AgResults Evaluation Design: Nigeria Aflasafe Pilot

Final Report

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Preface

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

The AgResults program team comprises a Steering Committee, a Secretariat, a Trustee, country-specific pilot implementers, and an external evaluator. The Steering Committee oversees the implementation of AgResults and is comprised of the five donor agencies and the Trustee. The Steering Committee is responsible for strategic oversight of the initiative, including endorsement of key management decisions, approval of concepts and business plans for proposed pilots, and the monitoring of pilots and the initiative as a whole. The Secretariat is responsible for implementation of the AgResults initiative and reports to the Steering Committee. In order to fulfil its role effectively, the Secretariat develops a close working relationship with the Trustee and ongoing external evaluator. Core functions include appointing and managing pilot implementation and verification agents, sourcing new pilots, and communicating results. As Trustee for AgResults, the World Bank provides an agreed set of financial intermediary services that include receiving funds, holding funds, investing funds, and transferring them to recipients or other agencies for implementation as directed by the Secretariat on behalf of the Steering Committee.

In Nigeria, AgResults is providing economic incentives to smallholder maize aggregators in two key agricultural regions of the country to increase the adoption of Aflasafe, an aflatoxin control technology shown to reduce aflatoxin contamination of maize by up to 99 percent. The pilot is designed to demonstrate a successful model for increasing smallholder adoption of biocontrol technology in Nigeria by reducing barriers to the widespread adoption of Aflasafe through a per-unit premium payment for maize verified to contain a high prevalence of Aflasafe. The AgResults pilot in Nigeria began with a pilot year in 2013, and will continue until March 2018. In Nigeria, the International Institute of Tropical Research (IITA) serves as the Program Support Services Manager, and Adebowale (Debo) Akande has been subcontracted as the Pilot Manager for the Nigeria pilot. As Pilot Manager, Mr. Akande is managing overall implementation of the pilot.

The Steering Committee appointed Abt Associates Inc. to serve as the External Impact Evaluator for the AgResults pilots. Abt's role is to use rigorous scientific tools to determine if the pull

mechanisms achieve their objectives – to measure whether the mechanisms produce private sector behaviours and social outcomes different from, and better than, what would have happened in the absence of the mechanism introduced by the pilot initiatives. In our role as the External Impact Evaluator, Abt will define the overall evaluation framework for the AgResults initiative and an impact analysis strategy for each pilot. We will also implement and analyse field surveys based on established best practices, conduct qualitative market analyses, and communicate evaluation findings to the Steering Committee and wider audiences as needed. Our role will be vital to the AgResults' learning agenda of understanding the potential of private sector involvement in the development and spread of agricultural innovation. We will also report our assessment of the sustainability of the results produced in the private market once the pilot incentives are removed.

This report presents Abt's evaluation design for the Nigeria pilot. The Abt team is headed by Stephen Bell, PhD, an expert in impact evaluation design and the evaluation's Quality Assurance Advisor. Tulika Narayan, PhD (Agricultural Economist and overall Quantitative Evaluation Lead) is the country lead for the Nigeria pilot evaluation; Denise Mainville, PhD (of Denise Mainville Consulting LLC), is the Agriculture Expert and overall Qualitative Lead; Judy Geyer, PhD (Impact Evaluation Expert) guides the quantitative analysis; and Mikal Davis (Evaluation Analyst and Country Coordinator) conducts data analysis and provides coordination support. The Abt team will work with in-country agricultural economists and a Survey Manager to implement the evaluation design.

