropriate comparison areas and households for the current evaluation may be infeasible due to potentially large differences between targeted and not-targeted areas and because such an effort would be costly. However, we are exploring the feasibility of a more cost-effective approach to comparison group construction, which entails looking for potential comparison group members in existing household-level datasets. One such dataset is the CIMMYT panel (CIMMYT 2011), which was administered to a nationally representative sample of approximately 1,300 households in the Kenya maize belt over the last decade, which includes data from treatment areas and from areas outside the treatment areas or potential comparison areas. Our plan entails mapping the areas in which the pilot program is implemented onto the CIMMYT panel to identify households that lived in the treated areas in the most recent survey administration in 2013 and to form a comparison group from the CIMMYT households living in other areas with similar characteristics to the potentially treated households. Note that while this approach entails using the CIMMYT panel to identify the comparison group households, these households will be administered the baseline and post-program surveys in the exact same manner as the households in the treatment group to ensure that the two groups have comparable data measures. Therefore, this strategy requires obtaining the identities and contact information of the CIMMYT households in order to administer additional follow-up interviews to treatment and comparison group households in the sample. We have contacted the administrators of the CIMMYT data to inquire into the possibility of implementing this approach.

3.2.2 Model specifications for the estimation of the overall impact of the AgResults pilot

This section presents prototypical model specifications that implement the SITS design framework to estimate the effect of the pilot on the two outcomes of interest. We start with simple models that do not explicitly control for confounding factors and then present models that incorporate an unaffected outcome to correct for such factors. These models will be estimated separately for all outcomes of interest – the two primary outcomes (smallholder uptake of technology and smallholder income), food security, smallholder's access to technology and farmers' knowledge and attitude on storage practices.

For all these outcomes the SITS design requires multiple measures of baseline and one post-intervention data point. These data points will be collected through two surveys administered to the smallholders: the baseline survey that will include recall questions to obtain three pre-intervention data points and the endline survey that will yield the post-intervention data point. We are concerned that obtaining reliable retrospective data on income will be challenging. We believe that the primary channel through which the pilot is expected to influence income is through a reduction in sell-cheap/buy-expensive maize transactions patterns among smallholders and/or the price per unit the smallholders receive when they do sell their harvest. Therefore, as a proxy for income, we intend to use the price at which smallholders sell their harvest (sale price) as the outcome measure that we will analyse using the SITS framework.

For each outcome measure, we will estimate separate models with data from the Rift Valley and the Eastern Province to obtain specific impact estimates for each outcome measure in each region. The data for these analyses will be obtained from surveys conducted with households in the treated areas. We intend to create a panel dataset that includes as many as three pre-intervention values of the outcome measure and one to two post-intervention values . As discussed in the next section, we intend to represent all counties in the two areas (nine counties in the Rift Valley and five counties in the Eastern region).

Levels of nesting in the data. Within each county, villages will be sampled randomly, and within each village, households will be selected randomly for the survey administration. Therefore, in each region, the nesting structure in the data will be of the following form: individual observations (or time) nested within households nested within villages nested within counties. The simplest SITS model specification that reflects this cluster structure is given in Equation 1 below:

$$(1)\ Y_{thjk} = \beta_0 + \beta_1 time_t + \beta_2 Post_t + \sum_{n=1}^{N} \beta_{n+2} X_{thjk}^{n} + + \sum_{m=1}^{M} \beta_{N+2+m} W_{tjk}^{m} + \sum_{r=1}^{R-1} \beta_{N+M+2+r} C_k^r + \mu_{jk} + \delta_{hjk} + \epsilon_{thjk}$$

where:

Y_{thjk} = Outcome measure for household *h* in village *j* in county *k* at time *t*. As mentioned above, this model will be estimated separately for all targeted outcomes of interest: two primary outcomes (uptake of on farm storage and sale price of maize) as well as food security and knowledge and attitude on storage practices.

$time_t$ = The counter for observations, and time=*t*=1, 2, and 3 denote the three pre-intervention periods, while time=*t*= 4 denotes the post-intervention period..

$Post_t$ = Indicator for the post-intervention observation (i.e., equals one if *t*=4 and zero otherwise).

C_k^m = Indicator (i.e., fixed effect) for county *m* *(m=1,2,…,M).* It equals one if *k*=*m* and zero otherwise.

X_{thjk}^{n} = The *n*-th characteristic of household *h* in village *j* in country *k* at time *t* (e.g., household size, age and gender of household head, land holdings, sources of income). Note that we allow these characteristics to be time variant, but we should be careful not to include those that could be endogenous (i.e., affected by the intervention).

W_{tjk}^{m} = The *m*-th characteristic of village *j* in country *k* at time *t* (e.g., distance to the main road, access to electricity, distance to markets). Note that we allow these characteristics to be time variant, but we should include only exogenous attributes.

μ_{jk} = Random effect for village *j* assumed to be distributed with a mean of zero and variance of σ_{μ}^{2}. This variance term captures the outcome variation across villages within a given county.

δ_{hjk} = Random effect for household *h*, which is assumed to be distributed with a mean of zero and variance of σ_{δ}^{2}. This variance term captures the outcome variation across households within a given village.

ϵ_{thjk} = Residual associated with observations at time *t*, which is assumed to be distributed with a mean of zero and variance of σ_{ϵ}^{2} . This term captures the variation in the outcome measures of a household across time.

In this model, county effects are modelled as fixed because all counties will be represented in the survey sample, while the village and household effects are modelled as random to reflect the sampling variability introduced by the sampling carried out at these levels. In Equation 1, β_1 captures the linear time trend in the outcome measure (which is essentially based on the change in the outcome measure during the baseline period), and β_2 captures the treatment effect at the post-intervention data point. This model can further be modified to accommodate more complex situations and data patterns, including non-linear time trends (e.g., with the addition of the square of the time variable).

Addition of an unaffected outcome to the analysis. As mentioned above, treatment effect estimates yielded by the models in Equation 1 and 2 will account for the secular time trends in the outcome measure but may be biased due to confounding if other influences on the outcome Y change simultaneously with the arrival of the treatment. We now turn to how an unaffected outcome, represented by Z_{thjk}, can be used to remove this confounding (as mentioned above, we are currently considering using *maize yield per hectare* as the unaffected outcome measure). First, consider the estimation of the pooled impact estimate across all post-intervention time points and the following model specification for Z_{thjk}, which is parallel to the specification in Equation 1:

$$(2)\ Z_{thjk} = \alpha_0 + \alpha_1 time_t + \alpha_2 Post_t + \sum_{n=1}^{N} \alpha_{n+2} X_{thjk}^{n} + + \sum_{m=1}^{M} \alpha_{N+2+m} W_{tjk}^{m} + \sum_{r=1}^{R-1} \alpha_{N+M+2+r} C_k^r + \lambda_{jk} + \nu_{hjk} + \xi_{thjk}$$

In Equation 2, all right-hand side variables are defined as in Equation 1, and the three error terms (λ_{jk}, ν_{hjk}, and ξ_{thjk}) capture the random errors at the village and household levels and the time-specific residual, respectively. In this specification, α_1 represents the linear time trend in the untreated outcome measure, while α_2 captures the pooled deviation from this trend for the post-intervention time, point which is attributed to confounders and considered to represent the effect of the confounding factors. Note that this is based on the assumption that Z_{thjk} is not specifically targeted by the intervention; therefore, the deviation of this measure from its baseline trend is fully attributable to confounding factors. Further, assuming the effect of the confounders on the treated outcome is proportional to the effect on the untreated outcome where the ratio of the two effects is equal to the ratio of the time trends, the impact estimate for the treated outcome that is adjusted for the confounders is given by:

(3) $\beta_2^{adj} = \beta_2 - \frac{\beta_1}{\alpha_1}\alpha_2$

In Equation 3, β_2^{adj} is essentially the impact on the targeted outcome that is free of confounding factors that affect both the affected and unaffected outcomes in the same direction.

