Evaluator's Lessons Learned Series

Nigeria Aflasafe™ Pilot Evaluation Findings

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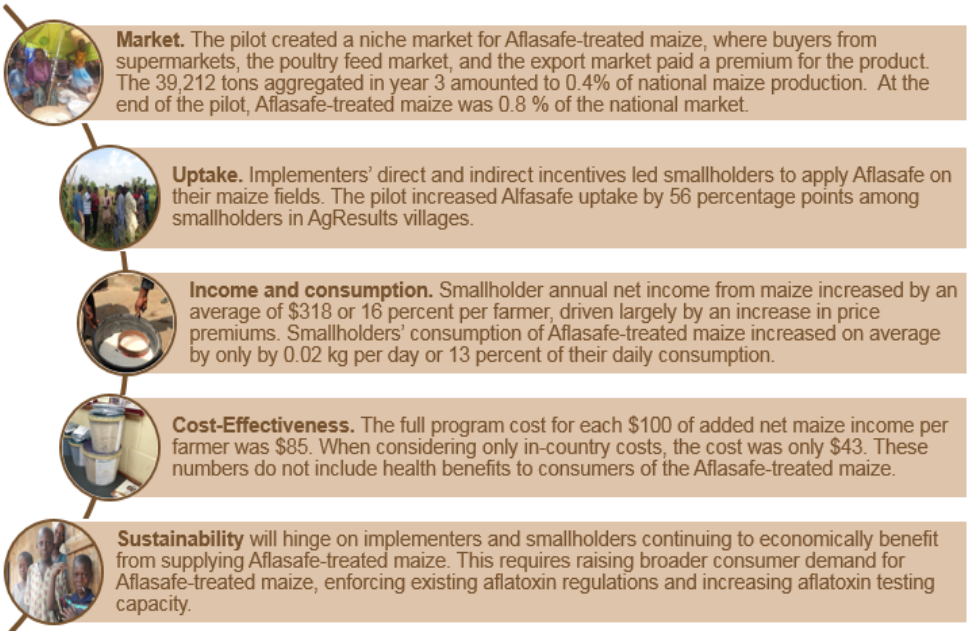
This brief presents findings from the first completed evaluation of an AgResults pilot project. It describes how the pilot created a niche market for Aflasafe-treated maize and discusses the pilot's impact on smallholders. In addition, it presents data on the pilot's cost effectiveness. Finally, it provides three high-level lessons learned.

Pilot's objective and theory of change

The AgResults Nigeria pilot has sought to catalyze development of a market for maize treated by 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 cancer[1] and is associated with stunting and a weakened immune system.[2] Acute exposure to aflatoxins can lead to liver edema and death.[3] Aflasafe works by outcompeting the toxic strains of fungus by introducing other native strains of Aspergillus that don't produce these toxins. Scientific trials have demonstrated that Aflasafe can lead to 80% to 99% reduction in aflatoxins in maize fields.[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 pilot focused most of its efforts.

Before the pilot, lack of awareness about the adverse health effects of

Evaluation's Key Findings



[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

[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

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 a minimum yield. Premium markets for AT maize such as export markets, supermarkets and the poultry feed market exist, but smallholders and value chain actors have limited access to these markets because of high information costs and other maize quality requirements that these markets impose.

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

The Nigeria pilot aimed to address these underlying constraints to create a private-sector led, smallholder-inclusive market using results-based incentives. Specifically, the pilot provided maize aggregators (called "implementers") an incentive of US$18.75 per metric ton of AT maize aggregated from smallholders, only after verifying that the aggregated maize met minimum standards for Aflasafe content. The pilot was intended to attract a diverse set of implementers 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 pilot's hope was that implementers would be motivated by the financial incentive and availability of premium markets for AT maize to increase smallholder 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. Demand from these downstream buyers would provide market incentives to produce AT maize that would flow through implementers to smallholder farmers, who would produce AT maize for both their own consumption and for sale.

The pilot design estimated that for smallholders to take up 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 smallholders typically set aside 1 MT of maize for their own consumption.[5]

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

- **Market impact:** Encourage diverse private sectors to increase the supply of AT maize by 480,000 tons (equivalent to 3% market penetration of AT maize) and create a market for AT maize.
- **Smallholder impact:** Benefit smallholders by making it economical 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 by increasing their consumption of AT maize by making them aware about its health benefits
- **Sustainability**: Foster sustainability of the market beyond the pilot by addressing underlying constraints of low awareness, and reducing initial costs for implementers and smallholders to engage in the AT maize market and access premium prices for AT maize, yielding the prospect of continued economic returns for the participants.

[5] Aflasafe cost ranges from $7 - $12 per hectare depending on currency exchange rates.