1. Setting for the AgResults pilot

1.1 The aflatoxin problem in Nigeria

Aflatoxins are naturally occurring toxins produced by certain fungi: *Aspergillus flavus and Aspergillus parasiticus.* There are several types of aflatoxins (B1, B2, G1, and G2) produced by these fungi, of which aflatoxin B1 is the most toxic: long-term exposure to aflatoxins results in liver cancer, with some evidence of impact on stunting, and short-term acute exposure can result in death because of aflatoxicosis. These aflatoxin-producing fungi are widely found in soil and contaminate a variety of food commodities that are important to Nigeria, including maize (Strosnider et al., 2006). Although data are not available for all regions in Nigeria, published prevalence data from Nigeria suggest that aflatoxin contamination in maize is considerably higher than the European Union (EU) aflatoxin standard (4 ppb) or the U.S. standard (20 ppb). A recent review of published articles reveals that the mean level of aflatoxin contamination in Nigerian maize is as high as 250 ppb.[1] Nigeria is the largest producer of maize in Africa, and maize accounts for up to two-thirds of calories consumed in some parts of the country. Nigeria produces most of the maize it consumes, and imports and exports of maize are small. Production is concentrated in the North-Central region of the country (particularly Kaduna), while consumption is concentrated in the South-West.

Figure 1-1 presents the average aflatoxin contamination in Nigerian maize using data from published sources. Maize contamination is higher in Niger, Nassarawa, and Oyo states.

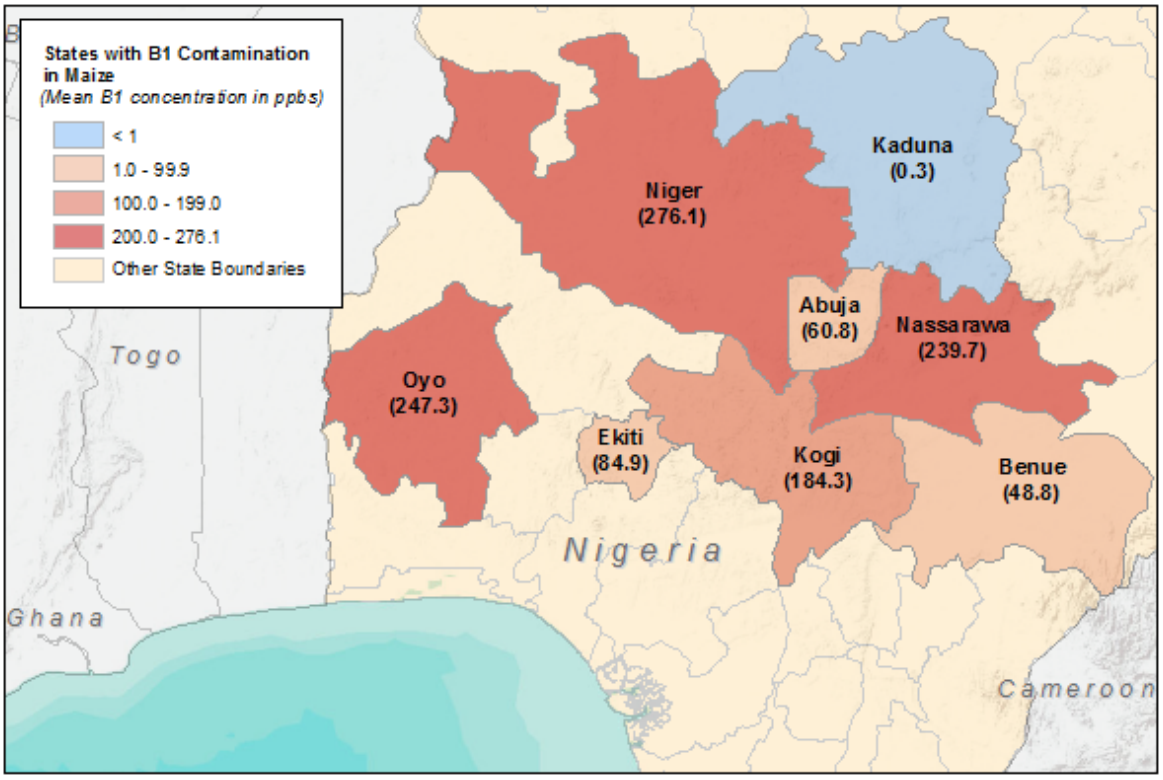
Aflasafe is a biocontrol containing native strains of *Aspergillus* that do not produce aflatoxins (atoxigenic strains) to naturally outcompete aflatoxin-producing strains and in doing so, greatly reduce the potential for aflatoxin contamination. The biocontrol is applied during the planting stage (more specifically, 10 days after planting), and works to reduce the population of aflatoxin-producing fungi in early stages, thereby affecting their prevalence throughout the value chain, from the field to the final consumer. A recent study notes that application of Aflasafe at a rate that results in 70 percent prevalence of Aflasafe in harvested maize can control 90 percent of the aflatoxin contamination (Dahlberg, 2012). Aflasafe has supporting scientific evidence and is one of the more efficacious potential interventions to reduce aflatoxin contamination. Aflasafe is approved for crop treatment in Nigeria by the Nigeria Agency for Food and Drug Administration (NAFDAC), and Nigeria is currently the only country in Africa where Aflasafe is registered.

