



AGRESULTS KENYA ON-FARM STORAGE CHALLENGE PROJECT – FINAL REPORT

2014 - 2018

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TABLE OF CONTENTS

INTRODUCTION	1
Project Goals	1
PROJECT THEORY OF CHANGE AND CONTEST DESIGN	2
Theory of Change	2
Selection of Project Regions in Kenya.....	3
Contest Design	4
PROJECT LAUNCH AND IMPLEMENTATION.....	6
Project Launch Issues.....	6
Identification of Competitors.....	6
Competitor Profiles.....	7
Device Eligibility	8
Changes in Competitor Business Models.....	9
VERIFICATION	10
Larger Grain Borer (LGB) Penetration Test	10
Sales Data Verification (Sales Audits)	10
Randomized Rural Household Survey (RRHS) and Market Penetration Surveys.....	11
PRIZE DISTRIBUTION	12
Mid-point Prizes for Rift Valley	12
End-point Prizes for Rift Valley and Eastern Region	12
PROJECT RESULTS AND IMPACT.....	13
Broader Impact on the On-Farm Storage Market.....	14
EVALUATION FRAMEWORK AND ASSESSMENT	14
Evaluation Approach.....	14
Evaluation Findings	14
LEARNING	15
1. Lesson One.....	16
2. Lesson Two.....	16
3. Lesson Three	16
4. Lesson Four	17
CONCLUSION AND LOOKING AHEAD.....	18
APPENDIX.....	19

Secretariat and Evaluator Learning Materials	19
News and Blog Coverage of Kenya On-Farm Storage Challenge Project.....	20

INTRODUCTION

Eastern Africa grows nearly 20% of the grain produced in sub-Saharan Africa, yet the region suffers from post-harvest grain losses that cost about US\$1.6 billion per year. Because many smallholder farmers are not aware of the benefits of on-farm storage and often cannot access it, they are often forced to sell their crops right after harvest. The peak supply period around harvest drives down the market price, reducing potential income. Farmers then must spend valuable resources to purchase maize later in the season. If farmers opt to use traditional methods to store their crops, especially in Kenya, they still run into trouble: They must rely on expensive pesticides, and even so, the grains often fall victim to larger grain borers and other pests.

The AgResults Kenya On-Farm Storage Challenge Project (the “Project”), which ran from 2014 to 2018, used a Pay-for-Results prize competition to motivate private sector competitors to develop, market, and sell on-farm storage devices to smallholder farmers in the country’s Rift Valley and Eastern Regions. By encouraging storage solution companies to promote improved storage solutions to smallholder farmers, AgResults aimed to overcome the hurdle of inadequate storage options and reduce post-harvest loss. With more grain safely stored, farmer households could sell later in the season or store for home consumption, thereby boosting incomes and becoming more food secure.

This final report describes the Project’s goals, approach, results, and lessons learned.

Project Goals

1. To increase smallholder farmers’ incomes by improving their access to storage solutions that safely store maize throughout the year and minimize crop losses.
2. To catalyze a sustainable market for on-farm storage solutions for smallholder farmers in Kenya that allows for potential spillovers as the cost of storage declines through economies of scale.
3. To test an innovative model of engaging the private sector to build linkages with smallholder farmers as the foundation for future delivery of other goods and services.

Overall Project Results

- Nine companies participated from 2014 – 2018.
- Competitors sold total of 1,390,777 improved storage devices.
- Storage device sales created 413,265 MT of improved storage capacity.
- More than 300,000 smallholder farmers benefited from hermetic storage devices.
- Successful companies received \$6.25 million in incentives.
- More than \$4.85 million leveraged in competitor investments

Lessons Learned

- The extent to which competitors have the skills and resources to adapt business models – for example, by investing in distribution networks or targeted marketing – is directly linked to success in an input delivery-focused prize competition.
- Too many restrictions on prize parameters deter competitors from investing in innovation, inhibiting the potential for impact.
- Before launching a prize competition, practitioners should clearly set rules to avoid confusion and subsequent rule adjustments.
- Prize competition periods must be long enough to allow the market to expand and actors to adopt improved business models that can support a sustainable market.

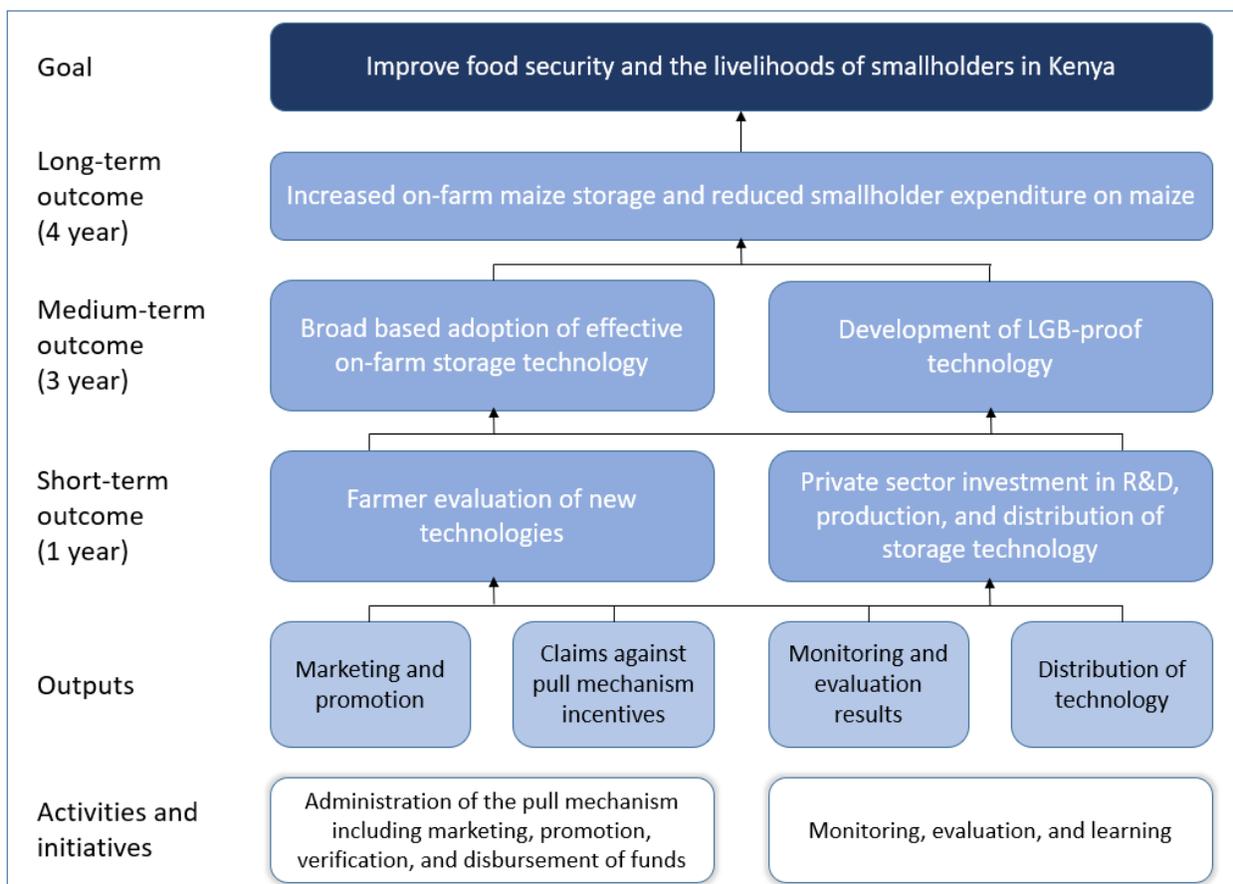
PROJECT THEORY OF CHANGE AND CONTEST DESIGN