Another approach for using the unaffected outcome is creating an adjusted version of the affected outcome that is free of the time trend and the influence of the confounding factors that operate in the post-intervention period. This approach entails estimating the time trends for the untreated and treated outcome measures using only the pre-intervention observations via the following models:

(4a)

$$Y_{thjk} = \beta_0 + \beta_1 time_t + \sum_{n=1}^{N} \beta_{n+1} X_{thjk}^{n} + + \sum_{m=1}^{M} \beta_{N+m+1} W_{tjk}^{m} + \sum_{r=1}^{R-1} \beta_{N+M+r+1} C_k^r + \mu_{jk} + \delta_{hjk} + \epsilon_{thjk}$$

(4b)

$$Z_{thjk} = \alpha_0 + \alpha_1 time_t + \sum_{n=1}^{N} \alpha_{n+1} X_{thjk}^{n} + + \sum_{m=1}^{M} \alpha_{N+1+m} W_{tjk}^{m} + \sum_{r=1}^{R-1} \alpha_{N+M+1+r} C_k^r + \lambda_{jk} + \nu_{hjk} + \xi_{thjk}$$

Once the time trends for the treated and untreated outcomes are obtained via models 4a and 4b, the modified version of the treated outcome measure is created as follows:

(5) $Y_{thjk}^{adj} = Y_{thjk} - \frac{\beta_1}{\alpha_1} Z_{thjk}$

This essentially creates a de-trended version of the treated outcome measure that is free of confounding factors that influence both the treated and untreated outcome measures. The adjusted outcome measure is then used in the following impact model:

(6)

$$Y_{thjk}^{adj} = \pi_0 + \pi_1 Post_t + \sum_{n=1}^{N} \pi_{n+1} X_{thjk}^{n} + + \sum_{m=1}^{M} \pi_{N+m+1} W_{tjk}^{m} + \sum_{r=1}^{R-1} \pi_{N+M+r+1} C_k^r + \mu_{jk} + \delta_{hjk} + \epsilon_{thjk}$$

Note that the model specification in Equation 7 does not include the time trend, which has already been netted out in the construction of the dependent variable. In this model, π_1 captures the treatment effect estimate that is adjusted for the secular time trend in the treated outcome measure. This estimate should be numerically equivalent to the adjusted impact estimate β_2^{adj} in Equation 3 while being more precise than β_2^{adj}. The difference between the precision levels of the two adjusted impact estimates is due to the time trend variable ($time_t$) used in the estimation of β_2 and α_2 being correlated with $Post_t$. Such undesirable correlation decreases the precision β_2^{adj} compared to that of π_1, which does not suffer from such a precision loss because the model in Equation 6 does not include the trend variable.

Possible comparison group analysis. As mentioned in the previous section, potential comparison group households identified through the CIMMYT panel could also be used to account for confounding factors by essentially treating outcomes for those households as untreated outcomes. For the estimation of the pooled impact across all post-intervention periods, this analysis would either:

- Option 1: Estimate the model in Equation 2 with data from the comparison sites to obtain estimates of $\alpha_1$and α_2, which will then be used to adjust the pooled effect obtained from the estimation of Equation 1 as shown in Equation 3; or
- Option 2: Estimate Equations 4a and 4b with data from treated and comparison sites and households, respectively, adjusting the outcome measures of the treated sites and households as shown in Equation 5, and using the adjusted outcome measure in Equation 6.

Note that both of these options are also flexible in the sense that each allows the time trend to be different for the treated and comparison units as well as imposing no restrictions on the county, village, and household-level effects across the two groups. Again, we anticipate that the two options described above should yield identical impact estimates that are corrected for the secular time trend in the treated outcome measure and confounders, and the latter option is expected to be more precise than the former, thus it is the preferred option.

3.2.3 Differential impact of the Agresults Pilot on subgroups of smallholders

In addition to reporting the overall average treatment effects, we propose to estimate the treatment effects for various subgroups of smallholders. We know that DFID is interested in exploring whether the impact of the pilot is different for female-headed households. Other potential subgroups of interest include smallholders who at baseline are (1) less credit-constrained, (2) have a higher level of education, (3) have a larger household (pool of potential laborers), or (4) have more (or more advanced) farming inputs. All of these groups may experience different intervention impacts than smallholders not in these categories. In order to investigate whether the pilot's impacts on any of these subgroups are different than the rest of the sample, we intend to (1) estimate the impact models specified in the previous section separately for each subgroup of interest and the rest of the sample (i.e., estimating one model using only the households in the subgroup of interest and another model for the rest of the sample) and (2) compare the resulting subgroup-specific impact estimate to that for the rest of the sample.

As described in the next section, the survey sample has not been built at a scale to provide for confident analysis of subgroup-specific effects given that only a portion of the data can be used for each examined subgroup. But it will be feasible to detect impacts on subgroups of a large magnitude for outcomes.

3.2.4 Statistical power analysis and sample size requirements

We conducted a series of statistical power analyses to estimate the number of villages and households that would be needed in the evaluation sample to be able to detect the targeted effect magnitudes with reasonable statistical power under the analysis approaches described above. The sample size requirement is determined based on the first outcome – uptake of storage, which is the most proximal outcome that the program aims to influence. We then present the effect size that can be detected for the second outcome (sale price of maize) with this sample size. Given our plans of conducting separate analyses for the two regions and the differences between the expected effects in the two regions (which is described in more detail below), we conducted the power calculations separately for the Rift Valley and the Eastern Province.

Minimum detectable effect size (MDES) formula for the preferred impact analysis model. The starting point for conducting a power analysis is to stipulate the underlying model specification that will be used to estimate intervention effects. In this case, given current uncertainties associated with securing a reasonable untreated outcome and/or comparison areas and household, we decided to be conservative and base the power analysis on the SITS model specification in Equation 1, which uses pre-intervention data points to form a linear baseline trend extrapolated into the post-intervention period to serve as the counterfactual, yielding a pooled treatment effect estimate across all post-treatment data points. Specifically, the following formula is used in the power analysis:

$$(7)\ MDES = Factor\ (\alpha, \beta, dof) * \sqrt{Var(\widehat{\beta_2})}$$

$$= Factor\ (\alpha, Power, dof) * \sqrt{\frac{\sigma_\mu^2(1-R_\mu^2)}{CJ} + \frac{\sigma_\delta^2(1-R_\delta^2)}{CJH} + \frac{\sigma_\epsilon^2(1-R_\epsilon^2)}{CJHTp(1-p)((1-R_{time,Post}^2)}}$$

where:

$MDES$ captures the smallest impact estimate that can be detected with the given significance level, statistical power, and other parameters that effect the standard error of the impact estimate including the number of counties, villages, households, and pre- and post-intervention time points. In order to have a standard measure of power that can be used across all outcomes of interest, MDES is expressed in terms of the standard deviation of the outcome measure (i.e., it corresponds to an effect size).

α = significance level (set to 0.05 for a 2-sided test).

$Power$ = desired level of statistical power (set to 0.80 which implies an 80 percent probability of detecting a true effect).

dof = degrees of freedom which equals the total number of observations minus number of covariates and groups (counties, villages, and households).

σ_μ^2 = proportion of the outcome variance that lies across villages within counties.

σ_δ^2 = proportion of the outcome variance that lies across households within villages.

σ_ϵ^2 = proportion of the outcome variance that lies across multiple observations that belong to the same households.

R_{μ}^2 = proportion of the outcome variance at the village-level explained by covariates included in the model.

R_{δ}^2 = proportion of the outcome variance at the household-level explained by covariates included in the model.

R_{ϵ}^2 = proportion of the within-individual outcome variance explained by covariates included in the model.

$R_{time,Post}^2$ = square of the correlation between the *Post* indicator in Equation 1 (which yields the treatment effect estimate) and the time count. Note that this correlation is proportional to the sample size requirements (i.e., a larger correlation increases the number of household keeping the MDES constant).

J = average number of villages per county.

H = average number of households per village.

T = number of observations per household.

p = proportion of observations in the post-treatment period (which equals 0.25).

Equation 7 is based on the assumption that the outcome measure will be scaled so that its standard deviation is one and the corresponding impact estimate is expressed as an effect size. This also implies that sum of the all variance components (i.e., outcome variance that lies at the county, village, household, and time levels) is one:

$$(8)\ \sigma_Y^2 = \sigma_c^2 + \sigma_\mu^2 + \sigma_\delta^2 + \sigma_\epsilon^2 = 1$$

Of these variance components, Equation 8 assumes that the outcome variance at the county-level (σ_c^2) is fully explained by the county-level fixed effects included in the model represented in Equation 1.

Required sample sizes. We used the MDES expression in Equation 7 to calculate the required sample sizes of households in the Rift Valley and the Eastern Province. These analyses are based a number of parameter values and inputs:

- *Values for the village, household, and time-level variance components ($\sigma_\mu^2, \sigma_\delta^2$, and σ_ϵ^2) and the R^2 terms at these levels (R_μ^2, R_δ^2, and R_ϵ^2).* These values are obtained from secondary analysis of the panel data maintained by Tegemeo Institute and Michigan University. From this dataset, we analysed two measures to obtain the corresponding parameter values for our two outcomes: (1) number of 90 kg bags used for storage (for the uptake of storage solutions) and (2) revenue obtained from maize sold (as a proxy for income).
- *Anticipated program penetration rates of 6 and 18 percentage points in the Eastern Province and the Rift Valley, respectively, obtained from the AgResults Pilot Business Plan (Dahlberg 2012).* Given that each "treated" household is expected to have access to four 90 kg bags and the standard deviation of the number of bags in the Tegemeo Institute dataset is close to four, the target penetration rates correspond to MDES estimates of 0.06 and 0.18 for the first

outcome uptake of storage solutions (as measured by the number of storage bags each household has) in the Eastern Province and the Rift Valley, respectively.

- *Availability of three pre-intervention data points and one post-intervention data point for each outcome measure in each region.*
- *Maximizing the number of villages sampled.* This is desired since it would minimize the first component of the MDES formula in Equation 8 (village-level variance term scaled by the number of villages) and consequently decrease the MDES estimate. We believe that the optimum number of households that can be surveyed in each sampled village is approximately six because a smaller threshold may lead to the inefficient use of visiting time to villages, while a larger number would not maximize the number of villages included.