Even though this aflatoxin mitigation strategy is available in Nigeria, there is low uptake of it by maize smallholders because Aflasafe application implies additional cost without any offsetting yield increase or revenue increase through price premiums. In Nigeria, there are only two markets that pay a premium for aflatoxin-free maize: the export market and to some extent the poultry feed market. However, export markets are not within the reach of a typical smallholder; there are many constraints to accessing this high-value market (inability to aggregate and other quality considerations being some of the reasons). Furthermore, only a small amount of maize is

[1] Published papers with information on aflatoxin prevalence in maize in Nigeria: Bankole and Mabekoje, 2004; Udoh et al., 2000; Atehnkeng et al., 2008; Oluwafemi and Ibeh, 2011; Bandyopadhyay et al., 2007; Oyelami et al., 1996; and Adebajo et al., 1994.

exported, in part because the Nigerian government often bans its export due to food security concerns. The poultry feed sector is a viable market for aflatoxin-free maize that smallholders have not yet tapped.

Figure 1-1. Prevalence of aflatoxin B1 in maize in Nigeria



Source: Narayan et al. (2013).

The domestic consumption market, on the other hand, does not pay a premium for aflatoxin-free maize. This is because consumers are not aware of aflatoxins or their adverse health effects, and are therefore not willing to pay more for aflatoxin-free maize.[2] The majority of the maize consumed in Nigeria is purchased from local markets that do not differentiate aflatoxin-free maize from other maize or from own consumption of farmed maize. Seventy percent of the country's maize is produced by smallholders with less than 6 ha of land and very low yields,[3] constituting 80 percent of all maize-producing households. Unless there are (1) awareness about the adverse impacts of aflatoxins leading to sustained demand for aflatoxin-free maize by end users, and (2) adequate returns to smallholders through yield increase and/or premium for aflatoxin-free maize, Aflasafe adoption is unlikely.

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2 An exception to this lack of awareness is the farmers and market actors who have been subject to specific educational campaigns such as those implemented by the International Institute for Tropical Agriculture (IITA).

3 Thirty percent of maize is grown by large-scale farmers who produce primarily for market. These farmers typically own 10–15 ha of land, and have yields up to 5 MT/ha (Dahlberg, 2012).

Even if there were awareness, another challenge in developing a market that pays a premium price for aflatoxin-free maize is that aflatoxins are not visible to the naked eye: maize with visible fungus may or may not contain aflatoxins, and maize without visible fungus can contain high levels of aflatoxins. Therefore, aflatoxin testing and branding are needed to allow reliable price differentiation between toxic and non-toxic grain.

A final solution might be regulation. The government of Nigeria, through NAFDAC, has a legal framework to regulate aflatoxin levels in maize and other food products and has capacity to conduct testing; however, its ability to enforce those regulations is severely hampered by the unavailability of aflatoxin-free maize in the market (a "chicken and egg" problem), such that enforcement of aflatoxin standards would likely catalyse a food security crisis. In addition, even if such maize were available, NAFDAC lacks capacity to conduct testing at a scale needed to regulate the local market. Furthermore, given the lack of capacity and political will to enforce any rules and regulations on "sensitive issues" that affect the majority of the people, market-driven approaches to promote Aflasafe are more viable options.