Theory of Change

AgResults' broad Theory of Change hinges on the idea that, if appropriately incentivized, the private sector will respond by creating and scaling new technologies to benefit smallholder farmers. Kenya's PFR incentive aimed to spark product innovation and motivate private sector actors (referred to here as competitors) to expand distribution networks and develop tailored marketing to encourage smallholder farmers to use on-farm storage technology. The Theory of Change asserted that as farmers became more familiar with storage devices, such as hermetically sealed plastic bags, plastic tanks, and metal silos, they would be more likely to invest in it to store more grain and reduce post-harvest loss. With more safely stored grain, farmers would not have to purchase as much for household consumption, in turn improving incomes and food security. Healthwise, if farmers could store grain in hermetically sealed devices after harvest, they could avoid applying pesticides that increase the likelihood of health issues for them and their families.

Figure 1 illustrates the full Theory of Change, showing how the specific intervention would result in a series of outputs to achieve the Project's intended outcomes.

Figure 1: Kenya On-Farm Storage Challenge Project Theory of Change



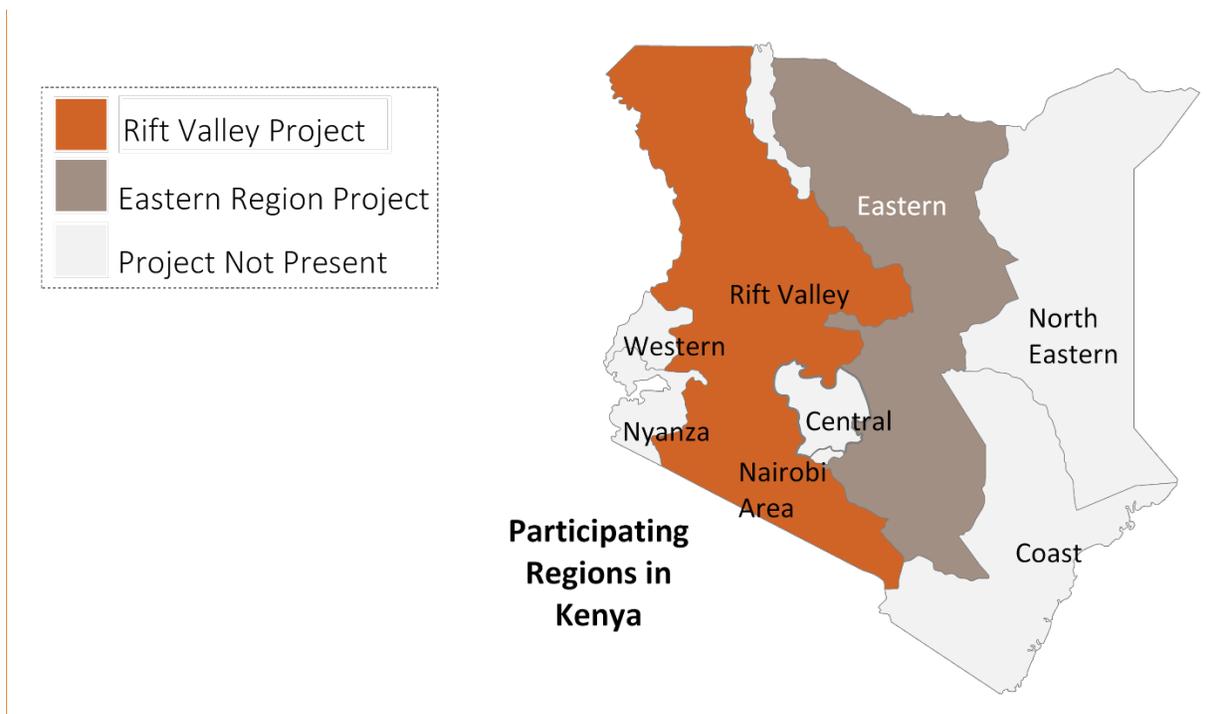
Selection of Project Regions in Kenya

As one of the main grain producers in East and Southern Africa, Kenya was an optimal market for the Project. Kenya has one of the most mature agro-dealer networks in the region; on average, smallholder farmers are within 7km of an agro-dealer. However, despite a strong existing agro-dealer network, the distribution networks have not fully conveyed the benefits of on-farm storage technology to smallholder farmers, limiting widespread adoption.

The Project chose to operate in two regions in Kenya, Rift Valley and Eastern (see Figure 2), each with an established agro-dealer presence but with very different markets. The Rift Valley Region produces approximately 60% of Kenya’s maize — 2 million metric tons each year — much of which smallholder farmers retain for consumption or later sale. Here, storage solution providers would be introducing on-farm storage devices to an area with high potential demand and an enormous potential market.

In contrast, the Eastern Region’s maize production has historically been lower, largely due to high rates of Larger Grain Borer (LGB, *Prostephanus truncatus*) outbreaks. LGBs are small beetles that burrow into stored maize grains to feed and lay eggs, decimating crops. According to the Kenya Agriculture Research Institute, Eastern Region’s arid climate exacerbates LGB infestation rates, and traditional storage methods do little to combat the problem. As such, the Eastern Region provided a market for the Project to test LGB-proof storage solutions. Figure 2 illustrates the Project’s two target regions.

Figure 2: Map of Project Regions



Contest Design

The Project offered two distinct competitions, one in the Rift Valley and one in Eastern region, but they both relied on measuring the amount of storage generated by on-farm storage devices sold to smallholder farmers. In each region, competitors had to sell at least 21,000MT of total storage capacity to qualify for a prize. To determine the amount of total storage provided by a device, AgResults multiplied the device’s annual storage capacity by its useful life — the number of years a device can be used before losing efficacy. For example, the sale of a 90kg bag with a useful life of three years provides 270kg of total storage potential. Figure 3 presents storage thresholds for the Project’s three categories of storage devices.