Based on these parameter values and assuming 3 data points before intervention and 1 after intervention, in the Rift Valley we expect that we would need as many as 540 households (with the sampling of all 9 counties, 10 villages from each selected county, and the sampling of 6 households from each selected village) to reliably detect the expected effect size of 0.18 on uptake of on farm storage. Due to its lower penetration rate and hence smaller expected average impact, in the Eastern Province we estimate that a sample of 4140 households (5 counties, 138 villages per county, and 6 households per village) will be needed to detect the anticipated effect size of 0.06 in that region. These sample sizes would also allow us to detect similar effects on the second outcome of interest (income or sale price of maize): 0.16 in the Rift Valley and 0.06 in the Eastern Province.

As mentioned above, these power analyses are conservative in the sense that they do not incorporate the potential use of an untreated outcome or a comparison group to strengthen the analysis. It is also important to note that they do not apply to analyses of impacts on subgroups of interest such as female-headed households. If, say, one-quarter of all smallholders fall into this category, we can be confident of detecting impacts twice the size of those stated above for such households. For example, in the Rift Valley true impacts on uptake of on farm storage in excess of 0.36 (in effect size units) could be ruled out should insignificant test results emerge, as could true impacts in excess of 0.12 (in effect size units) in the Eastern Province. Thus, even without significant findings (which are unlikely without much larger subgroup survey samples than can be afforded) something important will be learned about effects on subgroups of all sorts—not just the illustrative female-headed households discussed here.

3.2.5 Data

Data for the quantitative impact evaluation will come from baseline and endline surveys as described in Section 4. The baseline and endline surveys will capture comprehensive information about smallholder households, including modules on household characteristics and assets; farming practices and inputs; agricultural production, yield, and use (including sale, consumption and storage of maize and other grains); awareness of post-harvest storage options; income and expenditures; and food security.

Data will be collected electronically using tablets or smartphones and a to-be-determined survey software package (likely SurveyToGo or CSPro). Data will be reviewed daily during the survey period for accuracy and consistency by field supervisors and, in some cases, members of the Abt team. Data will then be uploaded to secure servers and cleaned in several stages by the survey firm and the Abt team using SPSS and/or Stata. Quantitative data analysis will be performed by members of the Abt team using Stata.

For the evaluation to accurately capture the impacts of the pilot, it must focus on the same areas where implementers operate most heavily. For this reason, the Abt team is using two sources of information to guide our selection of areas to survey. First, we have gleaned what we expect to be the key characteristics of the target areas. Second we have asked implementers directly to summarize their geographic targeting strategy as part of their application process for participation in the pilot. This ensures that, to the extent that potential implementers know their target areas before the pilot begins, we will be able to use their planned geographies of focus to inform the locations in which we survey. Third, we will also use county- and subcounty-level government data that we are in the process of obtaining from county Ministry of Agriculture offices on maize and other cereal production, yield, and price to supplement the information that potential implementers submit in their applications. The primary reason for this triangulation using government data is that not all implementers have previous operations on the ground in Kenya upon which to base their sales, marketing, and distribution assumptions. Some of these potential implementers have indicated because of this that they will not have detailed marketing and distribution plans by the pilot's launch, and we will have to use available data to estimate where they will operate for the purposes of targeting our baseline.

3.3 Evaluation Question 4: What has been AgResults' impact on poor consumers' demand for derivative food products?

This question is being excluded from the Kenya pilot evaluation, as no impact is expected on demand for derivative food products.

3.4 Evaluation Question 5: What evidence exists that the effects of the AgResults pilots will be sustainable in the medium to long term?

The sustainability of effects determines the potential for the AgResults initiative to make significant and long-lasting contributions to the development goals that motivate it. Assuming a positive initial impact, then the sustainability of the pilot will depend on whether market developments that have been stimulated by the pilot will continue following cessation of the direct pilot incentives; that is, whether the preconditions for a sustainable market have been established or not.

Qualitative contributions to the evaluation of sustainability will come from the SCP and farm-level analyses, and will focus on whether the basic conditions that provide incentives for storage providers and distributors to engage in the market are present, and whether the storage solutions that are provided are technologically and economically appropriate to smallholder farmers such that they are likely to continue to buy them following cessation of the pilot intervention.

These include, for example, whether there is adequate awareness of post-harvest losses as a problem and of the pilot technologies as a potential solution and whether farmers realize post-harvest loss reductions and gain the ability to store longer in anticipation of higher sale prices.

We will evaluate market actors' perspectives on the viability of the market and their intentions for engagement in the market through production, sale, and/or purchase of improved on-farm storage units following cessation of the pilot's activities. Specifically, we will ask providers of improved on-farm storage solutions (whether they were implementers in the AgResults initiative or not) about their interest and intentions around continued involvement in the market, inquire into the specifics of any plans they report to gain a sense of their nature and implementers' commitment to them. We will also investigate what conditions are necessary to carry out their plans (such as availability of supporting services from extension or development organizations), and their assessment of the likelihood of these conditions being fulfilled.

Data will be collected during the course of the questionnaires, previously introduced, and administered to private sector players, farmers, and consumers. Results will be compiled by the Agricultural Economist who is responsible for conducting the questionnaires. The data will be analysed and reported by the Qualitative Expert in conjunction with the Agricultural Economist.

3.5 Evaluation Question 6: What is the evidence on the scale of any effect on private sector investment and uptake and on the cost-effectiveness of AgResults as an approach?

The SCP qualitative analysis, particularly the documentation of market structure, will inform the calculation of the scale of the pilot's effect on private sector investment and farmer uptake of on-farm storage (see Section 3.1). Documentation of the market structure will include estimates of the numbers and characteristics of market actors involved at different levels of the market, as well as calculation of on-farm maize storage capacity that was purchased by farmers as a result of the initiative.

Here we discuss our approach to estimate the cost-effectiveness of AgResults, which we will complete in the endline when the total programme costs are known. Central to the motivation behind the use of incentive-based pull mechanisms is the expectation that they will be more cost-effective than traditional development interventions, and hence scalable. It is argued that the private sector can be closely attuned and responsive to the needs of agricultural markets if their incentives can be aligned to support the development of those markets. At the same time, incentive-based mechanisms have not yet been applied to any significant extent in agricultural development programming, so evidence about their cost effectiveness is as yet unavailable.

A critical aspect of a cost-effectiveness study is to causally attribute the outcome or impact to the programme. This aspect is addressed in our evaluation approach described in the sections above. The second important component is obtaining the cost of the programme. Cost effectiveness is defined as the cost per unit of impact. We will estimate this ratio per unit of increased technology adoption (number of farmers that adopt on-farm storage technologies and metric tons of capacity sold), and for other outcomes if found. The cost-effectiveness analysis will calculate the gross and net cost of the storage solutions and use that as the numerator in a series of ratios where the denominator will be the measured impacts on programme outputs and outcomes as estimated by the evaluation.

The total impact of the estimate is the product of number of farmers in the treatment group and the impact estimate. For example, to estimate the total income impact we will multiply the total number of farmers who have adopted new storage solutions with the average increase in net revenue estimated from Equation 1. We will divide this by the total cost of the programme attributed to the treatment group. If the specific cost is not estimable for the treatment group, we will take the total programme cost and multiply it by the ratio of smallholders in the treatment group to the total smallholders in the programme. The gross costs of each pilot will be based on actual project expenditures from the start of the project through its conclusion using project monitoring data. These expenditures will cover incentive payment, verification procedures, and a variety of other types of expenses for individual pilots. This accounting will also include pertinent AgResults project administration and management costs, which will be distributed over all of the pilots and also discounted. Thus, comparisons of AgResults cost-effectiveness results to the findings for other interventions should include discounting adjustments such that costs are expressed in terms of the same year. Net costs can be calculated as gross costs minus the tangible short-term economic output or savings generated by the pilot, which will be measured as part of the impact evaluation described above.

The cost-effectiveness ratio of the pilot will be compared to those of other AgResults pilots in Nigeria and Zambia. This will not be a cost-benefit analysis—that is, we will not assign a monetary value to technology adoption and will not compare the pilots' overall value to their costs. However, by calculating the net cost of the pilots (net of the increase in their returns) per smallholder adoption, as well as the gross cost per adoption, the proposed analysis will take account of the positive economic impacts of the pilots. In addition, the cost-effectiveness analysis will include sensitivity tests for alternative discount rates. We will also distinguish costs and benefits from different analytical perspectives including those for smallholders and aggregators.[2]

Finally, to compare the cost-effectiveness of the implemented programmes to counterfactuals, we will compare the AgResults cost-effectiveness ratios to cost-effectiveness information that can be obtained on any push mechanisms that have been used to achieve similar goals through a review of published articles that estimate these costs.

3.6 Evaluation Question 7: What lessons can be learnt about best practices in the design and implementation of AgResults?

Our evaluation of design effectiveness and identification of best practices is central to the evaluation and learning framework around the AgResults initiative. The most critical step for developing best practices is to identify what worked well in the pilot – specifically, objectives that the pilot achieved cost effectively. Therefore, as a first step of this analysis, we will synthesize the results of Evaluation Questions 1-6 to identify the specific outcomes the pilot achieved cost effectively and those that it did not.

