

Evaluator's Lessons Learned Series Brief 3, Updated November 2020

Nigeria Aflasafe™ Challenge Project Evaluation Findings

This brief presents findings from the AgResults Nigeria Challenge Project's evaluation (available [here](#)). The brief describes how the project created a niche market for Aflasafe-treated maize, discusses the project's impact on smallholder farmers, presents data on the project's cost effectiveness, and provides four high-level lessons learned.

Project's objective and theory of change

The AgResults Nigeria Challenge Project sought to catalyze development of a market for maize treated with Aflasafe, a biocontrol agent that limits aflatoxin contamination in maize and other crops. Aflatoxin is a naturally occurring toxin, produced by fungi commonly found in African soils – *Aspergillus flavus* and *Aspergillus parasiticus*. Chronic exposure to aflatoxins can cause liver cancer¹ and is associated with stunting and a weakened immune system.² Acute exposure to aflatoxins can be fatal.³

Evaluation's Key Findings



Market: The pilot created a niche market for Aflasafe-treated maize, where buyers from supermarkets, the poultry feed market, and the export market paid a premium for the product. The 82,355 MT aggregated in year 5 amounted to 1% of national maize production.



Uptake: Competitors' direct and indirect incentives led smallholders to apply Aflasafe on their maize fields. The pilot increased Aflasafe uptake by 56 percentage points among smallholders in AgResults villages.



Income and consumption: Smallholder annual net income from maize increased by \$318 on average or 16% per farmer, driven largely by an increase in price premiums. When considering only in-country, the cost was \$43. These numbers do not include health benefits to consumers.



Cost-effectiveness: The full program cost per farmer was \$134 when Aflasafe adoption was attributable to AgResults. Only in-country, the cost was \$95. The full program cost per MT was \$48 for aggregated AT maize attributable to AgResults. Only in-country, the cost was \$34.



Sustainability: Unstable market conditions following AgResults' conclusion highlighted the important role that AgResults played in offsetting market risk, bringing the market's sustainability into question given its endemic instability.

¹ Williams, J.H., T.D. Phillips, P.E. Jolly, J.K. Stiles, C.M. Jolly, and D. Aggarwal. 2004. Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions. *The American Journal of Clinical Nutrition* 80: 1106-1122

² Gong, Y.Y., K. Cardwell, A. Hounsa, S. Egal, P.C. Turner, A.J. Hall, and C.P. Wild. 2002. Dietary aflatoxin exposure and impaired growth in young children from Benin and Togo: cross sectional study. *BMJ*, 325: 20-21

³ Williams, J.H., T.D. Phillips, P.E. Jolly, J.K. Stiles, C.M. Jolly, and D. Aggarwal. 2004. Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions. *The American Journal of Clinical Nutrition* 80: 1106-1122

Aflasafe works by introducing native, non-toxic strains of *Aspergillus* that outcompete the toxic strains of the fungus. Scientific trials have demonstrated that Aflasafe can reduce aflatoxins in maize fields by 80% to 99%.⁴ Aflasafe's demonstrated effectiveness implies potential for its widespread use in Nigeria given the high prevalence of aflatoxins in Nigerian maize, particularly in the North, where the project focused most of its efforts.

Before the project, lack of awareness about the adverse health effects of aflatoxins and Aflasafe as a solution meant there was a "missing market" for Aflasafe-treated maize (AT maize). Aflasafe costs also meant that Aflasafe would be economically viable for smallholder farmers only if there were a price premium on AT maize or if high enough yields were realized to offset its cost. Premium markets for AT maize such as export markets, supermarkets and the poultry feed market exist, but smallholder farmers and value chain actors had limited access to these markets because of high information costs and difficulties meeting the volume, service, and other quality requirements of these buyers.



The external evaluators assessed the project's impact on the market for Aflasafe-treated maize and on smallholder farmers.

The Nigeria Challenge Project aimed to address these underlying constraints to create a private-sector led, smallholder-inclusive market using results-based incentives. Specifically, the project provided maize aggregators (called "competitors") an incentive of US\$18.75 per metric ton of AT maize aggregated from smallholder farmers, after verifying that the aggregated maize met minimum standards for Aflasafe content. The project was intended to attract a diverse set of competitors and increase the supply of AT maize beyond the needs of the currently existing premium markets. This excess supply was expected to set the stage for future investments to continue to develop the market for AT maize by increasing Nigerian consumers' demand for AT maize and government enforcement of aflatoxin standards.