Figure 3: Total Storage Thresholds by Technology

Storage Device	Annual Storage Capacity	Useful Life	Total Storage Capacity
Hermetic Bags	90kg	3 years	270kg
Plastic Containers	350kg	15 years	5,250kg
Metal Silos	540kg	20 years	10,800kg

The Rift Valley prize, which promoted on-farm storage technology that was not specifically LGB-proof, had two phases: First, AgResults offered a standard prize of US\$750,000 to the first five storage providers that sold enough devices to smallholder farmers to meet the minimum threshold of 21,000 MT of total storage capacity. A second prize totaling US\$1 million would be distributed based on proportional sales to all competitors that met or exceeded the threshold during the full period.

In the Eastern Region, the prize aimed to catalyze innovation for LGB-proof on-farm storage devices. This region featured a single prize of US\$3 million distributed to competitors based on their proportional sales above the minimum threshold of 21,000 MT of total storage capacity. The additional parameters around LGB resistance required on-farm storage devices to pass a technology efficacy test conducted by an expert storage committee.

Figure 4 summarizes the prize structure in both regions while Figure 5 presents the competition activities and timeline.

Figure 4: Kenya On-Farm Storage Incentive Structure

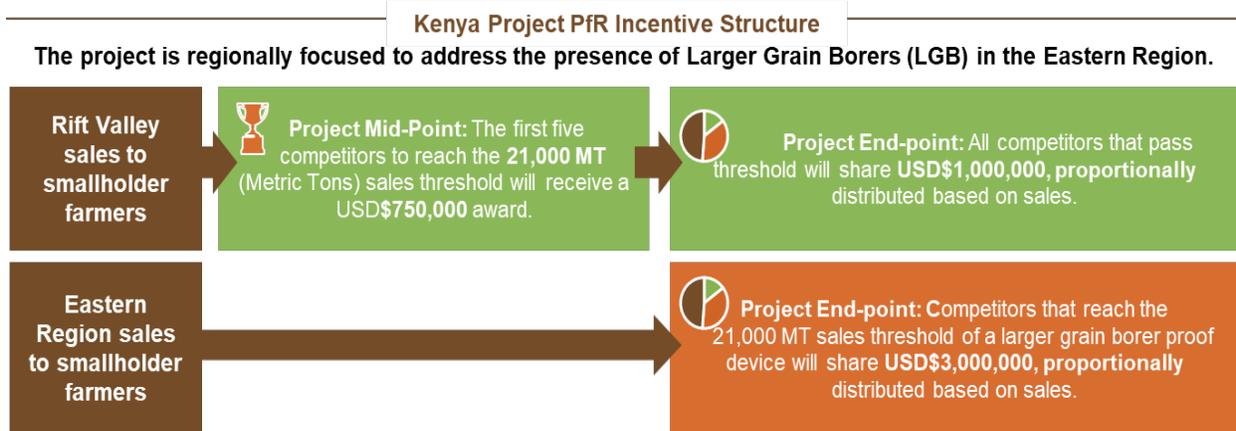


Figure 5: Kenya On-Farm Storage Challenge Project Activities and Timeline

Project Phases	Year 1 (2014)				Year 2 (2015)				Year 3 (2016)				Year 4 (2017)				Year 4 (2018)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Project Start-Up	[Timeline bars for start-up activities]																			
Launch Event (May 29, 2014)	[Timeline bar]																			
LGB Test Design (Dec 2014 - June 2015)	[Timeline bar]																			
RFP/Grant Development (May 2014 - April 2015)	[Timeline bar]																			
Verification	[Timeline bars for verification activities]																			
LGB Test (July 2015 - April 2016)	[Timeline bar]																			
Sales Verification (March 2016 - May 2018)	[Timeline bar]																			
Demographic Survey (June 2017 - Jan 2018)	[Timeline bar]																			
Rift Valley Contest	[Timeline bars for Rift Valley contest activities]																			
Competitor Recruit (April 2015 - Dec 2017)	[Timeline bar]																			
Sales Period (May 2015 - May 2018)	[Timeline bar]																			
Mid-point Prize Awarded (March 14, 2018)	[Timeline bar with money bag icon]																			
End-point Prize Awarded (Oct 30, 2018)	[Timeline bar with money bag icon]																			
Eastern Region Contest	[Timeline bars for Eastern Region contest activities]																			
Competitor Recruit (April 2015 - Dec 2017)	[Timeline bar]																			
Sales Period (May 2015 - May 2018)	[Timeline bar]																			
LGB Test (July 2015 - April 2016)	[Timeline bar]																			
End-point Prize Awarded (Oct 30, 2018)	[Timeline bar with money bag icon]																			

PROJECT LAUNCH AND IMPLEMENTATION

Project Launch Issues

AgResults held the official launch event for the Kenya On-Farm Storage Challenge Project on May 29, 2014, bringing together public and private sector stakeholders, including representatives from eight potential competitors. However, following the event, five significant challenges related to contest rules arose that demanded immediate action. Addressing these challenges pushed back the Project start date to May 1, 2015, shortening the sales period from four to three years:

1. **Government Policies around Prize Competitions under the Kenyan Betting Licensing and Control Board (“BLCB”)** – AgResults discovered that BLCB regulations state that all competitions in Kenya must report unawarded money and cede it to the BLCB. The Project delayed implementation for three weeks until it decided to distribute prizes as performance grants, which did not fall under BLCB jurisdiction.
2. **Larger Grain Borer (LGB) Testing** – The Project assumed that the Kenya Bureau of Standards (KEBS) could conduct testing to verify that the devices were LGB-proof. However, after launch, AgResults learned that KEBS did not have this capacity, and subsequently developed an LGB test in partnership with the Natural Research Institute and International Centre of Insect Physiology and Ecology (*icipe*). Testing began in July 2015 and ran through April 2016, effectively delaying widespread participation in the Eastern Region since most competitors wanted to receive the results before investing in marketing and sales. The “Verification” section below describes the LGB testing process in more detail.
3. **Verification of End-User Sales** – The design assumed that competitors would track sales down to the end user, but the companies did not track beyond their first point of sale to big distributors. To track bags and verify end user sales, the Project developed a market penetration survey, conducted by an independent third party, in February 2015 to identify end users, verify competitor sales, and determine prize eligibility.
4. **Definition of a Smallholder Farmer** – Although the design defined an eligible sale as “a sale to a smallholder farmer,” it had not defined “smallholder farmer.” To avoid misinterpretation before activities began, the Project determined that a smallholder farmer was an individual who cultivates less than 5 hectares (12.5 acres) of land. This definition aligned with the Kenya Agriculture Ministry’s categorization of farmers used at the time as part of its Agricultural Sector Transformation and Growth Strategy.
5. **Maximum Capacity** – The original design set the maximum eligible device size to 360kg and maximum hermetic bag capacity at 90kg. However, before implementation, AgResults increased the maximum device size to 540kg to include larger plastic containers and metal silos. Additionally, based on a fuller understanding of competitors’ existing devices and at their request, the Project increased maximum hermetic bag capacity to 100kg.