The next step is to identify the "practice" that was instrumental in achieving the outcomes. The primary mechanism in a best practice is the ability or the means to achieve a goal in a cost-effective manner – in this case, the pull mechanism. The secondary mechanisms include implementing features, supportive features, and optional features. Distinguishing the functions that make the mechanism work from the features that support those functions can be very complicated. Therefore, it is important to identify the core essence of the practice while allowing flexibility for how it is implemented so it remains sensitive to local conditions. This aspect of identifying the best practices, what Bardach (2011) calls observing the practice, requires inputs from key stakeholders of the pilot – the pilot managers, aggregators, verifiers, and farmers. As part of this analysis, it is also important to assess the implementation fidelity, the extent to which

[2] We will investigate whether all benefits and costs can be disaggregated in this way. For an example of such a disaggregated analysis, see Long (2008).

the programme deviated from its plans, and if those deviations contributed to its success (or not). Therefore, we will conduct a final best practices workshop in which we will describe the key elements of the pilot, its implementing features, and supportive and optional features that made it successful. While examining carefully why the best practice might succeed, in this workshop we will also examine the potential vulnerabilities that could lead the pull mechanism, as designed in the pilot, to fail. Finally, as part of the best practices workshop, we will also assess the conditions of success that are necessary for the pilot to be successful in another context. The conditions of success may be understood from local characteristics that vary within the pilot setting, such as varying levels of education of the aggregator, or the variation in the contractual arrangements, and local characteristics that do not vary within the pilot – cultural norms common to the entire pilot region that may have influenced the success of the pilot. This discussion can also reflect on the support structures that, if put in place, maximize the likelihood of success.

If the pilot is not successful, or only partly successful, we will still draw lessons learnt from the experience. At the workshop, we will assess the reasons why certain aspects of the programme worked and reasons why certain aspects of it did not work, focusing on the following five potential causes of deviations from the intended pilot results:

- Inaccuracies in conceptualization of the pilot (for example, mistaken assumptions about the nature of the market or anticipated behaviour of market actors);
- Issues arising from failure to implement the pilot as prescribed;
- Issues arising from failure to adjust pilot implementation to changing circumstances;
- Problems in capturing or communicating results resulting from the definition of the monitoring and evaluation agenda and tools;
- Deviations resulting from occurrences that could not realistically be anticipated or planned for (for example, major shifts in policy that affect the market, or agro-climatic issues such as severe drought, excessive rainfall, or disease outbreaks that fall outside of normal patterns for the implementation area).

We will use a “fidelity analysis” approach to compare the interventions that were planned to the interventions that were actually implemented. We will also examine how implementation of the interventions changes over time in response to managerial decisions based on issues arising from earlier implementation experience or in anticipation of changing contextual factors (see Appendix I).

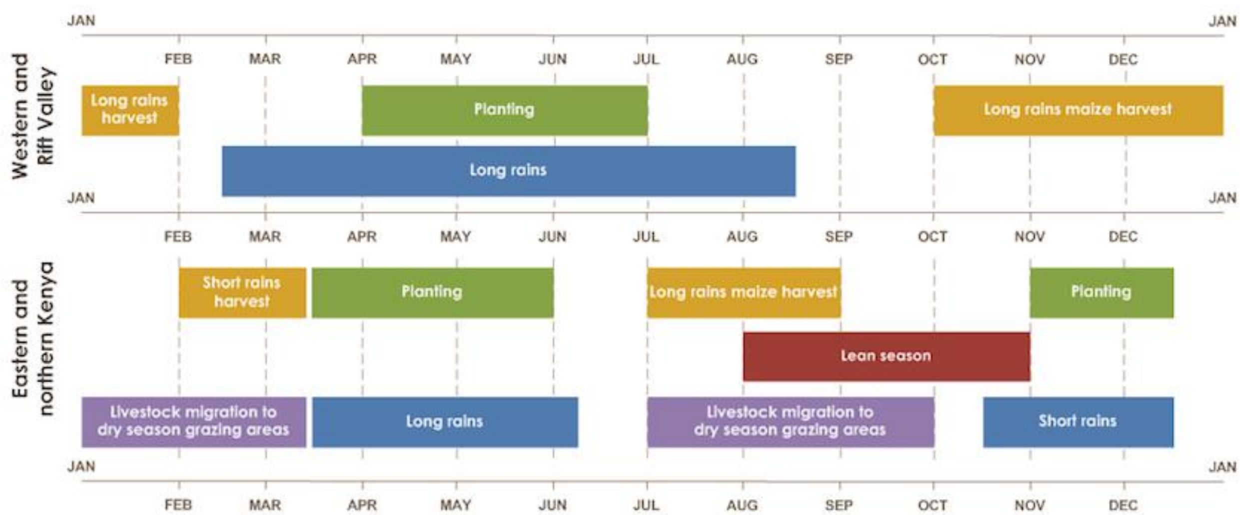
4. Evaluation implementation

Our approach to implementing the evaluation involves an initial qualitative assessment (IQA), baseline and endline surveys. Two phases of the IQA have now been completed, as have a series of one-on-one evaluation design p meetings with key stakeholders and a second workshop held as part of the pilot’s official launch.

For the quantitative aspects of the evaluation, in order to correctly capture the effects of the pilot and avoid bias, it is crucial to identify the ideal timing for the surveys with regard to the start of the pilot as well as planting and harvest cycles. For the baseline, the most critical timing consideration is that all surveys are completed before implementers have begun any sales or marketing activities in the target counties. This is especially important given the role that farmer awareness and attitudes on post-harvest loss and on-farm storage play as intermediate impacts of the pilot: if implementers have begun any marketing activities as part of their AgResults participation before the baseline survey, then our estimates of indicators of farmer awareness may be flawed. However, it is also very important that we conduct the baseline survey in the correct areas: the places where implementers will focus their efforts. Therefore, we need to wait until implementers are selected before we commence the baseline survey so that the surveys are administered in the ideal areas. Taking both of these factors into consideration, we will conduct the baseline survey in the short window between implementer selection and the official start of implementation activities.

For the endline survey, timing is also important. Length of storage is a key outcome, so the surveys must be conducted after a sufficient amount of time has passed that we can accurately assess how much farmers have stored and for how long. Given farmers' current practices, along with maize price cycles, we have concluded that conducting follow-up surveys four months after the previous harvest will allow enough time to accurately capture changes in post-harvest storage practices. As shown in Figure 5, the two implementation areas have different planting and harvest cycles, so to capture information from both at the same time (which maximizes survey efficiency), we will have to conduct the follow-up surveys based on the planting and harvest cycle in the Rift Valley. Harvests in the Rift Valley conclude during February with most harvesting completed by December or January, so taking into account the four-month post-harvest lag before each survey, we will conduct the endline survey in May 2017.

Figure 5. Planting and harvest cycle



The rest of this section describes the evaluation activities in more detail.

4.1 Initial qualitative assessment – Phase 1

The first phase of the IQA was completed in December 2013. It was intended to inform the design of the AgResults impact evaluations data collection protocols and instruments by delving into broad issues that affect the implementation success of the AgResults pilots. It was implemented with a literature review and field trips during which different actors in Kenya's maize economy were interviewed using semi-structured questionnaires.

Interviews were conducted face-to-face with respondents, usually at the site of their operations. The interviews were intended to contextualize and provide additional insight into the issues that were hypothesized to be relevant to the pilot's implementation based on business plan and literature review. Broadly, the research focused on the maize sector and marketing chain; characterization of the implementation areas; socio-economic characteristics of farming households; current farmer perceptions of maize storage; identification of other donor-funded and multilateral projects; local government, research, and extension; policy; and identification of other organizational players.

4.2 Initial qualitative assessment – Phase 2

For the second phase of the IQA, the team travelled to Kenya specifically to collect inputs to inform our quantitative impact evaluation design. The trip included meetings with pilot advisory council members, local post-harvest and cereal value chain experts, potential implementers, distributors of post-harvest technologies already on the market, government officials, local organizations that have been involved in awareness creation for post-harvest storage, and farmers in both the Rift Valley and the Eastern region. (For a complete list of stakeholders met, see Appendix I). Information gathered included the following:

- *Geography:* within the pilot's target counties, there is considerable variation in factors that make an area more or less attractive to implementers. These include average farm size, maize and other cereal production, yield, farmer wealth, and the presence of existing distribution networks. Because of this, it is important that our quantitative surveys take place in areas where implementers are likely to target their efforts. Therefore, we collected qualitative information on the factors mentioned here as well as asking stakeholders already involved in on-farm storage awareness creation and distribution which areas they focus on and why. This information will help us to target our survey such that we maximize the likelihood of detecting impacts that occur.
- *Sample size:* as enumerated in earlier sections, a number of variables affect the minimum sample size needed to detect the expected outcomes. We met with a wide variety of stakeholders and gathered both numerical and anecdotal evidence on these variables.
- *Information on potential non-equivalent outcomes for the SITS design:* we vetted several options (primarily yield or storage of other crops) before identifying maize yields as the best potential unaffected outcome, which will be contemplated further.
- *Potential implementer plans:* although implementers have not yet officially been selected, some potential implementers have already submitted expressions of interest in the AgResults pilot. We met with some of these potential implementers to collect information on their planned phasing and geographical targeting (should they be selected).
- *Concurrent push mechanisms:* several on-farm storage technologies are associated with ongoing push efforts that could confound our estimates of AgResults' impact if not taken into account. We gathered information on all such activities and will continue to track them throughout the evaluation.
- *Existing data on maize production and storage in Kenya* that we can use to calculate inputs for our power analysis and/or to potentially use as the base of our own survey panel by re-visiting the same households if household identification can be made

available: Surveying some households from a pre-established panel may allow for a smaller survey sample and could potentially add some counterfactual (non-target county) observations to our study. The datasets vetted are shown in Table 1.