The project's hope was that competitors would be motivated by the financial incentive and availability of premium markets for AT maize to increase smallholder farmer awareness and utilization of Aflasafe, and that they would also invest in developing demand for AT maize among maize buyers such as poultry farmers, feed millers, exporters, and other processors and traders. By increasing smallholder farmers' capacity to produce AT maize and investing in development of a value chain for AT maize, it was hoped that a sustainable market for AT maize would develop by the time that the project incentive ended. Additionally, farmers were expected to benefit from producing AT maize by keeping some of their production for their own consumption; thus reducing their exposure to aflatoxins in the maize they consumed. The project design estimated that for smallholder farmers to use Aflasafe economically, they would need maize yields above 2 metric tons (MT) per hectare or price premiums on AT maize of 1-4 percent assuming that smallholder farmers typically set aside 1 MT of maize for their own consumption.⁵

⁴ Bandyopadhyay, R., A. Ortega-Beltran, A. Akande, C. Mutegi, J. Atehnkeng, L. Kaptoge, A.L. Senghor, B.N. Adhikari, and P.J. Cotty. 2016. Biological control of Aflatoxins in Africa: current status and potential challenges in the face of climate change. *World Mycotoxin Journal*, 9: 771-789

⁵ Aflasafe cost ranges from \$7 - \$12 per hectare depending on currency exchange rates. As farmers' yields increase, Aflasafe's cost per kilogram of maize produced decreases.

In summary, the project expected to realize the following objectives:

- **Market impact:** Encourage diverse private sector actors to increase the supply of AT maize by 480,000 tons (equivalent to 3% market penetration nationally), thereby creating a market for AT maize.
- **Smallholder impact:** Make it profitable for smallholder farmers to adopt Aflasafe, assuming they would receive price premiums for AT maize and/or be able to increase their maize yields to at least 2 MT/hectare, and improve their health by increasing their consumption of AT maize.
- **Sustainability:** Foster sustainability of the market by addressing underlying constraints limiting development of the market, thereby offering the prospect of continued economic returns to motivate competitors, smallholder farmers, and other maize value chain actors to continue to engage in the market following the project's conclusion.

Evaluation objectives and methods

The evaluators used rigorous quantitative and qualitative methods to assess the project's impact on the market, its impact on smallholder farmers, and its cost-effectiveness. To assess the project's ability to engage the private sector and create a market for AT maize, the evaluation used qualitative methods guided by the structure-conduct-performance framework, a theory-based paradigm that links market conditions to the behavior of economic agents in markets, which in turn influence the market's structure and its performance. It used a quasi-experimental design to assess the project's impact on smallholder farmers (see graphic) and drew on project costs and publicly available data to assess its cost effectiveness.

The evaluation conducted:

- **Qualitative analysis** of 223 interviews with maize value chain actors to assess the development of the market using a structure-conduct-performance framework.
- **Quantitative analysis** of data from structured surveys of 1,823 smallholders in Kano, Kaduna, and Katsina to assess the pilot's impact on:



- **Cost-effectiveness analysis** using pilot monitoring data, pilot costs, and publicly available data.

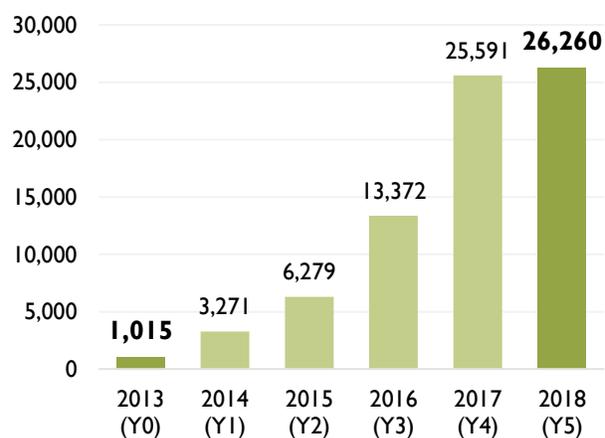
After three years of project operation, the evaluation examined findings related to market impact and sustainability, smallholder farmer impact, and cost effectiveness; the market and cost-effectiveness assessments were repeated at the end of year five.⁶ The following summarizes these findings.