Identification of Competitors

After adjusting the prize parameters, the Project assessed the market landscape of grain storage device production to identify and contact possible competitors in March 2015. The assessment, which looked at

Kenyan and international storage device suppliers, revealed very few players in the storage market that were focused on smallholder farmers.

Armed with this information, AgResults issued an Implementer Request for Applications (RFA) to invite interested companies to apply to the competition in April 2015. The RFA explained that competitors needed to increase the demand for improved grain storage technology among smallholder farmers by selling devices that were hermetic and affordable.

Because many companies had not previously engaged in a Pay-for-Results competition, they were initially hesitant to take this risk. To create buy-in and convince competitors that the incentive was real, the Project facilitated ongoing communications between the companies and the Project Manager and Verifier, such as one-on-one meetings, emails, and phone calls.

The Project accepted applications on a rolling basis and received ten applications from 2015 to 2017; by the final year, nine competitors had been accepted.

Competitor Profiles

The nine competitors, including local, regional, and international private sector companies, joined with varying on-farm storage technologies and production capacities. Although all were already developing storage devices, none specifically targeted smallholder farmers. Figure 6 shares the participating companies' profiles and devices.

Figure 6: Kenya Competitor Profiles and On-Farm Storage Devices

Competitors	Profile	Devices
African Farms and Markets Ltd. (AFMA)/GrainPro	AFMA is an agribusiness company that works with smallholder farmers in Kenya to increase income by improving their capacity to trade. To participate in the Project, AFMA entered into a consortium agreement with GrainPro where AFMA would promote, sell, and distribute GrainPro's storage solutions in the targeted regions.	GrainPro SuperGrainBag Farm™ 90kg GrainPro SuperGrainBag IV-R™ 90kg GrainPro GrainSafe Mini™ 250kg
A to Z Textile Mills Ltd.	A to Z Textile Mills, a Tanzanian company established in 1977, manufactures and sells plastic products (hermetic bags, PP woven bags, plastics, bed nets, garments, mineral water, etc.). A to Z joined the competition to expand on-farm storage sales into Kenya, selling two types of their AgroZ Bag, a multi-layered hermetic bag.	AgroZ Bag 100kg AgroZ Bag 50kg
Bell Industries	Bell Industries is an agro-business, health products, and solutions company. Since 1992, the company has sold agriculture inputs, fertilizers, herbicides, and farming machinery to help smallholder farmers in the Eastern Region increase yields and profits. Bell expanded operations to the Rift Valley to participate in the Project.	PICS Bag 100kg PICS Bag 50kg

Corporate Business Forms Ltd. (CBF)/Vestergaard	CBF Limited is a Kenyan supplier and distributor of Vestergaard Products. These two companies partnered to participate in the Project and sell the ZeroFly Storage Bag, an insecticide-incorporated woven polypropylene bag developed for post-harvest storage for smallholder farmers.	ZeroFly Hermetic Storage Bag 100kg
Ekima Engineering Works	Ekima Engineering Works, founded in 2004 and based in Kenya's Eastern Region, trains local artisans to design, fabricate, and market metal silos in Ethiopia, Kenya, Rwanda, Somalia, South Sudan, and Uganda. Ekima produces its custom-sized metal silos for smallholder farmers at a specialized workshop in Machakos.	Metal Silo (Nine sizes ranging from 50 – 540kg)
Elite Innovations Ltd.	Elite Innovations was founded in 2013 in Eldoret, Kenya, as a social enterprise to promote improved grain storage and mitigate post-harvest losses. In 2015, Elite was purchased and became a commercial business. Elite joined the Project to sell its hermetic Elite Bags to smallholder farmers.	Elite Bag Heavy Duty 100kg Elite Bag Light Duty 90kg Elite Bag Light Duty Double Layer 90kg
Kentainers Ltd.	Kentainers is a leading manufacturer of polyethylene roto molded products in Eastern and Central Africa to improve water management, food production, and storage for rural and urban consumers. To participate in the competition, they adapted their plastic water tanks and developed a plastic GrainSilo.	GrainSilo 380kg
Kenya Promotion and Marketing Company (KPMC)	KPMC is a value chain service provider that collaborates with private and public sector players to address smallholder farmer needs. The company sells their Grain Storage Bag (GSB), a multi-layer polyethylene bag, across East Africa. Prior to the Project, KPMC sold approximately 80,000 bags through Ministry of Agriculture programs.	KPMC GSBL 90kg KPMC GSBL 60kg
Post Harvest Africa	Post Harvest Africa is a Kenyan private enterprise that targets smallholder farmers across Africa. They sell Grainz bags, hermetic grain storage devices that require no pesticides, so food is free of chemicals and insects.	Grainz bag 100kgs

Device Eligibility

All devices had to meet these technological and logistical parameters to qualify for the competition:

- Increase the length of time grain could be safely stored compared to traditional storage methods
- Not exceed the maximum 540 kg storage capacity
- Be easy for smallholders to use and suitable for storing crops for individual consumption
- Prevent insects and other storage pests from damaging the stored grain
- Prevent increased infestation of pests from outside the container during a reasonable storage life of the crop (approximately 4-6 months)
- Not cause any adverse effects on crop quality

- Be approved by the Kenyan government, including the Kenya Bureau of Standards (KEBS) and, as applicable, the Pest Control Products Board (PCPB)
- Prevent LGB penetration and eliminate infestation as determined by LGB-proof testing (only in the Eastern Region given LBG infestation challenges in that area as explained in the “Selection of Project Regions in Kenya” section)

Changes in Competitor Business Models

Competitors quickly realized that to sell enough devices to qualify for a prize, they would need to adapt their business models to better reach and retain smallholder farmers as customers. By expanding their distribution networks, competitors could incorporate targeted marketing to reach smallholder farmers and drive up adoption of on-farm storage devices.