Table 1. Existing Datasets

Dataset	Relevant contents	Availability
University of Egerton, Tegemeo Institute of Agricultural Policy and Development/Michigan State University Agricultural Monitoring and Policy Analysis Project Household Survey, 2000 and 2004 waves	Household characteristics, maize and other agricultural production, maize storage, income	2000 and 2004 data procured; household identifications not available
International Maize and Wheat Improvement Center (CIMMYT) metal silo impact evaluation household survey data, 2010 and 2013 waves	Household characteristics, maize production, maize storage, income, food security	Data and household identification request pending

4.3 Evaluation design workshop #1

An evaluation design workshop was not conducted as planned because of delays in the pilot's official launch resulting from the legal concerns around the pilot. Therefore, during our IQA Phase 2 trip in country, we conducted individual evaluation meetings with various stakeholders to discuss options for the evaluation design as well as potential outcomes, geographical considerations, and how implementation may play out in practice. We covered all the material we would have covered during a workshop, including background and motivation for the evaluation, possible evaluation design options, and expected outcomes. We also sought feedback from stakeholders on the design options as well as on geographical considerations and intermediate outcomes that may be most important in changing farmer behaviour (i.e., farmer knowledge, attitudes, and practices on post-harvest management), and typologies of farmers.

4.4 Evaluation design workshop #2

Our second evaluation design workshop occurred during the pilot's official launch event. Attended by Qualitative Lead Denise Mainville in person and the rest of the Abt team by video conference, the second workshop consisted of a presentation on the preliminary evaluation design and the solicitation of feedback from stakeholders during group discussions. There was a particular focus on geographical considerations we will need to take into account in selecting our survey areas as well as potential implementation challenges from the perspective of on-farm storage providers. We also discussed the need for coordination and data sharing on implementers' historical sales and awareness-creation activities and the importance of holding off any awareness activities until the baseline was completed.

4.5 Smallholder survey instrument pretest

The pretest of the smallholder baseline survey instrument will be conducted prior to the baseline survey by the evaluation's Kenya-based survey firm. The survey firm will be chosen from among several candidate organisations through a competitive process. The firm will translate the instrument into several local languages and script the questions into their smartphone software.

The main objective of the pretest is to identify any weaknesses in the survey questionnaire design and also assess the ability of farmers to recall maize production, yield, and price information for past seasons. Based on the assessment of farmers' recall during the pre-test (based largely on farmers own assessment of how well they can remember), we will adjust our questionnaire accordingly to capture only the number of past years' data that farmers in the pretest can recall with a great degree of confidence (likely about 2-3 years).

4.6 Baseline data collection—quantitative and qualitative

As mentioned above, we anticipate fieldwork for the baseline smallholder survey to commence during June 2014 and expect it to last three to four weeks. The evaluation team will work closely with the selected survey firm to establish clear data management, processing, and cleaning plans, as well as create materials to be used to train enumerators and implement quality control measures. Lessons learnt from the pretest will be incorporated into the survey instrument and field administration procedures to ensure the highest quality data collection possible in the main survey.

Remaining qualitative baseline data collection—beyond the now-completed IQA—will occur concurrently with the quantitative baseline survey and is estimated to take three to four weeks. The qualitative data collection will follow the protocol outlined in Section 3 of this document and involve semi-structured interviews with a variety of actors in the maize value chain as described in those sections. The results from both data collection efforts will be reported in our baseline survey and qualitative assessment report to be submitted to DFID in late summer 2014.

4.7 Ongoing qualitative assessment

Following baseline data collection, the evaluation team will continue to monitor the pilot implementation as part of our ongoing qualitative assessment. This will consist of regular communications with the Pilot Manager, the Secretariat, DFID, and the Steering Committee to keep track of any issues that arise, their importance to the pilot's implementation, and how they are eventually resolved. This will continue up to the point of endline data collection in 2017.

4.8 Endline data collection

In or around May 2017, we will conduct the endline survey with the same sample of households surveyed at baseline. The evaluation's analysis of endline data, including findings on results realized in the intervening years of implementation, will be submitted to DFID in late summer 2017. We will present the sustainability assessment in the spring of 2019, assuming extension of the evaluation contract.

References

Baoua, I. B., et al. "Side by side comparison of GrainPro and PICS bags for postharvest preservation of cowpea grain in Niger." *Journal of Stored Products Research* 54 (2013): 13-16.

Baoua, I. B., et al. "PICS bags for post-harvest storage of maize grain in West Africa." *Journal of Stored Products Research* (2014).

Bloom, H. (2003). Using "short" interrupted time-series analysis to measure the impacts of whole-school reforms: With applications to a study of accelerated schools. *Evaluation Review, 27*(1), 3–49.

Caves, R. (1987). American Industry: Structure, Conduct, Performance.

CIMMYT. "Effective Grain Storage for Better Livelihoods of African Farmers Project." (2011).

Coryn, C. L. S., & Hobson, K. A. (2011). Using nonequivalent dependent variables to reduce internal validity threats in quasi-experiments: Rationale, history, and examples from practice. In S. Mathison (Ed.), *Really new directions in evaluation: Young evaluators' perspectives. New Directions for Evaluation, 131*, 31–39.

Dahlberg (2012). Agricultural Pull Mechanism Initiative: On-Farm Storage. World Bank.

Government of Kenya (2011). Economic Review of Agriculture. Nairobi, Ministry of Agriculture.

Holtzman, J. S. (2003). Using Subsector Analysis to Assess the Impact of Policy Reform. Does Agricultural Policy Reform Work? The Impact on Egypt's Agriculture 1996-2002. G. Ender and J. S. Holtzman, Abt Associates, Inc.: 111 – 134.

Jones, M., C. E. Alexander and J. Lowenberg-DeBoer (2011). An intial investigation of the potential for hermetic Purdue Improved Crop Storage (PICS) bags to improve incomes for maize producers in Sub-Saharan Africa, Purdue University.

Kirimi, L., N. J. Sitko, T. S. Jayne, F. Karin, M. Muyanga, M. Sheahan, J. Flock and G. Bor (2011). A Farm Gate-to-Consumer Value Chain Analysis of Kenya's Maize Marketing System. Food Security International Development Working Papers, Michigan State University.

Long, D. et al. (2008). "Evaluating the Benefits and Costs of the Job Corps" in Cost-*Benefit Analysis and Public Policy*, ed. by David Weimer (New York, NY: John Wiley and Sons).

Mainville, D. (2013). Phase 1 IQA report for AgResults Kenya On-farm Storage Pilot, AgResults Impact Evaluation.

North, D. C. (1990). Institutions, Institutional Change and Economic Performance. New York, Cambridge University Press.

Komen, J. J., et al. (2010). "Economics of post-harvest maize grain losses in Trans Nzoia and Uasin Gishu districts of northwest Kenya." Kenya Agricultural Research Institute, Kitale.

Scherer, F. M. and D. Ross (1990). Industrial Market Structure and Economic Performance. Chicago, Rand McNally & Co.

Shadish, William R.;Cook, Thomas D.; Campbell, Donald T. (2002). Experimental and quasi-experimental designs for generalized causal inference. Boston, MA, US: Houghton, Mifflin and Company.

Sutton, J. (1992). Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration. Cambridge, MA, The MIT Press.

Trochim, William and James P. Donnelly. 2007. *The Research Methods Knowledge Base, 3rd Edition.* Cincinnati, OH, Atomic Dog Publishing.

World Bank (2011). Missing Food: The case of postharvest grain losses in Sub-Saharan Africa, World Bank Natural Resources Institute Food and Agriculture Organization.

Yin, R. K. (2003). Case Study Research: Design and Methods. Thousand Oaks, Calif., Sage Publications.