In summary, the key requirements for creation of a market for aflatoxin-free maize are:

- Sustained demand by end users
- A testing and certification process for identifying and preserving the integrity of maize
- An adequate volume of aflatoxin-free maize
- Adequate returns to smallholders for growing aflatoxin-free maize.

The next section describes the AgResults pilot and how it hopes to address these key requirements to develop a sustainable market for aflatoxin-free maize.

1.2 The AgResults pilot objectives

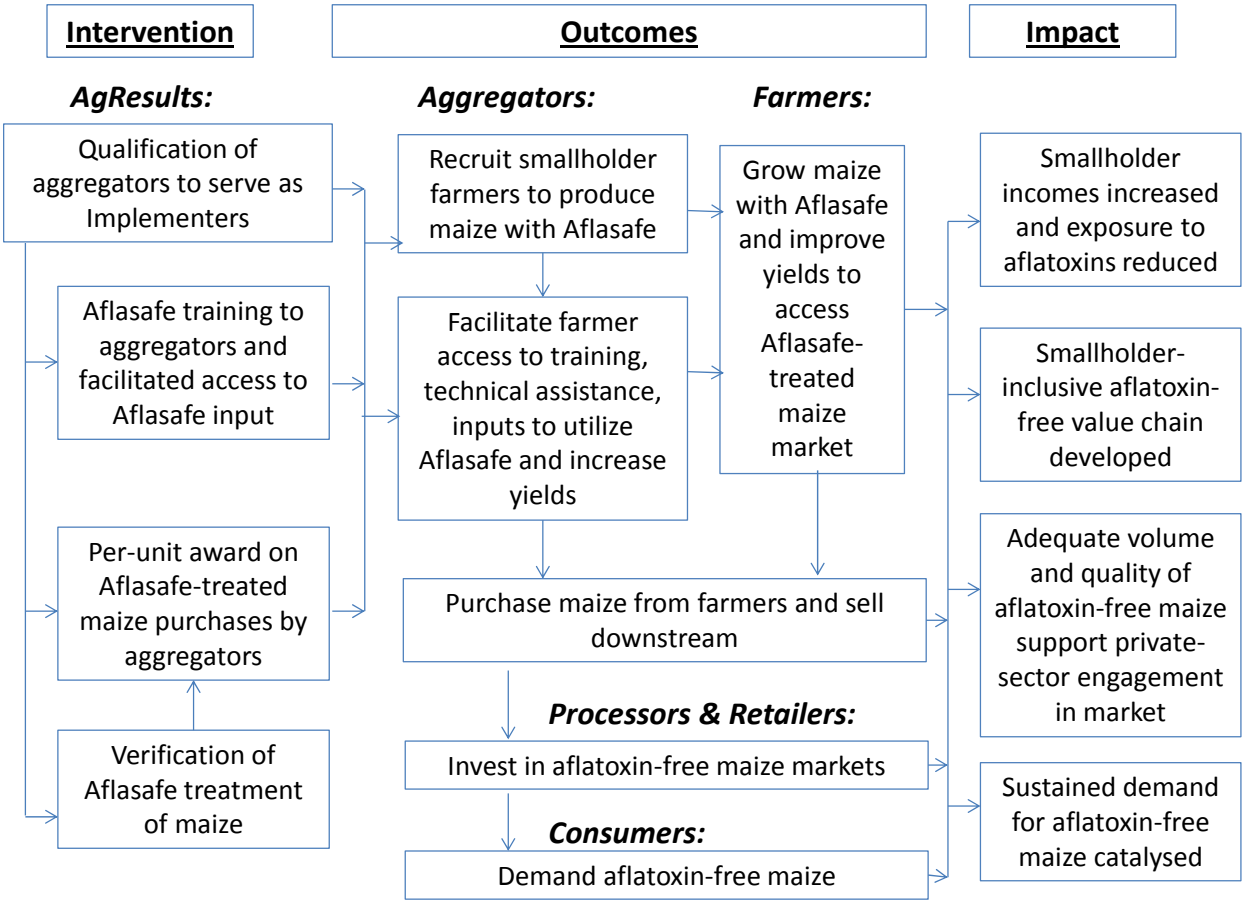
The AgResults Aflasafe pilot aims to catalyse a smallholder-inclusive, private-sector driven market for aflatoxin-free maize by creating the preconditions to support the emergence of the market using incentives (see Figure 1-2 for the AgResults theory of change). The pilot is managed by Deloitte Consulting, which has hired Debo Akande from the International Institute of Tropical Agriculture as the Pilot Manager in Nigeria. IITA also provides technical expertise as the developer and manufacturer of Aflasafe and provides services for testing of Aflasafe levels in maize. As noted in the theory of change, the following are the specific expected outcomes of the AgResults Aflasafe pilot:

- Increased application of Aflasafe by smallholders
- Increased smallholder sale of Aflasafe-treated maize to downstream high-premium markets
- Increased availability of aflatoxin-free maize
- Increased consumption of aflatoxin-free maize by smallholders and in the downstream markets
- Increased income due to increased yield and the sale of aflatoxin-free maize
- Increased awareness about aflatoxins and Aflasafe as a control strategy.

The pilot uses a "pull" mechanism—financial incentives to private sector actors in the value chain—to stimulate demand for Aflasafe-treated maize and its use by smallholders. Specifically, the pilot provides aggregators incentives in the form of price premiums for procuring maize treated with Aflasafe. The pilot encourages the aggregators to use contract farming arrangements

for encouraging the application of Aflasafe in maize fields by smallholders. The pilot pays aggregators $18.44 (3000 Naira) per metric ton (MT) of Aflasafe-treated maize procured from smallholders if the Aflasafe level in the procured grain is above 70 percent. This premium is paid only after the Pilot Manager has verified the presence of Aflasafe above the threshold. Third-party verifiers collect maize samples at designated points of aggregation of Aflasafe-treated maize for each aggregator for testing (implying that the Aflasafe levels are not determined at the smallholder level). The premiums are based on presence of Aflasafe rather than absence of aflatoxins because climatic conditions determine the presence of aflatoxins, and it may be that the maize of a farmer who did not apply Aflasafe (or did not adopt the technology being promoted) can have low levels of aflatoxins. The independent verifier takes one sample per 30 MT and provides it to IITA for testing, with actual tests occurring in U.S. Department of Agriculture laboratories in Arizona where Aflasafe was invented.

Figure 1-2. AgResults theory of change



In addition to encouraging Aflasafe application, the pull mechanism creates an indirect incentive for aggregators to help smallholders increase their maize yields. Given the price of Aflasafe, and potentially additional labour costs to apply Aflasafe, at the current yields smallholders will face negative returns. Without a yield or price increase, smallholders will not have any incentive to adopt Aflasafe. Currently, the price of Aflasafe is $1.84 (300 Naira) per kilogram (the price is

expected to go down as production is scaled up with growing demand), which at the desirable application rate of 10 kilograms per hectare translates to an Aflasafe cost of $18.44 (3000 Naira) per hectare. At maize yield of 1 MT per hectare the incentive payment is exactly equal to the Aflasafe cost per hectare. This implies that yields higher than 1 MT are needed for Aflasafe application to result in net positive returns per hectare—assuming that all the incentives are given to the smallholder. The pilot business plan accounts for own consumption of approximately 1 MT per hectare. This implies that yields greater than 2 MTs per hectare are needed for net positive returns on investment (Dahlberg, 2012). Since no incentives are provided for the maize kept for own consumption, the incentive payment is exactly equal to the cost of Aflasafe at a yield of 2 MTs per hectare. For higher yields, incentive payments will be greater than the cost of Aflasafe, increasing the likelihood of adoption. Thus, increasing yields at smallholder plots beyond 2 MTs per hectare (current maize yields are generally below 2 MTs per hectare) is necessary for Aflasafe application to be profitable.