Before they joined the Project, most competitors used one or two distribution channels to sell their devices — either big distributors, agro-dealers, or direct sales to farmers. However, it became clear that they would not achieve the high sales thresholds by relying only on existing channels, so they began adjusting their approach.

First, many competitors began deprioritizing big distributors, who demanded large margins but did not sell enough devices to smallholder farmers. Instead, they focused on sales representatives or field staff and agro-dealers, who already had established ties to smallholder farmer groups. The distribution channels, summarized in Figure 7, also enabled competitors to more efficiently replenish their stocks.

Figure 7: Competitor Distribution Channels

Distribution Channel Overviews	
Distributors	Large aggregators of various agro-inputs in the big urban centers sell devices to downstream smaller distributors (agro-dealers or agro-vets) in rural areas, and sometimes to the farmer. Distributors often require high profit margins from Implementers, up to 25%.
Direct Sales to Farmers	This entails by-passing all the distribution chain intermediaries and selling directly to the end-user. Direct selling is used by start-ups and smaller companies like Elite; However, for bigger companies like Bell, this selling method is rarely cost effective or feasible.
Agro-dealers	Agro-dealers, or agro-vets, are smaller Distributors spread across the counties. Agro-dealers are the last point of sale as they are closest to the farmer. There are over 10,000 agro-dealers in Kenya.
Sales Representatives/Field Staff	These are Implementer-hired staff who act as proxy ‘Distributors’. They mainly liaise with agro-dealers to assess demand and stock levels in the field and ensure agro dealers are amply supplied with devices. In addition, they carry out farmer and agro dealer sensitization and trainings
Commercial Villages	AFMA uses a “Commercial Villages” model developed and prescribed by the parent company, Farm Concern International.

Second, as they expanded distribution channels, competitors reached more smallholder farmers and began to develop tailored marketing for that group. They offered farmer sensitization training to agro-

dealers as well as training to farmers on use and benefits of hermetic storage devices. Such efforts cemented relationships between farmers and storage providers, driving up awareness and sales.

VERIFICATION

All AgResults projects include a verification process to determine if competitors meet the prescribed requirements to qualify for a prize. In Kenya, AgResults used three verification processes to qualify devices for the contest and to validate direct sales to smallholder farmers: the LGB penetration test, sales data verification (sales audits), and market penetration surveys.

Larger Grain Borer (LGB) Penetration Test

In the Eastern region, only companies whose grain storage devices passed LGB-proof standards could register for the competition. Because no such standard existed in Kenya, the Project commissioned and conducted independent tests.

In November 2014, with the support of International Centre of Insect Physiology and Ecology (*icipe*) and the Natural Resources Institute (NRI/University of Greenwich), the Project developed standardized procedures to assess the efficacy of different storage devices. An NRI storage expert helped design and implement the trials, acting as a scientific advisor and monitor, while the *icipe* post-harvest team conducted the tests. *icipe* selected 13 storage devices to participate in the LGB tests, which ran from July 2015 to April 2016, and involved three sets of experiments:

- **Insect Damage Trial:** Testing the efficacy of 13 storage devices to protect grain seeded with LGB and *Sitophilus* weevils from further damage during a 24-week storage period
- **Penetration 1 Test:** Testing whether LGB or *Sitophilus* could penetrate the storage device material over a 2-4-week period. This experiment involved placing discs of the storage device into small areas and adding test insects.
- **Penetration 2 Test:** Testing whether insects released outside a life-size storage device full of maize grain would penetrate the device within a 4-week period. Insects were released into test boxes that housed the devices.

Sales Data Verification (Sales Audits)

In addition to LGB testing, the Project contracted an independent sales verifier that performed quarterly sales reviews to validate and confirm competitors' self-reported sales. These reviews determined which companies were eligible for the prize and measured the competition's overall impact.

Competitors had to use a sales reporting template to track and report monthly sales data to AgResults, including information on:

- Total sales disaggregated by storage device
- Total sales disaggregated by region (Rift Valley or Eastern) and by county
- Number of returned, refunded, or unsold devices originally reported in previous periods

Sales verification would confirm that self-reported numbers were accurate, commercially verified, and devoid of subsidies. The verification also confirmed that prize payments were correct, mitigating the risk of paying a prize based on misstated or fictitious sales. Sales audit activities included:

- 100% examination of sales data and underlying documentation

- Testing of business control processes
- Visits to distributors along the supply chain
- Visits to farmers who had bought and were using storage devices
- Mystery shopper procedures

The Sales Verifier performed eight Sales Audits, each of which took 4-6 weeks. In the initial sales reports, the verifier determined that the highest percentage of ineligible sales reported by competitors were due to outstanding payments. Prior to the Project, the competitors had not been monitoring outstanding payments, but following the verifier’s initial reports, they began tracking and clearing these payments. Most of the ineligible sales identified were cleared once payments were received.

Overall, more than 91% of the sales reported were deemed eligible. The 9% that were deemed ineligible were due to duplicated sales, sales outside the project region, lack of supporting documentation, and no distributor sales information. All competitor-reported sales were deemed accurate with no cases of fraudulent activity detected.

Randomized Rural Household Survey (RRHS) and Market Penetration Surveys

Because only sales to smallholder farmers qualified for a prize and competitors could not track sales down to the consumer, the Project had to develop a methodology to estimate the percentage of on-farm storage devices sold to farmers. Unfortunately, no disaggregated census data existed to determine how many smallholder farmers lived in each region, forcing AgResults to gather this data directly.

To determine the proportion of sales to smallholder farmers in each region, AgResults engaged a firm to conduct a randomized demographic rural household survey (RRHS) and two market penetration surveys. These studies would calculate the percentage of devices purchased by smallholder farmers. The Project could then apply that percentage to the total audited sales reported by each company.

Randomized Rural Household Survey

- Conducted in October 2017
- 5,647 households across 14 countries surveyed (99.7% response rate)
- 89% of target county population were smallholder farmer households
- 91.2% of storage devices purchased by smallholder farmers

The complexity of the survey design and ongoing political events — primarily the Kenyan presidential election — delayed the RRHS: Although the Project finalized the survey in July 2017, it was conducted only in October 2017. The RRHS had two objectives:

1. Establish the proportion of smallholder farmers in the 14 targeted counties; and
2. Estimate the number of eligible grain storage devices purchased by smallholder farmers at the time of the survey.

The firm collected data on 5,647 households across 14 counties, with a 99.7% response rate. The RRHS determined that smallholder farmer households made up 89% of the population in the targeted counties, and they purchased 91.2% of all devices. These results indicated that the devices were predominately purchased by smallholder farmers.

Once the RRHS data confirmed that on-farm storage devices were being sold primarily to smallholder farmers, AgResults determined that the two planned large market penetration household surveys were no longer needed.

