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Evaluation Findings: Kenya On-Farm Storage Challenge Project

This brief presents findings from the second completed evaluation of an AgResults challenge project. It describes how the project helped to create an emerging market for improved on-farm grain storage devices and discusses the project's impact on smallholder farmers. In addition, it presents data on the project's cost-effectiveness. Finally, it provides three high-level lessons learnt.

Challenge project objective and theory of change

The AgResults challenge project was designed to create a sustainable market for improved on-farm storage (OFS) devices in Kenya. The project rewarded private sector companies ('competitors') for selling these devices to smallholder farmers. Improved OFS devices are designed to reduce post-harvest loss of grain due to pests and spoilage during storage. The project's business plan estimated that Kenya's farmers lose up to 25% of their maize during storage, though post-harvest loss estimates in the literature vary from single digits to 40%.

In Kenya, as in many other countries, there was a 'missing market' for such OFS devices prior to the AgResults initiative. In other words, both demand for and supply of these devices was low, despite the apparent benefit of the devices to farmers and the apparent business opportunity for the private sector to supply these devices. On the supply side, before the project, improved OFS suppliers had limited

Key Findings



Market: AgResults catalyzed the development of an emerging OFS market, with market share heavily concentrated among three 'frontrunners'.



Uptake: AgResults had a large and statistically significant positive impact on adoption of improved on-farm storage in Kenya.



Income: The evaluation found a modest but statistically significant impact of adoption on maize sales revenue: \$1.69 per household per year.



Food security: Adopters were significantly less likely than non-adopters to use pesticides in stored maize and less likely to lose maize during storage. The evaluation found no impact on the amount of maize purchased for consumption.



Cost-effectiveness: The project cost donors \$25 per metric ton of capacity sold to smallholders and \$39 for each smallholder household that adopted the technology. The cost per unit of impact was higher in Eastern than in Rift Valley.



Sustainability: The market for improved OFS devices is likely to sustain, given farmer demand and competitors' stated eagerness to continue. However, donor and government subsidies could crowd out private sector investment.

distribution networks to make OFS technologies available to smallholder farmers, and development of effective market-based distribution systems was costly. On the demand side, farmer awareness of improved OFS was limited, and the devices were more expensive than the polypropylene bags most farmers used. Both the supply and demand constraints represented significant barriers to entry for private sector actors interested in supplying improved OFS devices to smallholder farmers.

The AgResults challenge project aimed to address this market failure by introducing a pay-for-results prize that would reward competitors for selling improved OFS devices to smallholder farmers. The prize was expected to motivate private sector investment in the market for OFS solutions. The theory of change was that the prize would spur competitors to engage in development, distribution, financing, and awareness-creation activities, leading to a robust market for OFS in Kenya that would continue following the project.

The project worked in two Kenyan regions (Eastern and Rift Valley). In the Rift Valley region, the prize had two components: a mid-point prize and an end-of-project prize. The first five competitors to sell a targeted amount of storage capacity each got a US\$750,000 prize. Then, all competitors whose sales exceeded the targeted amount got a share of a US\$1 million prize distributed proportionally based on the amount of storage sold. In the Eastern region, the project's criteria for eligible devices were stricter because of the higher prevalence of the large grain borer, a particularly destructive pest. All competitors whose devices qualified and that met the sales target got a share of US\$3 million, distributed proportionally based on the amount sold.



The external evaluators assessed the project's impact on the market for improved on-farm storage devices, examples of which are pictured here.

The challenge project's designers expected to realize the following objectives:

- **Market impact:** Encourage firms to generate at least 172,000 metric tons of storage capacity, increase market penetration of improved OFS to 18% in the Rift Valley region (i.e., with 18% of smallholder farmers adopting the technology) and 6% in the Eastern region, and create a market for improved OFS.
- **Smallholder impact:** Create US\$14 million in smallholder benefits. The project designers envisioned creating benefits by reducing smallholder farmers' loss of grain during storage, avoiding the use of pesticide on stored grain,¹ and reducing incidence of aflatoxin.² Benefits were also expected to come from reducing expenditure on maize purchases, because farmers would not need to purchase grain for consumption before harvest when retail prices are higher, and increasing income by allowing farmers to store grain for longer and sell when prices were higher.

¹ It was outside the evaluation's scope to assess pesticide dust's health impacts. Pesticide dust is approved for sale in Kenya for use on grain to be eaten, and the evaluation team is not aware of evidence of negative health impacts when used correctly. However, our research revealed a widespread belief among farmers that pesticide dust carries health and safety risks. Farmers also reported that it adds an undesirable taste to the grain.

² The evaluation did not assess aflatoxin levels, as this was outside of the evaluator's scope.

- **Sustainability:** Promote sustainability of the market beyond the project by addressing underlying market constraints of low farmer demand and lack of distribution networks for improved OFS.