Evaluation objective

The external evaluators sought to assess whether the pilot met its objectives by comparing expected impacts against actual findings using rigorous quantitative and qualitative methods. To assess the pilot'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 that links market conditions to the behaviour of economic agents in markets, and the consequent link to market structure and market performance. It used a quasi-experimental design to assess the pilot's impact on smallholders (see box).

Evaluation Method

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 1823 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

Evaluation Findings

After three years of pilot operation, the evaluation examined findings related to market impact, smallholder impact, and cost effectiveness. It also considered the likelihood that the impact of the pilot would be sustained. Additional evidence concerning market impact will be reported after the fourth year of the pilot operation.[6] These findings are summarized below.

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

- **Engaging the private sector.** The pilot engaged 24 private sector actors – seed producers, poultry-feed producers, maize aggregators, and social enterprises – as implementers. These implementers aggregated AT maize from 13,372 smallholders. Interviews with implementers revealed that in many cases they took on new roles in maize markets, such as upstream or downstream integration, and that they upgraded diverse aspects of their business systems and processes as a result of their engagement with AgResults. All in all, this amounts to broader engagement, particularly by private

[6] As planned in the evaluation protocol, the final evaluation was conducted in year 3 of the four-year pilot to allow the pilot to expand to comparison villages in its last year. After the final evaluation was begun, the pilot was extended to a fifth year. Although resources do not allow for an additional endline survey, additional qualitative data will be collected after year 4.

companies, than would characteristically be envisioned or achieved in a traditional push intervention where typically a single entity is paid based on its delivery of technical assistance.

- **Size of the emerging market.** The evidence thus far suggests that a niche market for AT maize has been created. By the end of the pilot's year 3 in 2017, implementers had aggregated 39,212 tons of AT maize, which amounted to 0.4 percent market penetration in Nigeria. Compared to the objective of reaching 3 percent national penetration, this is smaller than expected. At the end of the pilot, implementers had aggregated 82,541 tons of AT maize which amounted to 0.8 percent market penetration[7]. While most implementers reported having ready markets for their AT maize, limited access to finance was a consistent constraint to expansion of their operations for many implementers and is largely attributable to the lower market penetration than was envisioned in the pilot design.

- **Future prospect of market.** The niche market for AT maize was supported by premium prices from the existing market for AT maize with implementers reporting price premiums averaging 8 percent beyond the AgResults incentives. To some degree, these premiums reflected market demand for high quality maize rather than a premium for AT maize *per se.* Unexpectedly, the poultry sector did not emerge as the backbone to demand as was hypothesized, and not all implementers were able to obtain the market premiums that they had anticipated. Implementers also noted other motivations to engage beyond premiums, including access to markets they had not been exposed to before, access to training and inputs, and access to implicit branding resulting from their association with the pilot quality assurance to final buyers. Some implementers were also motivated to address a public health concern generally. That said, the future of the niche market will depend on both implementers and smallholders accessing premium markets. Further, there was little awareness of Aflasafe or aflatoxins beyond the value chain actors that AgResults engaged with, which presents a constraint for mainstreaming the market for AT maize beyond a niche market.

Smallholder impact. The quantitative analysis compared smallholders in AgResults villages to smallholders in comparable villages that were not touched by AgResults. The findings are as follows:

- **Uptake.** The pilot increased Alfasafe uptake by 56 percentage points among smallholders in AgResults villages[8].
- **Awareness.** Compared to the uptake rate, the impact of the pilot on awareness about health risks of aflatoxins was comparatively much less (only a 22 percentage-point difference farmer awareness between AgResults and comparison villages)[9]. This implies that farmers who adopted Aflasafe did not always fully understand the adverse effects of aflatoxins, and were driven more by the economic reasons to adopt Aflasafe. Intra-household information sharing was also low. The increase in awareness about health risks of aflatoxins among those responsible for cooking maize, typically women, and making decisions on what type of maize to use for consumption was even lower (only a 6 percentage-point increase).

[7] This is based on draft numbers on Aflasafe treated maize aggregated at the end of the pilot.
[8] The percentage of smallholders who applied Aflasafe on at least one plot was 57 percent for the treatment group farmers, and 1 for the comparison group.
[9] Twenty three percent of farmers in AgResults villages and one percent of farmers in comparison villages knew about aflatoxins.