PRIZE DISTRIBUTION

Mid-point Prizes for Rift Valley

Because the RRHS and Sales Audits took longer than expected, the mid-point prize for the Rift Valley was postponed from November 2017 to March 2018. At the award ceremony in Nairobi, Kenya, on March 14, 2018, AgResults presented \$750,000 each to three companies that reached the 21,000MT total storage capacity threshold: A to Z Textile Mills Limited, Bell Industries, and Elite Innovations. The Project was prepared to award five individual \$750,000 prizes, but two prizes remained unawarded.

End-point Prizes for Rift Valley and Eastern Region

On May 1, 2018, the Project’s full sales period ended, and the final sales verification confirmed results in Rift Valley and the Eastern Region. On October 30, 2018, the Project awarded the end-point prizes totaling \$4 million to three companies that reached the threshold — A to Z Textile Mills Limited, Bell Industries, and Elite Innovations. Although these competitors used different tactics (see Figure 8 below), they shared one underlying strategy: They were willing to dedicate skills and resources to adapt their business models, investing in distribution networks and targeted marketing so they could increase sales to the target smallholder farmer population. Lesson One in the Learning section explores why this willingness to make drastic operational changes and an appetite for risk set these three participants up for success in an input delivery-focused prize competition.

Figure 8: Successful Competitor Profiles

Competitor	Tactics Used to Reach Sales Threshold
A to Z Textile Mills Ltd.	<p>Investments: Purchased a new hermetic bag production line in Arusha to compete in the Project. Heavily invested in marketing and distribution (launch, radio ads, vehicle purchases for agronomists, etc.).</p> <p>Distribution: Initially focused on direct sales to smallholder farmers but then started using agro-dealer networks and sales agronomists to expand reach.</p> <p>Marketing and Sales: Established over 400 agro-dealer linkages in 36 counties since October 2015. Employs 11 sales agronomists equipped with vehicles.</p>
Bell Industries	<p>Investments: Expanded manufacturing capacity by opening a new production facility to increase their annual production.</p> <p>Distribution: Initially used big distributors but expanded to smaller distributors to boost sales, increasing distribution outlets from 30 to 144 in 2016.</p> <p>Marketing and Sales: Used mass media, mainly radio/TV ads, and expanded coverage from three to eight sales representatives.</p> <p>Other: Was an early market entrant (pre-AgResults) and relied on brand name recognition associated with PICS bags.</p>

Elite Innovations Ltd.	<p>Investments: Attracted startup investments to expand their business and participate in the Project.</p> <p>Distribution: Initially sold directly to farmers and hired three sales representatives and sales agents on commission who sold directly to farmers. Incorporated agro-dealers to work with sales representatives, growing from three agro-dealers in 2015 to more than 1,000 in 2018.</p> <p>Marketing and Sales: Attended trade fairs and organized group meetings to reach smallholder farmers directly.</p> <p>Other: Initially operated as a community-based empowerment group in North Rift Valley and became a commercial business in 2015.</p>
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PROJECT RESULTS AND IMPACT

During the sales period from May 1, 2015 to May 1, 2018, competitors sold 1,390,777 improved storage devices, generating 413,265 metric tons (MT) of improved storage capacity for smallholder households. The successful companies received a total of US\$ 6.25 million in incentives.

Sales varied across the 14 targeted counties in the two Project regions: The participating companies initially focused on areas with higher farmer awareness of on-farm storage and slowly expanded to other areas that had lower penetration rates. Understandably, competitors sold more devices where they had established networks and brand recognition. Figure 9 provides a detailed breakdown of sales by region and county.

Figure 9: AgResults Kenya Hermetic Device Sales (May 2015 – May 2018)

AgResults Kenya On-Farm Storage Project: Hermetic Device Adoption to Smallholder Farmers May 2015 through May 2018			
Region & County	Total hermetic devices sold	Total MT of Improved Storage	% of Region Sales
Eastern	662,118	196,236	
Embu	115,749	34,687	18%
Kitui	77,259	22,988	12%
Machakos	303,721	89,901	46%
Makueni	67,374	19,592	10%
Meru	98,015	29,068	15%
Rift Valley	728,659	217,029	
Baringo	24,681	7,502	3%
Bomet	11,328	3,370	2%
Kericho	87,286	25,846	12%
Laikipia	13,639	4,020	2%
Nakuru	145,916	43,703	20%
Nandi	101,644	30,398	14%
Narok	5,746	1,674	1%
Trans Nzoia	125,060	37,256	17%
Uasin Gishu	213,359	63,262	29%
Grand Totals	1,390,777	413,265	

Broader Impact on the On-Farm Storage Market

By promoting and selling storage devices, the participating companies improved the landscape of the on-farm storage market in Kenya with marked economic, health, and business impacts. The economic impact of limiting post-harvest loss was significant: 413,265 MT of improved storage translates to approximately 4.6 million 90-kilogram bags of maize safely stored after harvest. Ordinarily, up to 20% of that maize might have been lost due to pest damage. Using a 12-20% loss range and assuming a market price of KES 2,500 per bag, sales of the improved devices created between KES 1.38billion – KES 2.3billion in savings.

Beyond the economic impact, farmers saw a perceived health benefit from on-farm storage because the hermetic devices reduced the amount of pesticide they had to apply. Farmers were used to applying pesticides to their grains three to four times per season, a practice that left traces of toxic materials during consumption. With high-quality hermetic devices, this was no longer necessary.

In addition, the Project positioned storage providers to create critical business linkages that have laid the foundation for long-term use of hermetic devices. By building relationships with agro-dealers and sales representatives in targeted counties, competitors ensured that hermetic storage devices will continue to be available close to smallholder farmers. This easy access will cement local demand and enable farmers across Kenya to adopt hermetic storage as a standard practice.

EVALUATION FRAMEWORK AND ASSESSMENT

In parallel to project implementation, Abt Associates, in partnership with Denise Mainville Consulting, serves as the External Evaluator for AgResults. The evaluator employs a common framework to examine how each Challenge Project incentivizes the private sector to overcome market failures and improve smallholder farmer welfare.

Evaluation Approach

In Kenya, the evaluator designed a mixed methods evaluation to answer questions as described in the [evaluation design report](#). To assess the Project's impact on the improved on-farm storage device market, the evaluator used qualitative approaches and descriptive analysis of project monitoring data. To estimate the Project's impact on adoption of on-farm storage devices, the evaluator used an interrupted time series design. Finally, to estimate the impacts of adoption on other smallholder farmer outcomes, such as income and food security, the evaluation team used a difference-in-differences impact evaluation design. This approach allowed them to compare the outcomes of adopters of the technology with a matched group of non-adopters before and after the Project.