Evaluation methods

The evaluation consisted of a quasi-experimental impact evaluation and a pre-post performance evaluation using both qualitative and quantitative methods. To assess the project's success in engaging the private sector and creating a market for improved OFS, the evaluation team implemented a pre-post performance evaluation. The evaluation used qualitative data and was guided by the structure-conduct-performance framework, which links underlying market conditions to economic agents' strategies regarding their market activity, with that strategic behaviour at an aggregate level determining the market's structure and performance. To measure the project's impacts on improved OFS adoption, the impact evaluation used an interrupted time series design. To measure the impacts of adoption on income and food security, the impact evaluation employed coarsened exact matching to identify comparable adopters and non-adopters of improved OFS and a difference-in-differences design to compare their outcomes. The evaluation also employed cost-effectiveness analysis and syntheses of findings to address evaluation questions on scale, cost-effectiveness, lessons learnt, and sustainability. The evaluation used the following data sources:

- Household survey of 4,091 smallholder farmers
- Semi-structured interviews with 88 market participants, including farmers and competitors
- Data on the cost of the challenge project provided by the AgResults Secretariat

Evaluation findings



Market impact. AgResults likely created an emerging market for improved OFS, particularly in the Eastern region, with substantial increases in both supply of and demand for improved OFS. Nine companies participated in the competition, with six making qualifying sales of improved OFS and three achieving the threshold required for prizes. Competitors used strategies such as partnerships with non-governmental organisations, investments in refining and manufacturing their products, incentives to distributors, and promotion via various channels (especially radio). This amounted to broader private sector engagement than a traditional 'push' intervention, where a single entity is paid based on its delivery of technical assistance, would typically achieve. At endline, the total market penetration in Rift Valley was 10% (compared to projections of 18%), and market penetration in Eastern was 22% (compared to projections of 6%).



Smallholder farmer impact. There was a substantial increase in adoption of improved OFS, and time series analysis indicated that much of the increase was due to the project. Among adopters, use of pesticide dust was reduced substantially. For smallholder farmers who adopted the improved OFS devices, there were limited economic impacts (less than US\$2 in increased maize revenue per household per year). The evaluation estimated a total of US\$368,195 in smallholder farmer benefits over the three years of project implementation. (This amount was calculated by multiplying the estimated number of farmers who adopted improved OFS because of the project by the estimated increase in maize revenue as a result of adopting improved OFS). The pre-project estimate of potential smallholder farmer benefits was US\$14 million over four years (this was the planned length of the project before delays shortened the sales period). Neither of these estimates included potential future benefits beyond the project's sales period.

- **Uptake.** At baseline, the adoption rate for improved OFS in both Eastern and Rift Valley hovered around 1%. By 2017, the last year of the project, 28% of sampled households in Eastern and 10% in Rift Valley reported having adopted improved OFS. A time series regression model predicted that, in the absence of the project, adoption would have risen to 5% in Eastern and 4% in Rift Valley. Comparing the predicted to actual adoption rates, we calculated that AgResults likely contributed to a 23 percentage point increase in adoption in Eastern and a 6 percentage point increase in Rift Valley. The increases each year were large and statistically significant above what was predicted based on pre-project trends. Cumulatively, about 220,000 more smallholder farmers purchased improved OFS across the two regions than would have been expected in the project's absence, compared to the pre-project estimate of 480,000 smallholder farmers.³
- **Income.** Revenue from maize sales was the primary pathway through which the project was expected to influence farmer income. There was a small but statistically significant increase in gross maize revenue as a result of adopting improved OFS, about 169 Kenyan shillings (about US\$1.69). The impact of adoption on net maize revenue (gross revenue less costs of storage and maize purchased for consumption) was not statistically significant. This is in part because only a minority of farmers reported selling maize.
- **Food security.** The evaluation examined household expenditure on maize for consumption during the past year as the primary food security outcome. The regression-adjusted average expenditure on maize for consumption was lower for OFS adopters than non-adopters, but the difference was not statistically significant. Notably, adopters were only about 7 percentage points less likely than non-adopters to report any grain losses during storage—and only a minority of farmers reported losses at all. However, the impact on pesticide use was large and statistically significant: households that adopted improved OFS were 36 percentage points less likely than non-adopters to use any pesticides in grain they stored for household consumption. These results suggest that many farmers were already successfully mitigating post-harvest grain loss using polypropylene bags and pesticides, though qualitative interviews revealed that many perceived uptake of improved OFS to have reduced their anxiety over potential food losses.



Scale and cost-effectiveness. The project reached significant scale. About 334,000 metric tons of storage were sold, and about 220,000 farmers adopted improved OFS above what would have been expected in the project's absence.