Appendix A: Data needs from pilot managers and verifiers

For each implementer

1. Districts in which implementer is active
2. Identification and contact info for distributors
3. Sales by county, subcounty, outlet
   a. Number of units (for each unit type)
   b. Number of farmers
4. Prices and sales/service conditions

Appendix B: Pilot implementer & OFS provider survey

1. Identifying information
    a. Interviewee name, Position
    b. Firm name, Location,
    c. Contact information
2. Brief background on firm
    a. Brief history of firm
    b. Is firm part of a chain or franchise?
    c. If yes, how many branches?
    d. Where is headquarters?
3. Brief characterization of agricultural activities and storage solutions (both on-farm and off-farm) offered by firm
    a. Background on engagement in market for on-farm storage before AgResults
    a. Agricultural commodity and OFS product/service offerings
    b. Number of full-time employees
2. Background on involvement in AgResults pilot—how did firm come to be involved?
3. How did/will they enter the market for OFS in Kenya? Describe evolution in the following areas if it has changed over time. Include specifics (numbers, location, relationship, and other key aspects) of those activities.
    a. Manufacturing/sourcing
    b. Distribution channels
    c. Retail distribution
    d. Promotion of on-farm storage products (advertising, etc.)
    e. Will they/did they partner with any other firms or organizations to promote awareness/uptake/production/distribution of their product?
    f. Scale of operations
    g. Other?
4. What were successes and challenges in each of those areas? What changes did they make to adjust and how did those work?
5. What are their perceptions on small farmers as potential market for storage?
    a. Are they a good potential market? Why or why not?
    b. Are there other options (such as off-farm storage, warehouse receipts system) that compete with OFS?
        i. If so, what are the pros and cons of each relative to small farmers' needs?
    c. What is the value proposition that will motivate small farmers to buy OFS?
    d. What are constraints (such as credit), and how will they address those to make OFS accessible to them?

   e. Have they done any calculations on the returns to small farmers who adopt their solution?
      i. What will it cost?
      ii. How long should it last?
      iii. On what terms is it provided?
      iv. What is the basis for economic benefits to the farmers?
6. Information on on-farm storage sales
   a. What specific markets are they working in (locations)?
   b. What are sales arrangements between supplier (implementer) and distributor?
   c. What are sales arrangements between distributor and farmer?
   d. What services are offered in combination with the units? Describe
      i. Training
      ii. Delivery
      iii. Set-up
      iv. Maintenance
      v. Credit
      vi. Other
7. What do they know of the ultimate buyers (farmers) of the storage?
   a. Scale of production
   b. Commercial vs. subsistence orientation
   c. New or established customer
   d. Farmer preferences/areas of concern
   e. Source of finance for purchase
   f. Association with any project/NGO/government group or other initiative
   g. How they use the storage, what kinds of issues they have
8. What are their reflections on participation in the pilot?
   a. What has gone well and not?
   b. How could the pilot have been better structured to motivate investment in on-farm storage?
   c. Do they think the pilot will succeed in catalysing a sustainable market (that doesn't depend on NGO or project support) for on-farm storage? Why or why not?
      i. Is there adequate demand for OFS for small farmers?
      ii. Are there supply issues that affect the viability of the market?
      iii. Are there effective means to promote the storage and educate farmers on its availability?
      iv. Are there adequate means to overcome other constraints, such as credit and liquidity constraints of small farmers?
   d. What have they learnt through the course of participating in the pilot?

    e. If they were to do it over (choose whether or not to participate in the AgResults pilot), what would they do differently?
    f. Do they intend to continue to participate in the pilot?
9. If they were to do it over (sell improved storage to farmers), what would they do differently?
10. What changes do they anticipate making in the near future (or would they like to make if they could under pilot guidelines)
11. Do they think they'll continue in market once pilot ends?
    a. Why or why not?
    b. How will they change the nature of their engagement in the market?
        i. Manufacturing/sourcing
        ii. Distribution channels
        iii. Retail distribution
        iv. Promotion of on-farm storage products (advertising, etc.)
        v. Will they/did they partner with any other firms or organizations to promote awareness/uptake/production/distribution of their product?
        vi. Scale of operations
        vii. Other?
    c. Do they think other key players (such as distributors) will continue too? Why or why not? What might they do differently if they continue?
12. Any further comments about the AgResults pilot and/or market for on-farm storage?

Appendix C: Short survey for community-level respondents (CDAs, AAEOs, Chiefs)

Kenya County Director of Agriculture survey

Interviewer and interview data

Name of interviewer
- ❍ Tabitha
- ❍ Other ____________________

Was interview sound-recorded?
- ❍ Yes
- ❍ No

Interview date

Interview start time: _________________

Respondent and county information

Respondent name:

Respondent position
- ❍ County Director of Ag (DAO)
- ❍ Other ____________________

Telephone

Email

District drill-down

Sub-counties and wards--verification and more info

❍	❍ Name of sub-county	❍ Average farm size	❍ Avg. maize yield	❍ Surplus producer?			❍ Area maize cultivated last major season	❍ AEO name and contact info	❍ Unit			❍ Primary agro-ecological zone						❍ What do they consider a smallholder? (e.g. less than __ acres)	❍ Population	❍ Quantity of maize produced last season _or_ % county total
	name	acres	yield per unit	Yes	No	Sometimes	acres	specify	90kg bag	kg	MT	1. Low Tropics	2. Dry Mid Altitudes	3. Dry Transitional	4. Moist Transitional	5. High Tropics	6. Moist Mid Altitudes	acres	people	Quantity or %
1				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
2				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
3				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
4				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
5				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
6				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
7				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
8				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
9				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			
10				❍	❍	❍			❍	❍	❍	❍	❍	❍	❍	❍	❍			

Storage use, issues, and options

Are you familiar with the grain storage issues that farmers in your area face?

❍ Very familiar
❍ Somewhat familiar
❍ Vaguely familiar
❍ Not familiar at all

How severe are the following storage issues?

❍	❍ Click to write Column 1					❍ Comments
	Severe	Significant	Minor	Not a problem at all	Don't know	Comments
Weevils	❍	❍	❍	❍	❍	
Rodents	❍	❍	❍	❍	❍	
LGB	❍	❍	❍	❍	❍	
Aflatoxin	❍	❍	❍	❍	❍	
Mold	❍	❍	❍	❍	❍	
Theft	❍	❍	❍	❍	❍	
Poor conditions (due to rain, etc.) for post-harvest management of grain	❍	❍	❍	❍	❍	
Other	❍	❍	❍	❍	❍	

What storage solutions do smallholders use for cereals and grains in area?

❍	❍ What share of smallholders use option?	❍ What is most common source?						❍ Where is source located?	❍ Specify source and contact info
	%	MoAg	NGO	Membership organization	Commercial supplier (including artisan)	Project	Other	Describe	name, phone/email
Poly-pro bags w/ or w/o chemicals		❑	❑	❑	❑	❑	❑		
Traditional and/or home-made storage		❑	❑	❑	❑	❑	❑		
Pesticide impregnated bags		❑	❑	❑	❑	❑	❑		
Hermetically sealed plastic bags		❑	❑	❑	❑	❑	❑		
Hermetically sealed plastic tubs or bins		❑	❑	❑	❑	❑	❑		
Metal Silos		❑	❑	❑	❑	❑	❑		
Community storage banks		❑	❑	❑	❑	❑	❑		
Private storage including WRS		❑	❑	❑	❑	❑	❑		
NPCB		❑	❑	❑	❑	❑	❑		

Any other comments?

Interview end time: _________________

Kenya sub-county (AAEO) survey

Interviewer and interview data

Name of interviewer
- ❍ Tabitha
- ❍ Other ____________________

Was interview sound-recorded?
- ❍ Yes
- ❍ No

Interview date

Interview start time: _________________

Respondent and county information

Respondent name:

Respondent position
- ❍ AAEO
- ❍ Other ____________________

Telephone

Email

Province
District
Name of sub-county

Locations within sub-county--verification and more info

❍	❍ Name of location	❍ Average farm size	❍ Avg. maize yield	❍ Surplus producer?			❍ Area maize cultivated last major season	❍ Unit			❍ Primary agro-ecological zone						❍ Population	❍ Quantity of maize produced last season _or_ % county total
	name	acres	yield per unit	Yes	No	Sometimes	acres	90 kg bag	kg	MT	1. Low Tropics	2. Dry Mid Altitudes	3. Dry Transitional	4. Moist Transitional	5. High Tropics	6. Moist Mid Altitudes	people	Quantity or %
1				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
2				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
3				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
4				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
5				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
6				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
7				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
8				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
9				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		
10				❍	❍	❍		❍	❍	❍	❍	❍	❍	❍	❍	❍		

Storage use, issues, and options

Are you familiar with the grain storage issues that farmers in your area face?

- ❍ Very familiar
- ❍ Somewhat familiar
- ❍ Vaguely familiar
- ❍ Not familiar at all

How severe are the following storage issues?

❍	❍ Click to write Column 1					❍ Comments
	Severe	Significant	Minor	Not a problem at all	Don't know	Comments
Weevils	❍	❍	❍	❍	❍	
Rodents	❍	❍	❍	❍	❍	
LGB	❍	❍	❍	❍	❍	
Aflatoxin	❍	❍	❍	❍	❍	
Mold	❍	❍	❍	❍	❍	
Theft	❍	❍	❍	❍	❍	
Poor conditions (due to rain, etc.) for post-harvest management of grain	❍	❍	❍	❍	❍	
Other	❍	❍	❍	❍	❍	

What storage solutions do smallholders use for cereals and grains in area?