Evaluation Findings

The evaluation revealed the following key findings and lessons:

- **Development of the market for improved on-farm storage:** The Project created an emerging market for improved on-farm storage: Six competitors made qualifying sales, although three large firms dominated the market at end line. Although some of these firms were already active in the market before the Project began, the successful competitors all ramped up their distribution and marketing substantially during the competition, creating a more robust market at end line.
- **Impacts on adoption of the technology:** Smallholder farmer adoption of the technology was substantial. Compared to models of what would have happened in the Project's absence, the evaluation revealed that the Project likely increased adoption by 23 percentage points in the

Eastern Region (with a total of 28% of farmers reporting that they had adopted on-farm storage devices) and six percentage points in Rift Valley (with a total of 10% of farmers reporting they had adopted on-farm storage devices). Although the interrupted time series design cannot definitively determine causality, these findings strongly suggest that much of the uptick in adoption was likely due to AgResults.

- **Impacts on smallholder farmers:** Although the overall rate of adoption of on-farm storage technology was high, other effects at the smallholder farmer level were muted. The evaluation did not find an impact on farmers' expenditures on maize for consumption. However, it revealed that adopters of improved on-farm storage increased their maize sales revenue by nearly US\$2 per year. Multiplying this increased revenue by the total number of new adopters who likely adopted the technology because of the Project, the evaluation team estimates US\$368,195 in overall economic benefits. The most substantial impact was a 36 percent point reduction in farmers' pesticide use. In other words, adopters appeared to switch storage technology habits from polypropylene bags and pesticide dust to improved on-farm storage. Many farmers said they preferred the new technology over pesticide dust for several reasons: The dust was more laborious to apply, it left a taste after storage, and farmers feared it could negatively impact health (although evidence on health impacts is lacking). Over their lifetime, the cost of improved on-farm storage is roughly equivalent to the combined cost of polypropylene bags and pesticide dust, so there does not appear to be a net economic benefit of the Project other than the small increase in maize revenue.
- **Cost-effectiveness:** Cost-effectiveness is the measure of cost per unit of impact — in this case households reached and metric tons of storage of devices sold. The cost per household reached was US\$39, while the cost per metric ton of storage sold was US\$25.
- **Sustainability:** The supply and demand conditions at end line strongly indicate that the market will be sustained. Furthermore, conversations with on-farm storage providers demonstrate they are optimistic that product demand will remain strong and they are keen to continue participating in this market.

Complete findings are available in the evaluation's baseline and final reports (final report forthcoming).

LEARNING

The Project illuminated four main lessons on how a PfR prize competition can succeed and what can help or hinder competitors. This section explores those lessons in more detail.

Key Lessons Learned

1. The extent to which competitors have the skills and resources to adapt business models – for example, by investing in distribution networks or targeted marketing – is directly linked to success in an input delivery-focused prize competition.
2. Too many restrictions on prize parameters deter competitors from investing in innovation, inhibiting the potential for impact.
3. Before launching a prize competition, practitioners should clearly establish and communicate rules to participants to avoid confusion and subsequent rule adjustments.
4. Prize competition periods must be long enough to allow the market to expand and actors to adopt improved business models that can support a sustainable market.

1. Lesson One

The extent to which competitors have the skills and resources to adapt business models – for example, by investing in distribution networks or targeted marketing – is directly linked to success in an input delivery-focused prize competition.

Design Assumption: All competitors, regardless of size, would be able to compete with the potential to reach the sales thresholds and qualify for a prize.

What We Learned: When the Project began, all competitors were already selling on-farm storage devices, but only those that heavily invested to adapt their business models to reach smallholder farmers achieved the prize sales threshold. To increase sales to the target smallholder farmer population, competitors had to develop a new approach to target and access this group — raising awareness of the benefits and highlighting the quality and hermetic capabilities of their devices. They needed to transform their business models to reach a new consumer group who were unwilling to travel more than 5km to purchase storage solutions, especially new, unfamiliar devices.

To not only reach but also secure farmers as customers, storage providers had to expand into multiple distribution channels and invest in marketing campaigns that specifically targeted this group. Such drastic operational changes demanded higher investments as well as an appetite for risk and a willingness to diversify. Of the nine participating companies, only three succeeded in making the necessary changes and investments to sell enough devices to qualify for prizes within the three-year sales period.

2. Lesson Two

Too many restrictions on prize parameters deter competitors from investing in innovation, inhibiting the potential for impact.

Design Assumption: Defining an eligible sale in the following way would be feasible for competitors to achieve: An eligible sale is an on-farm storage device sold to smallholder farmers in the Rift Valley or Eastern Region that is LGB-proof and has a storage capacity of less than 540kg.

What We Learned: As the competition progressed, AgResults learned that the original eligibility requirements were so constraining that some companies did not see the benefit of competing for the prize. The prize design required competitors to sell a high number of hermetic on-farm storage devices; simultaneously, they had to meet several other product and geographic requirements. Setting parameters around LGB resistance and storage capacity forced companies to take more time during production to modify their devices. In the Eastern Region, competitors had to first pass the Project's LGB test to prove the devices were pest-resistant. This requirement left less time for them to sell to farmers. Furthermore, restricting the Project to two regions in Kenya made it difficult for the competitors working in other parts of the country to move their operations to the target regions. Several companies did not do so because it was simply too big of a risk to take. These requirements made it difficult for certain competitors to participate and benefit from the PfR prize during the three years.

3. Lesson Three

Before launching a prize competition, practitioners should clearly establish and communicate rules to participants to avoid confusion and subsequent rule adjustments.

Design Assumption: The Kenya Bureau of Standards (KEBS) would have the capacity to regulate product standards and verify product quality, both of which were critical to determining prize allocation.

What We Learned: Following launch, KEBS indicated that it did not have LGB standards in place or the capacity to conduct the LGB testing required for the Eastern Region competition. As a result, the Project had to create and conduct its own tests before fully accepting companies into the Eastern Region competition, delaying activities.

While the tests took place in 2015 – 2016, competitors could still sell devices, but only sales of devices that passed the ongoing test counted toward the prize threshold. During the testing period, competitors could not confirm that their devices qualified for the prize. The uncertainty caused four of the six Eastern competitors to wait for the LGB test results before they invested in the competition, delaying broad participation by more than a year.

In contrast, if the Project had finalized the rules and determined KEBS' ability early on, storage providers would have had a much clearer picture of the overall requirements. This would have delayed Project startup by at least one year but would have avoided the cascading effects that stifled participation. Rather than having to react in the moment, the competitors could have planned their approach more strategically. A thoroughly vetted design process — for example, confirming stakeholders' capacity prior to implementation — can go a long way in clearly defining rules and creating a straightforward competition.