⁶ The evaluation design planned to conduct the final evaluation at the end of year 3 of the four-year project to allow competitors to expand to comparison villages in its last year. After the final evaluation was begun, the project was extended to a fifth year. Although resources did not allow for an additional endline survey, a follow-up qualitative assessment was conducted to update evaluation results regarding the project's impact on the market and cost-effectiveness.

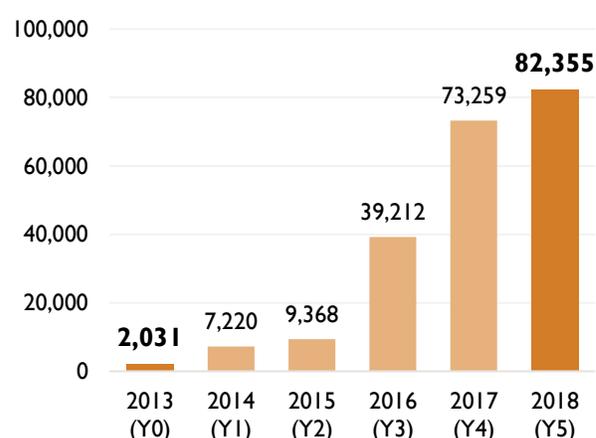
Market impact. Qualitative analysis has produced evidence of impact on the market for AT maize:

- **Engaging the private sector.** By the end of year 5, the project engaged 24 competitors who aggregated AT maize from 26,260 smallholders. Diverse private sector actors – seed producers, poultry-feed producers, maize aggregators, and social enterprises – participated as competitors and in many cases took on new roles in maize markets involving upstream or downstream integration. They also commonly upgraded diverse aspects of their business systems as a result of their engagement with AgResults. All in all, this activity amounts to broader engagement, particularly by private companies, than would characteristically be envisioned or achieved in a traditional push intervention that engages the private sector by rewarding their activities rather than their results.
- **Size of the market.** The project can be credited with the development of a niche market for AT maize. In year five of the project, competitors had aggregated 82,355 MT of AT maize, which amounted to 1 percent market penetration in Nigeria. Compared to the objective of reaching 3 percent national penetration, this is smaller than expected. Limited access to finance was a consistent constraint to expansion of many competitors' operations and can help explain the lower market penetration than was envisioned in the project's design.

Number of farmers



Maize aggregated for sale (tons)



- **Sustainability of the market.** Sustainability of the market depends on several factors. Foremost, smallholder farmers and competitors would need to continue to realize economic returns from engaging in the market. During the project, many AgResults competitors obtained premium prices for the AT maize they sold—the top ten AgResults competitors, who together accounted for 48 percent of the maize aggregated in the project's final year, reported market price premiums averaging 6 percent⁷. While to some degree, these premiums reflected market demand for high quality maize rather than a premium for AT maize *per se*, accessing the markets that sought this high quality maize did typically require meeting aflatoxin standards, making the treatment of maize with Aflasafe an important part of the equation. Similarly, farmers also received premium prices as described in the next section on farm-level impact.

During our interviews at the project's conclusion, we found that almost all competitors desired to continue their engagement in AT maize, and also reported their intent to continue to source their

⁷ International Institute of Tropical Agriculture (IITA). 2019. *AgResults Aflasafe™ Annual report 2018-2019*. Ibadan, Nigeria: IITA.

maize from smallholder farmers with whom they have established relationships through AgResults. (Several competitors also reported plans to expand their procurement of AT maize to large farmers also.)

Despite these encouraging signs, however, the market's sustainability is threatened by the endemic instability in Nigeria's maize markets, subsidized delivery of Aflasafe to entities and farmers unassociated with the supply base developed by AgResults, and delays in government efforts to increase enforcement of aflatoxin standards and increase awareness about the benefits of AT/AC maize. The planting season following the project's conclusion saw significant reductions in purchases of Aflasafe by former AgResults competitors (although this was in part due to carryover of Aflasafe from previous years), as well as reductions in planting of AT maize, largely as a result of the market's instability and, presumably, the absence of a guaranteed return (formerly provided by the AgResults incentive) to offset risk of investing in the market. Thus, the sustainability of the AT maize market that AgResults helped to create is not assured.