❍	❍ What share of smallholders use option?	❍ What is most common source?						❍ Where is source located?	❍ Specify source and contact info
	%	MoAg	NGO	Membership organization	Commercial supplier (including artisan)	Project	Other	Describe	name, phone/email
Poly-pro bags w/ or w/o chemicals		❑	❑	❑	❑	❑	❑		
Traditional and/or home-made storage		❑	❑	❑	❑	❑	❑		
Pesticide impregnated bags		❑	❑	❑	❑	❑	❑		
Hermetically sealed plastic bags		❑	❑	❑	❑	❑	❑		
Hermetically sealed plastic tubs or bins		❑	❑	❑	❑	❑	❑		
Metal Silos		❑	❑	❑	❑	❑	❑		
Community storage banks		❑	❑	❑	❑	❑	❑		
Private storage including WRS		❑	❑	❑	❑	❑	❑		
NPCB		❑	❑	❑	❑	❑	❑		

Any _active_ ag-related (e.g. community/livelihoods/economic development) initiatives? Specify project, organization, and what they do that is related to ag and/or storage.

❍	❍ Project name	❍ Organization (e.g. Caritas, etc.)	❍ Locations	❍ Ag and/or storage-relevant activities	❍ Contact info
Project 1 Project 2 Project 3 Project 4 Project 5	Answer 1	Answer 1	Answer 1	Answer 1	Answer 1

Any member-based agriculture organizations (farmers groups, etc.) that might serve as a distribution channel for on-farm storage?

❍	❍ Organization name	❍ Locations	❍ Ag and/or storage-relevant activities	❍ Contact info
Organization 1 Organization 2 Organization 3 Organization 4 Organization 5	Answer 1	Answer 1	Answer 1	Answer 1

Any other comments?

Interview end time: _________________

Appendix D: Key informant interview for maize and storage sector specialists

1. Identifying information
    a. Interviewee name, Position
    b. Organization/Firm name, Location,
    c. Contact info

2. Are you familiar with post-harvest losses of maize as an issue affecting small farmers? If yes, please describe your understanding of the pilot, and the possible solutions to it.

3. What NGO, donor or government programs are currently working on issues relating to storage of maize?

4. Do you know anything about the AgResults pilot and/or activities of private firms selling on-farm maize storage solutions to farmers? What do you know/think about:

    a. Purpose of project
    b. How it is being implemented
    c. Who is participating
    d. How implementation is proceeding in terms of progress, constraints, successes, failures, outcomes
    e. How farmers use the storage
    f. Impact on farmers
    g. Impact on post-harvest losses
    h. Sustainability of private sector participation
    i. Sustainability of a private sector driven market for OFS of maize in general

Appendix E: Survey for OFS distributors

Kenya OFS Distributor survey

1. Name of interviewer
- ❍ Tabitha
- ❍ Other ____________________

2 Was interview sound-recorded?
- ❍ Yes
- ❍ No

3 Interview date
(Table Truncated to 63 Columns)

4 Interview start time: _________________

5 Survey number: Use this interview number to link the data entry form to the PID (including interviewee name, position, firm name, location, and contact info) which you are recording separately.

6 Type of firm/organization
- ❍ Agro-input dealer (that sells seeds and crop products such as fertilizers and protectants)
- ❍ Hardware (that sells farm implements)
- ❍ Membership organization (describe) ____________________
- ❍ Other ____________________

7 Is firm formally registered?
- ❍ Yes
- ❍ No
- ❍ Unknown

8 Is respondent male or female?
- ❍ Male
- ❍ Female
- ❍ Don't know

9 Is firm owner/operated?
- ❍ Yes
- ❍ No
- ❍ Unknown

10 Is respondent owner or employee or other?
- ❍ Owner
- ❍ Employee
- ❍ Other ______________________

11 Where is firm headquartered?
- ❍ Nairobi
- ❍ Other ______________________

12 What locations does firm/org work in?

13 What specific sub-counties and locations does firm distribute to?

14 Does firm wholesale, retail, or both?
- ❍ Wholesale only
- ❍ Wholesale primarily but also some retail
- ❍ Retail only
- ❍ Retail primarily but also some wholesale
- ❍ Both equally
- ❍ Other ______________________

15 Is firm part of a chain or franchise?

- ❍ Chain
- ❍ Franchise
- ❍ No

16 If yes, how many outlets does firm operate (i.e. own or franchise)?

17 If wholesaler, how many outlets does it distribute to (including those that it does not own)?

18 How many full-time employees does firm have?

19 Where does firm obtain merchandise from?

- ❍ Direct from importers/manufacturers (Syngenta, Monsanto, etc.)
- ❍ Commercial distributor (specify which distributor and obtain contact info if possible) ____________________
- ❍ Intermediary (indeterminate sources)
- ❍ Agro-input dealer in town (specify name of agrodealer and town) ____________________
- ❍ Other ____________________

20 Are you informed/aware of the issues farmers' face with losing grain they have stored?

- ❍ Very aware/informed
- ❍ Somewhat aware/informed
- ❍ Vaguely aware/informed
- ❍ Not at all aware/informed

21 How severe is the problem of farmers losing grain from storage in the area you work in?

- ❍ Very severe
- ❍ Significant
- ❍ Minor
- ❍ Not a problem at all

22 How severe are the following problems affecting grain losses in storage in the area you work in?? (theft, rats, weevils, LGB, mold, aflatoxins, bad post-harvest conditions, need cash, optimal market, other____)

❍	❍ Click to write Column 1			
	Severe	Signifcant	Minor	Not a problem
Theft	❍	❍	❍	❍
Rodents (rats)	❍	❍	❍	❍
Weevils	❍	❍	❍	❍
LGB/Osama	❍	❍	❍	❍
Mold	❍	❍	❍	❍
Aflatoxins	❍	❍	❍	❍
Bad post-harvest conditions (such as too much rain)	❍	❍	❍	❍
Other	❍	❍	❍	❍
Other	❍	❍	❍	❍

23 Do you currently sell or have you ever sold any on-farm grain/cereal storage products/materials suitable to small-scale farmers' needs? Yes/No (if no go to Q27)

❍	❍ Currently sell or once sold			❍ Year began	❍ Year stopped (if stopped)	❍ Brand	❍ Supplier/source	❍ No. sold past year (e.g. 2013)	❍ Supplier arrangement			❍ Cost/unit in KES				❍ Specify if "other"
	Currently sell	Once sold	No	Answer 1	(leave blank if still selling)	Answer 1	Answer 1	Answer 1	Cash	Consignment	Other	50 kg	90 kg	100 kg	Other size (specify)	Answer 1
Poly-propylene bags	❍	❍	❍						❍	❍	❍					
Sisal bags	❍	❍	❍						❍	❍	❍					
Pre-treated poly-pro bags	❍	❍	❍						❍	❍	❍					
Hermetically sealed bags	❍	❍	❍						❍	❍	❍					
Hermetically sealed tubs/bins	❍	❍	❍						❍	❍	❍					
Metal silos	❍	❍	❍						❍	❍	❍					
Other	❍	❍	❍						❍	❍	❍					

24 For any OFS sold, what is included (I), available for extra (E), or "facilitated" (F) with purchase (i.e. distributor links buyer with organization or someone else to provide the service but doesn't provide it directly)?

❍	❍ Information (e.g. brochure)			❍ Demo			❍ Training			❍ Credit			❍ Delivery ❍ /set-up			❍ Maintenance			❍ Warranty/ ❍ Guarantee			❍ Other (describe)		
	I	E	F	I	E	F	I	E	F	I	E	F	I	E	F	I	E	F	I	E	F	I	E	F
Pre-treated poly-pro bags	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Hermetically sealed bags	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Hermetically sealed tubs/bins	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Metal silos	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

25 What are the typical characteristics of farmers who buy the improved storage solutions?

❍	❍ Describe
	Answer 1
Scale of production (i.e. acres cultivated)	
Commercial vs. subsistence orientation	
New client to distributor?	
Source of financing?	
Any organizational affiliation?	
Motivation for purchase?	
Other salient characteristics?	

26 For each type of improved storage carried, ask:

❍	❍ Storage type 1	❍ Storage type 2	❍ Storage type 3
	Answer 1	Answer 1	Answer 1
Specify type of storage			
What were/have been successes associated with carrying this storage?			
What were/have been problems?			
If you stopped carrying it, why?			
Do you think it is a commercially viable product? Why or why not.			
How do farmers who bought it differ from other farmers (who buy other storage options or don't buy)			
If still carries: Do you intend to continue carrying it? Why or why not?			
If intends to continue, do you plan any changes to how you will source, distribute, market, or price it? Describe.			
Has your arrangement with the supplier of the product worked out? What has worked vs. not worked? Do you feel you have been given adequate incentive/risk protection?			
Do you think the supplier will continue to market through you and similar distributors? Why or why not.			
Do you think the supplier will make any changes to how it sources, distributes, or markets the product? Describe.			

27 Have you ever been asked to sell, or considered selling, any of the above-mentioned storage options but decided against it?

❍ Yes

❍ No

28 If yes, which ones, and what drove your decision? What was your perception of the market (supply and demand) and how did that influence your decision?

❍	❍ Considered carrying?		❍ Why decided against it?
	Yes	No	describe
Pre-treated poly-pro bags	❍	❍	
Hermetically sealed bags	❍	❍	
Hermetically sealed tubs/bins	❍	❍	
Metal silos	❍	❍	
Other	❍	❍	

29 Looking forward, would you consider selling any of the improved types of storage? Which ones and under what circumstances? Who would buy it?