Cost-effectiveness is calculated as project cost per unit of impact—in this case, the evaluation team calculated cost per additional farmer adopting improved OFS and cost per metric ton of storage capacity sold to smallholder farmers.⁴ Cost information was collected from the AgResults Secretariat, which managed implementation. The key cost-effectiveness results are as follows:

³ Because the model does not include a comparison group, the evaluation team cannot completely rule out the influence of other factors on these results. Further, we cannot rule out that the increase in adoption would have occurred in the absence of the project, inasmuch as adoption may follow an S-curve and not a linear trend. However, it would be a remarkable coincidence if the inflection point in the adoption S-curve occurred exactly when AgResults was initiated.

⁴ Cost-effectiveness results include only increases in smallholder farmers adopting and storage capacity sold that the evaluation estimated likely occurred *because of the project*. As mentioned above under the 'uptake' heading, some sales of improved OFS were already occurring in the absence of the project.

- Considering all program costs (cost of project design, oversight by the AgResults Secretariat, and in-country costs of management, verification, and prizes):
 - The cost of each added farmer adopting improved OFS was \$39.
 - The cost per metric ton of storage capacity sold to smallholder farmers was \$25.
- Considering only in-country costs (management, verification, and prizes):
 - The cost of each added farmer adopting improved OFS was \$27.
 - The cost per metric ton of storage capacity sold to smallholder farmers was \$17.



Sustainability. AgResults motivated competitors to invest and overcome significant barriers to market entry. This investment positions them to continue to serve the market, which they report planning to do. Substantially higher farmer awareness of improved OFS technologies at endline compared to baseline also supports the potential for sustainability.

Future sustainability will hinge on whether product quality and farmer training on proper use are maintained, whether improved OFS suppliers maintain distribution channels in lower-performing areas, and whether private sector investment is crowded out by donor- or government-subsidised distribution. The evaluators will examine the sustainability of the project's impact with a follow-up study in late 2020, two years after the end of the project.

Lessons learnt

The evaluation generated insights and lessons on best practices for implementation of prize competitions intended to catalyse the development of markets for agricultural technologies. We summarize three key lessons below:

Prize competitions aiming to strengthen agricultural market systems are subject to risk because of the complexity of these systems and the challenge of constructing an accurate theory of change.

In this case, reasonable but ultimately flawed assumptions (about the magnitude of the post-harvest loss problem and farmers' interest in selling maize later if they could store it longer) meant that the expected smallholder income benefits of the project were significantly less than expected. The lesson the evaluation team draws from these findings is that challenge project designs should include a thorough exploration of the causal linkages and assumptions underlying the theory of change about how the technology will benefit smallholder farmers. This can then form the basis of sensitivity analysis to test the effect of different assumptions on potential project benefits and cost-effectiveness.

The attractiveness of the market matters—not just the attractiveness of the incentive. The project's designers assumed that Rift Valley would be the higher volume market, predicting 18% market penetration of improved OFS devices there. The total prize pool there was higher, and it included a large mid-point prize to encourage early crowding-in by competitors. Overall sales in Rift Valley were lower than expected—the actual penetration rate was 10%. In Eastern, the story was the opposite. Despite the requirement that devices be larger grain borer-proof and the lack of a mid-point prize, sales were higher than expected—22%, compared to a projected penetration of only 6%. The evaluation findings suggest that the Eastern region may have simply been a more attractive market, and that proved to be more important than the mid-point prize when it came to competitor efforts. The lesson is that in a more attractive market environment, prize designers may not need to offer early or extra incentives. An attractive market plus a later or moderate incentive may be enough.

Less burdensome sales verification may be appropriate when products are well-targeted for smallholder farmers. Verifying whether sales actually went to smallholder farmers was more difficult than initially envisioned. Competitors did not have sales tracking mechanisms that would allow them to report

on whether the end users of their products were smallholder farmers or larger farmers. After consideration of multiple options to verify whether sales actually went to smallholder farmers, the project conducted a large-scale household survey, which required substantial resources. This was done in combination with sales auditing to prevent fraud. The verification survey revealed that 91% of sales were in fact to smallholder farmers, indicating that the product may have been designed in such a way that smallholder farmers were its natural market. In future agricultural challenge projects, further investigation may help determine whether the precise targeting of a product could reduce the verification burden.

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AgResults is a \$152 million multilateral initiative. It promotes the development and dissemination of high-impact agricultural innovations for global food security, health, and nutrition through the design and implementation of challenge projects, which provide payments for results intended to foster the creation of sustainable markets benefitting smallholder farmers. The AgResults initiative is a partnership between the Australian Government, the Bill & Melinda Gates Foundation, the Government of Canada, the United Kingdom's Department for International Development, the United States Agency for International Development, and the World Bank.

Abt Associates, in partnership with Denise Mainville Consulting, is an external impact evaluator of AgResults. Abt Associates uses rigorous evaluation methods to answer critical questions about the impact of P4R projects and identify best practices in their design and implementation. These briefs summarize our lessons learnt on individual projects.

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