Smallholder farmer impact. The quantitative analysis compared smallholder farmers in AgResults villages to farmers in comparable villages not touched by AgResults. The findings are as follows:

- **Uptake.** The project increased Aflasafe uptake by 56 percentage points among smallholder farmers in villages where competitors worked (hereafter referred to as “AgResults villages”).
- **Awareness.** Compared to the uptake rate, the project had a muted impact on farmers' awareness of the health risks of aflatoxins – there was only a 22 percentage-point difference in farmer awareness between AgResults and comparison villages). This implies that farmers who adopted Aflasafe did not always fully understand the adverse effects of aflatoxins, and were motivated more by economic factors to adopt Aflasafe. Intra-household information sharing was also low – there was only a 6 percentage point increase in awareness of aflatoxins' health risks among household members responsible for cooking and making decisions on what type of maize to use for consumption.

Impact on smallholder farmer uptake

Outcome	Treatment Mean (A)	Comparison Mean (B)	Impact in percentage points on:	
			Smallholders Villages Engaged by Competitors (C = A-B)	Smallholders in Treated Villages who Adopted Aflasafe (D= C / 0.56) ¹
Primary outcome				
Uptake. Percentage of smallholders who applied Aflasafe on at least one maize plot	57%	1%	56 ***	100 ***
Exploratory outcome				
Farmer had heard about Aflasafe	73%	6%	67 ***	NA
Farmer knew how to use Aflasafe	10%	1%	9 ***	17 ***
Farmer knew the health risks of aflatoxins	23%	1%	22 ***	39 ***
Cook knew about the health risks of aflatoxins	6%	0%	6 ***	10***
Cook knew how Aflasafe works	10%	0.3%	9 ***	17 ***

Data: AgResults Nigeria smallholder survey, March-May 2017. Sample sizes: Treatment group N = 933, Comparison group N = 876

¹ This estimate is based on the assumption that all impacts measured in the treatment group were generated by smallholders that applied Aflasafe to at least one plot. p<0.1 * p<0.05 ** p<0.01 ***

- Income.** Smallholder farmers in AgResults villages in the North increased their net income from maize by \$318 per annum as a result of the project, an increase of 16 percent relative to maize farmers in villages that were not part of AgResults.⁸ They also increased maize sales by \$315 per annum and the amount of maize sold per farmer by 1 metric ton. This confirms that smallholder farmers benefitted economically from their uptake of Aflasafe, which should motivate their continued production with Aflasafe if favorable market conditions continue. The increase in net income and sales was driven by price premiums on the maize they sold (5 percent). Both prices and average yields exceeded the thresholds estimated by the project to make Aflasafe uptake economical. Focusing on only those farmers in AgResults villages who used Aflasafe (as opposed to all farmers in AgResults villages), the increase in net maize income was even larger, at \$568 per annum. These results imply – and smallholder farmers substantiated in our qualitative inquiry – that competitors provided an attractive market for their produce. Smallholder farmers also cited improved access to inputs as a benefit of working with competitors. (Our evaluation results show that input costs decreased for smallholder farmers in AgResults villages but this result was not statistically significant.)

Impact on income

Outcome	Treatment Mean (A)	Comparison Mean (B)	Impact on:	
			Smallholders Engaged by Competitors (C= A-B)	Smallholders in Treated Villages who Adopted Aflasafe (D= C / 0.56) ¹
Primary outcome				
Net maize income (\$ per annum)	2,305	1,987	318 (16%)***	568***
Exploratory outcome				
Maize price (\$/MT) ²	428	407	22(5%)*	38*
Maize yield (MT/ha) ²	2.8	2.7	0.1 (4%)	0.2
Maize sales (\$)	1,348	1,033	315 (31%)**	563**
Maize sales (MT) ²	4	3	1 (35%)***	2***
Input costs (\$)	521	546	-25 (-5%)	-45

Data: Smallholder survey, March-May 2017. Statistical significance 10%*, 5%** and 1%***

¹ This estimate is based on the assumption that impacts estimated for the full treatment group were generated by the 56% of treatment group smallholders that applied Aflasafe to at least one plot.

² MT = metric tons, ha = hectares

- Consumption.** Since the project was also intended to lead smallholder farmers to consume AT maize once made aware of its health benefits, evaluators also assessed whether the project increased consumption of AT maize. The project increased daily AT maize consumption by an average of only 0.02 kg per person, or an increase of 13 percent, given that individuals on average consumed 0.17 kg of maize daily⁹. The low awareness about adverse health risks of aflatoxins potentially explains the small magnitude of impact. It is also conceivable that the project's incentives and market premiums led smallholder farmers to sell rather than consume AT maize.