Impact on smallholder uptake

Outcome	Treatment Mean (A)	Comparison Mean (B)	Impact in percentage points on:	
			Smallholders Villages Engaged by Implementers (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.** Smallholders in AgResults villages in the North increased their net income from maize by $318 per annum as a result of the pilot. This represented an increase of 16 percent relative to maize farmers in villages that were not part of AgResults. [10] This confirms that smallholders economically benefitted from uptake of Aflasafe, which should motivate their continued production with Aflasafe if these favorable market conditions continue. This increase was driven by the price premiums on maize (5 percent) which were on the high side of the 1-4 percent range expected to make Aflasafe uptake economical. Maize yield increased marginally by 4 percent but the result was not statistically significant. Of note, the average maize yield was greater than the yield threshold to make Aflasafe uptake economical. Focusing on only those farmers in AgResults villages who used Aflasafe (as opposed to all farmers in those villages), the increase in net maize income was $568 per annum. Notably, the smallholders in AgResults villages increased maize sales ($315 per annum) and the amount of maize sold per farmer (1 metric ton). This implies that implementers provided a ready market for their produce, which smallholders identified as an important reason for continuing to work with the implementers. Smallholders also noted improved access to inputs as a benefit of working with implementers. The input costs decreased for smallholders in AgResults villages but this result was not statistically significant.

[10] Net revenue from maize per hectare, or gross margins per hectare increased marginally, but were not statistically significant.

Impact on income

Outcome	Treatment Mean (A)	Comparison Mean (B)	Impact on:	
			Smallholders Engaged by Implementers (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 outcomes				
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 pilot was also intended to lead smallholders to consume AT maize once made aware of its health benefits, evaluators also assessed whether the pilot increased consumption of AT maize. The pilot increased daily AT maize consumption by only 0.02 kg per household, or an increase of 13 percent, given that households on average consumed 0.17kg of maize daily. The low awareness about adverse health risks of aflatoxins potentially explains the small magnitude of impact. It is also conceivable that the pilot's incentives and market premiums led smallholders to sell rather than consume AT maize.

Cost-effectiveness. Cost information was collected from the World Bank (which managed the initial design of the pilot) and the Secretariat (which managed implementation). The key cost measurements are as follows:

- Considering all program costs (cost of pilot design, oversight by the AgResults Secretariat and in-country costs of management, verification, and prizes):
  - The cost of each added farmer adopting Aflasafe was $216.
  - The cost for each $100 of added net maize income per farmer was $85.

- Considering only in-country costs (management, verification, and prizes):
  - The cost per farmer adopting Aflasafe was $109
  - The cost of $100 in added net maize income per farmer was $43.

These findings indicate that the cost was less than the returns to farmers if we include all programmatic costs or consider only in-country cost. These returns do not include any health benefits to the farmers or the final consumers of AT maize.

Sustainability. Sustainability of the results depend on several factors. Foremost, smallholders and implementers would have to continue to realize economic returns from engaging in the market, i.e., they would need continued access to already existing and newly created premium markets for AT maize. Almost all implementers expected to continue their engagement in AT maize if the price premiums continue. They also said they are likely to source their maize from smallholders with whom they have established relationships through AgResults, although several implementers also reported plans to expand their procurement of AT maize to large farmers also. To mainstream the market beyond the current niche, demand would need to expand through increased consumer awareness supported by enforcement of aflatoxin regulations, access to aflatoxin testing with the ability to brand AT maize, and continued access to Aflasafe. Whether the market will continue grow and continue to be smallholder inclusive when pilot incentives end remains to be seen, and can be assessed with a sustainability analysis a few years after pilot ends.

Lessons Learned

The results of the evaluation indicate that the pilot created a niche market for AT maize in Nigeria. The results will sustain if smallholders and implementers continue to benefit economically from engaging in AT maize, which primarily depends on their access to premium markets for AT maize. Low awareness about health impacts of aflatoxins and low consumption of AT maize among smallholder farmers suggests that additional public investment may be needed such as in in raising broader awareness, which was the key underlying constraint limiting the development of a market for AT maize. The final evaluation report presents a full chapter examining lessons learned from several angles; these will be detailed in a subsequent Lessons Learned brief. We summarize three high-level lessons below:

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 smallholders, 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 implementers implies that the scale of impact may be modest, 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. This pilot 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 smallholders would learn more about the health benefits of AT maize as part of implementers' strategy to increase adoption of Aflasafe and consequently consume more of it, which did not turn out to be the case. The implementers were also driven by economic motives and focused more on aggregating maize even though they reported sharing 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 and cost-effectiveness. The final lesson is that although pull mechanisms "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. However, if the pull mechanism causes a functioning market to sustain, even if it is a niche market, the benefits may indeed more than offset the costs. Whether a market for AT maize sustains in Nigeria remains to be seen after the pilot closes in 2019.

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Contact
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AgResults is a $122 million multilateral initiative incentivizing and rewarding high-impact agricultural innovations that promote global food security, health, and nutrition through the design and implementation of pull mechanism pilots, 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 the external impact evaluator of AgResults. Abt Associates uses rigorous evaluation methods – both quantitative and qualitative – to determine if the AgResults pilots' achieve their objectives. These briefs summarize our lessons learned on individual pilots, as well as:

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

The contents of this brief do not necessarily reflect the views of the AgResults partners. For more information about AgResults, visit: http://www.agresults.org.

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