4. Lesson Four

Prize competition periods must be long enough to allow the market to expand and actors to adopt improved business models that can support a sustainable market.

Design Assumption: The four-year sales period would give competitors enough time to meet and exceed the sales threshold in one or both regions.

What We Learned: Several challenges around prize parameters and government policies delayed the beginning of the sales period by a year and limited competitors' ability to fully develop and execute improved business models. The original design planned to give companies four years to reach the sales threshold, but issues that arose immediately after launch shortened the sales period to three years. With less time, competitors struggled to enact key changes to their business models to properly reach smallholder farmers, a consumer group they were not used to pursuing. Attracting investments, establishing new distribution networks, and investing in marketing and promotion were critical strategies that all took time to develop and execute.

At the end of the Project, several competitors expressed their desire to extend the sales period because it took time to find investors and establish relationships with the right distribution channels. With additional time, some of these competitors may have reached the sales threshold and received a prize. Future prize competitions should build calendars that allow for potential adjustments that do not reduce the time competitors have to develop and hone their approaches.

CONCLUSION AND LOOKING AHEAD

From 2014 to 2018, the AgResults Kenya On-Farm Storage Challenge Project engaged private companies across the country through a PfR prize competition, encouraging them to develop, market, and sell on-farm storage devices to smallholder farmers in the Rift Valley and Eastern Regions. During the three-year sales period, the Project advanced the Theory of Change by incentivizing nine competitors to sell 1,390,777 on-farm storage devices and transform the on-farm storage market in Kenya. The Project illustrated that in the right conditions, a prize can significantly shape a market for a proven technology and smallholder farmers are indeed a profitable consumer base.

The Project increased interest in the sector among competitors who are expanding their operations not only throughout Kenya but also throughout Africa. The learning and achievements of the Project have also increased interest in implementing similar contests in different locations. As was the case in Kenya, these contests could work on reducing post-harvest loss by encouraging the private sector to sell on-farm storage devices to smallholder farmers – spurring new relationships and transforming entire markets.

Results and Observations

- **Prizes:** Three companies were awarded \$6.25 million for sales in Rift Valley and Eastern Region of Kenya.
- **Adoption of On-Farm Storage:** Nine companies sold 1,390,777 hermetic storage devices, creating 413,265 MT of improved storage capacity.
- **Impact on Post-Harvest Loss:** Approximately 4.6 million 90-kilogram kg bags of maize were safely protected from pests, avoiding normal 12-20% post-harvest loss.
- **Future of the Market:** Competitors built key linkages with local agro-dealers and representatives to strengthen networks to reach smallholder farmers and cement demand.

APPENDIX

Secretariat and Evaluator Learning Materials

Secretariat	
Kenya Randomized Rural Household Survey Final Report (January 2018)	<p>This report from January 2018 presents the findings from a Randomized Rural Household Survey (RRHS) conducted in 14 counties of Kenya as part of the AgResults Kenya On-Farm Storage Challenge Project. The RRHS aimed to understand the proportion of smallholder farmers living in those 14 counties where the project worked and to estimate the number of on-farm storage devices purchased by those farmers.</p>
Cost versus Complexity in Pay-for-Results Prize Verification: Lessons from the Kenya On-Farm Storage Challenge Project (March 2018)	<p>How do you design an effective approach to project verification in a Pay-for-Results project? This Lessons Learned article explains how the Kenya On-Farm Storage Challenge Project ran into challenges with its original verification structure and course-corrected using survey data.</p>
Incentivizing Affordable On-Farm Storage for Smallholder Farmers in Kenya (September 2018)	<p>This presentation from the Scaling Up Conference at Purdue University in September 2018 explores how private sector companies participating in the Kenya On-Farm Storage Challenge Project employed different tactics to increase smallholder farmers' access to and use of on-farm storage devices.</p>
The Kenya On-Farm Storage Pay-for-Results Contest: Competitor Responses and Perspectives (March 2019)	<p>Which factors empowered private sector companies to develop, market, and sell on-farm storage devices to smallholders in Kenya? Which factors hindered others' success? This Lessons Learned article explores the perspectives of those competitors who participated in the Kenya On-Farm Storage Challenge Project.</p>
Evaluator	
Evaluation Design: Kenya On-Farm Storage Challenge Project (June 2014)	<p>The Kenya On-Farm Storage Challenge Project's evaluation design report lays out the approach to assess whether the project stimulates a smallholder-inclusive market for improved on-farm storage devices. Evaluators assess impact on the market using a structure-conduct-performance framework. To evaluate resulting smallholder benefits, the report describes a short-interrupted time series design.</p>

Evaluation Baseline Report: Kenya On-Farm Storage Challenge Project (April 2015)	<p>This report presents baseline findings for the Kenya On-Farm Storage Challenge Project based on survey data from 4,765 farming households and extensive qualitative data. It describes low uptake of improved on-farm storage at baseline but identifies latent demand in the market. The report also describes farmers' maize revenue and food security.</p>
Evaluator Lessons Learned #2: Pull Mechanisms for Overcoming Market Failures in the Agriculture Sector (November 2017)	<p>Pull mechanisms require a solid understanding of the market and the motivations of the private sector. This November 2017 brief, with examples from AgResults' work in Kenya, provides guidance for development practitioners interested in incorporating pull mechanisms in their own work.</p>
Project Manager	
AgResults Kenya On-Farm Storage Challenge Project: Summary Report (December 2018)	<p>Written by Tanager, the Project Manager for the Kenya On-Farm Storage Challenge Project, this report summarizes the objectives, approach, and achievements of the project, which aimed to encourage sales of on-farm grain storage devices to smallholder farmers.</p>

News and Blog Coverage of Kenya On-Farm Storage Challenge Project

- [Expert Analysis: Three Insights Implementing Prize Competitions in Zambia and Kenya \(April 22, 2019\)](#)
- [Development Experts Convene to Discuss Pay-for-Results Experiences in Dynamic “Power Talks” Event \(April 11, 2019\)](#)
- [Private Sector Leverages Technology and Distribution to Improve On-Farm Storage for Smallholders \(October 31, 2018\)](#)
- [Debating the Efficacy of Pull Mechanisms at DFAT’s InnovationXchange \(March 8, 2018\)](#)
- [Kenyan Elections and Unrest Hinder Sales but Do Not Impede the AgResults Pilot \(December 7, 2017\)](#)
- [New On-Farm Storage Devices Sold in Kenya Pilot \(September 8, 2017\)](#)
- [DFID Investment Priorities Blog \(September 8, 2017\)](#)