⁸ Per-hectare net revenue (gross margins) from maize increased marginally, but were not statistically significant. Maize yield also increased by 4 percent but the result was not statistically significant.

⁹ The AgResults project manager reported higher rates of consumption of AT maize among verified farmers who adopted Aflasafe. The evaluator's analysis, on the other hand, examined the impact of the AgResults program among farmers targeted by competitors, 43 percent of whom did not use Aflasafe.

Cost-effectiveness. Our cost-effectiveness findings indicate that returns to farmers exceeded the cost of the project. Cost information was collected from the World Bank (which managed the initial design of the project) and the Secretariat (which managed implementation). The table below presents the cost-effectiveness ratios. Including both project design costs and Secretariat management costs, the cost of AgResults was \$134 for every farmer whose adoption of Aflasafe was attributable to the program. Including only in-country costs, the cost per farmer was \$95. The cost per MT of AT maize was \$48 including all costs. Including only in-country costs, the estimated cost per MT of AT maize was \$34.

The cost-effectiveness ratios will continue to improve as production and sale of Aflasafe-treated maize attributable to the project continues following the conclusion of the project. This is because outcomes (the numerator in the equation) will continue to grow while project costs (the denominator in the cost-effectiveness equation) are stable following the conclusion of the project.

Cost-effectiveness ratios for the Aflasafe Project

Cost-effectiveness ratios	Total costs	In-country costs
Uptake. Cost per added farmer adopting Aflasafe	\$134	\$95
Market. Cost per added MT of maize treated with Aflasafe	\$48	\$34

Lessons Learned

We summarize four high-level lessons learned; these are described more comprehensively in the final evaluation report which presents a full chapter to lessons learned.

Private sector engagement and market impact. One lesson is that prizes can incentivize a diverse and large number of private sector entities to offer new technologies to a considerable number of smallholder farmers, and that these prizes can lead to the creation of a small niche market. At the same time, the capacity and constraints of the targeted competitors may limit the scale of impact, underscoring the challenge of achieving large-scale impact when there are complex market failures such as those associated with technologies that result in public benefits, or benefits beyond those who adopt the technology.

Technology uptake and development impact. The project demonstrated that smallholders were willing to adopt a new technology. It also demonstrated that they were driven more by economic returns and not by the desire for health benefits. There was an assumption that smallholder farmers would learn more about the health benefits of AT maize as part of competitors' strategy to increase adoption of Aflasafe and consequently consume more of it, which did not turn out to be the case. The competitors were also driven by primarily by economic motives and focused largely on the challenge of aggregating AT maize from their smallholders, rather than on messages on health benefits of AT maize. This suggests that adoption faces special challenges when part of the benefit of the technology does not yield direct economic returns.

Sustainability. Our results highlight the vulnerability of a newly emergent market to underlying conditions in the related mainstream commodity market. While our evaluation demonstrates that a Pfor prize competition can stimulate the creation of a market, the sustainability of this market can be threatened if the enabling environment does not evolve in a supportive direction. This threat to sustainability can be exacerbated if underlying market conditions, such as chronic instability, increase investors' exposure to risk of investing in the newly emergent market.

Cost-effectiveness. The final lesson is that although prize competitions “pay only for results,” and therefore don’t involve the often considerable technical assistance costs of push mechanisms, they can entail significant costs to get the design right, to encourage the private sector to participate, and to verify the results. In the case of the AgResults Nigeria project, the benefits accrued by the project—in terms of farmers applying Aflasafe to their maize, the production of AT maize, and net income increases all compared favorably to the costs incurred in achieving those objectives. Cost effectiveness will continue to improve now that all project costs have been incurred and project-induced outcomes continue to mount. Nonetheless, as emphasized in our discussion of sustainability, the longstanding contribution of the project’s achievements—and ultimately the value of donor investment—will depend heavily on the sustainability of the market for AT maize in the years to come.

Recommended Citation

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AgResults is a \$152 million multilateral initiative incentivizing and rewarding high-impact agricultural innovations that promote 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 Foreign, Commonwealth, and Development Office; 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 PfR projects and to identify best practices in their design and implementation. These briefs summarize our lessons learned on individual projects, as well as cross-cutting topics.

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