❍	❍ Consider carrying?			❍ If yes or maybe, what is attractive about option?	❍ Under what circumstances would carry?	❍ Who would be best clients? (scale, commercial vs. subsistence orienation, motivation, etc.)
	Yes	No	Maybe	describe	describe	describe
Pre-treated poly-pro bags	❍	❍	❍			
Hermetically sealed bags	❍	❍	❍			
Hermetically sealed tubs/bins	❍	❍	❍			
Metal silos	❍	❍	❍			
Other	❍	❍	❍			

30 Do you have any questions or comments on the topics we've discussed? (If not, thank you for your participation.)

31 Interview end time: ________________

Appendix F: Information needed from farmer survey

1. How farmers store maize
2. Purchases of storage equipment/material
3. Any purchases of AgResults-target storage units
    a. Which ones?
    b. From where/whom?
    c. How many units?
    d. How much paid?
    e. How financed?
    f. What services included in purchase or paid for separately?
        i. Training
        ii. Delivery
        iii. Set-up
        iv. Maintenance
        v. Credit
        vi. Other
4. Who in household is responsible for maintenance of storage unit?
5. Who is responsible for decision of extracting grain for consumption?
6. Who makes decision to extract grain for sale?

Appendix G: Qualitative Farmer Questionnaire

1. Screening questions for selection criteria
    a. What area did you cultivate maize on during the previous main production season?
    b. Did you sell any of the maize that you produced during that season?
    c. In 2013, approximately what share of your household's income came from sale of agricultural products that you cultivated?
    d. Is there a male head of household?
    e. How many kilometres is household located from main road?
2. Enumerator info
    a. Name of interviewer
    b. Date of interview
    c. Interview start time
    d. Interview end time
    e. Was interview sound-recorded?
3. Farm household information
    a. Name of respondent
    b. Gender of respondent
    c. GPS coordinates of farm-household
    d. Location
    e. District
    f. What is place of respondent in household (e.g., male head of household)?
4. Household's storage activities
    a. Who in household is responsible for
        i. Preparation of grain for storage (drying, cleaning, treating with chemicals)?
        ii. Maintenance of storage unit?
        iii. Decision of extracting grain for consumption?
        iv. Decision to extract grain for sale?
    b. How do you currently store maize?
        i. How long have you been storing it this way?
        ii. What drove any recent changes?
        iii. Where did you obtain the maize storage materials/solutions that you currently use?
    c. What alternative means of maize storage do you know of? (have pictures/summary descriptions of AgResults-supported storage)

	Do you know of it? (no, vaguely, in detail, seen in use, have used)	Is it available? If so, from where?	What are benefits?	What are drawbacks?	What does it cost?
On-farm storage					
Poly-pro bags					
Sisal bags					
Metal silos					
Hermetic plastic containers					
Hermetic bags (GrainPro, PICS)					
Other:					
Off-farm storage					
NCPB					
Private storage					
PPP-supported WRS					
Other:					

5. Use of AgResults-promoted storage

For any AgResults storage solutions that respondent has used, ask:

a. When and where did you obtain it?
b. How many units?
c. How much did you pay?
d. How did you finance it?
e. What services were included with the purchase or did you pay for separately?
    i. Training
    ii. Delivery
    iii. Set-up
    iv. Maintenance
    v. Credit
    vi. Other
f. How/from where did you learn about it?
g. What motivated you to purchase it? For example
    i. Reduce post-harvest losses from pests
    ii. More secure from theft
    iii. Tidier, keeps maize cleaner
    iv. Better control over moisture
    v. Easier to use
    vi. Longer-lasting/durability
    vii. Good market price

viii. Available at "promotional" or special price
ix. Recommended by someone trusted

h. How did you reach the decision to purchase the storage unit?
    i. Who discussed it and what were the different opinions expressed? How did that influence the outcome?
    ii. Did you consider any other storage solutions before deciding on that one?
        1. Which ones, and why did you decide against them?
i. How has the storage performed relative to your expectations?
j. If you were to do it over would you purchase it again?
k. Have you or your family benefitted from using the storage? How?
l. Do you store all your maize here? If not, what alternative storage do you use and what do you use maize stored in each for? (e.g., household consumption vs. sale)
m. Have your maize activities changed as a result of getting that storage? How?
    i. Have you made any changes to your maize production activities? (e.g., changing varieties)
    ii. Have you made any changes to your harvest and post-harvest (drying, cleaning, treatment) activities? Which?
    iii. Have your sales and/or purchases of maize changed as a result of this storage? How?
n. What was your experience of purchasing the storage from the distributor you purchased it from (agro-vet, etc.)?
    i. Were you already a client?
    ii. Did the source make you feel more or less confident in the purchase in terms of
        1. That you were making a good decision
        2. That product would be good quality
        3. Confidence that any problems with it would be addressed reasonably
        4. Other
    iii. Was the supplier adequately familiar with the product and its use?
    iv. Was the supplier a good source of information about the unit, or did you rely on information obtained elsewhere?
    v. Overall, what were the benefits of purchasing storage from that source relative to what you would expect from another source?
    vi. What were the drawbacks?
o. Looking forward
    i. Will you continue to use the storage that you purchased? Why or why not?
    ii. Will you purchase more of that storage? Why or why not?

Appendix H: Process analysis template

Time period	Structure	Issues	Resolution
Conception (business plan)			
Start-up			
Year 1			
Year 2			
Year 3			
Year 4			
Year 5			

Appendix I: Stakeholders met during IQA Phase 2

Surname	First name	Type	Institution	Title/Expertise
Akinyi	Margaret	Government	Ministry of Agriculture (Uasin Gishu county)	County Agriculture Officer
Alexander	Corinne	Expert	Purdue / PICS	Grain Marketing
Baributsa	Dieudonne	Expert	Purdue / PICS	Assistant Professor
Berg	Brekke	Expert	One Acre Fund	
Brown	Nick	Potential implementer	AtoZ	
Cheruiyot	Pauline	Farmer		Farmer (Uasin Gishu county)
Chipchoge	Rebecca	Farmer		Farmer (Uasin Gishu county)
Chomba	Peter	Potential implementer	Bell Industries	Sales Representative, Eastern region
Coffi	Hubert	Potential implementer	AtoZ	
De Bruin	Tom	Potential implementer	GrainPro	President/CEO
Gelbert	Jacob Ricker	Expert	Purdue / PICS	Assistant Professor
Gicheru	Joseph	Government	Ministry of Agriculture (Embu county)	County director of Agriculture
Gitonga	Zachary	Expert	CIMMYT	Research Associate
Guantai	Stanley	Pilot Manager	ASI	
Irungu	Johnson	Government	Ministry of Agriculture	Director, Crops Management
Juma	Elijah	Potential implementer	Vestergaard	
Kinyumu	Ephiphanaia	Expert	Tegemeo	Research Associate
Kipsang	Amos	Potential implementer	Bell Industries	Sales Representative, Eldoret
Lowenberg DeBoer	J.	Expert	Purdue / PICS	Professor of Agricultural Economics
Masila	Gerald	Advisory Council member	East African Grain Council	Executive Director
Maulidi	Badi	Potential implementer	GrainPro	Regional Manager Eastern Africa
Mokeyna	Isaac	Partner organization	Caritas Eldoret	Microfinance Project Officer
Mosigisi-Mboya	Priscilla	Potential implementer	GrainPro	Sales Manager
Muremi	Evans	Partner organization	Caritas Meru	
Muriuki	Leah	Potential implementer	Bell Industries	General Manager
Musavi	Francis	Government	Ministry of Agriculture	Post-Harvest Specialist
Mworia	Stanley	Government	Ministry of Agriculture (Meru county)	Deputy Director of Agriculture
Njeri	Lunah	Potential implementer	Bell Industries	Marketing Assistant
Njue	Benjamin	Potential implementer		Metal silo artisan, Meru county
Odera	Johnson	Potential implementer	AtoZ	
Odhiambo	Scholastica	Government	Ministry of Agriculture (Uasin Gishu county)	County Horticulture Officer
Opiyo	Kevin	Expert	Tegemeo	
Owane	John	Expert	Tegemeo	
Sebastian	Wanjala	Pilot Manager	ASI	Team Leader, Kenya On-Farm Storage Pilot
Stathers	Tanya	Expert	Natural Resources Institute (University of Greenwich)	Senior Research Scientist, Food Security Department

Tefera	Tadele	Potential implementer	CIMMYT / metal silos	Effective Grain Storage Project Leader
Wafula	George	Government	Ministry of Agriculture (Uasin Gishu county)	Eldoret East Subcounty Officer
Walker	Sophie	Pilot Manager	ASI	
Wanjohi	Peter	Advisory Council member	Cimbria	Technical Sales Assistant
	Jane	Partner organization	Caritas Eldoret	Officer

Focus group discussions and farmers met		
Location	**Number of farmers**	**Gender composition**
Uasin Gishu County	8	5 men, 3 women
Meru County	12	9 men, 3 women