Consequently, one of the expectations is that aggregators will provide necessary extension service and/or access to inputs to improve smallholders' yields. Aggregators could potentially use the incentive payments to finance this assistance. Aflasafe application itself requires specific direction on application rate and timing of application, direction that the aggregators are expected to relay to smallholders. Aggregators can use a variety of ways to provide extension and monitor correct application of Aflasafe. Overall, there will be variation in the ways that individual aggregators incentivize the smallholders to increase yields and adopt Aflasafe. Some aggregators may provide Aflasafe for free or provide upfront credit. Some aggregators may make incentive sharing with smallholders conditional on accurate application of Aflasafe. Our field investigations suggest that some aggregators will offer output buyback guarantees to smallholders but may not share the monetary incentives (on the other hand, smallholders may potentially not honour the output buyback and sell to another buyer).

Although there are direct incentives within the pilot for increasing the supply of Aflasafe-treated maize (and by implication aflatoxin-free maize), and indirect incentives to increase maize yields, increases in on-farm consumption of aflatoxin-free maize may not necessarily occur. The provision of incentives to produce aflatoxin-free maize to sell may present a trade-off with the use of aflatoxin-free maize for home consumption; particularly if Aflasafe itself is accessed by smallholders through the aggregators who are contracting them to grow maize on their behalf. Consumption of aflatoxin-free maize may increase because smallholders, who always set aside a portion of what they produce for consumption, may consume the aflatoxin-free maize they grow. However, it is not necessary that they become aware of the adverse health impacts of aflatoxins. This is because the aggregators do not have any direct incentive to raise awareness among smallholders. It is not clear if aggregators will find it strategic to create awareness of aflatoxins as a means of increasing adoption of Aflasafe by smallholders. They may instead focus on the premium price that aflatoxin-free maize fetches or simply provide incentives for accurately applying Aflasafe. Without awareness generation among smallholders, smallholders may prefer to sell all the aflatoxin-free maize they produce in premium markets rather than consume a portion. Since the ultimate objective of the pilot is to develop a market for aflatoxin-free maize in a way that benefits smallholders, it will be important to find out if smallholders were made aware of aflatoxins and their health impact.

Since so much hinges on how aggregators conduct business with smallholders, it is useful to review the expectations the AgResults Aflasafe pilot establishes for aggregators as reflected in the criteria used for their selection. These criteria include the ability on the part of aggregators to:

- **Work with Smallholders:** Have the ability and capacity to organise and coordinate smallholders through pre-planting, planting, and post-harvest handling of maize that has been treated with Aflasafe, with at least 300 smallholders.
- **Incentivize Smallholders to Adopt Aflasafe:** Be capable of providing support to smallholder productivity through extension and access to farm inputs, and the capacity to train and monitor smallholder groups on the environmental application of Aflasafe, post-harvest management, and the safe transfer and storage of Aflasafe-treated maize. This could include having systems in place to add value to production of maize or link smallholders to a package of yield-enhancing inputs (e.g., fertilizers, storage facility, finance). This includes the capacity to facilitate or coordinate the purchase of Aflasafe on behalf of the smallholder groups as required.
- **Support Verification of Aflasafe Levels in Maize:** Be able to organise a system of aggregation points and storage to support verification and sale to end-customers.
- **Access Premium Markets:** Have downstream market linkages to efficiently aggregate and sell Aflasafe-treated maize at a premium.
- **Enforce Contracts:** Have the ability to enter into contracts with smallholders that are honoured by both parties, which has historically been a challenge in Nigeria and in Africa more generally.

The pilot initiated in 2014 is expected to engage approximately 9 aggregators and 3,452 smallholders in the first year; 24 aggregators and 10,468 smallholders in the second year (2015); 38 aggregators and 20,885 smallholders in the third year (2016); and 46 aggregators and 35,448 smallholders in the final year (2017).[4] Of the 9 first-year aggregators, 7 are expected to be in the north in Kaduna and Kano states and 2 in the south. The aggregators will work with selected smallholders in specific local government areas (LGAs). Therefore, within a given village some smallholders will be a part of the pilot and some will not.

Several external factors might impact the success of the project. Most importantly, the policy and regulatory environment will affect the sustainability and success of the pilot. Simultaneous efforts are ongoing to change this environment, which will be important to track. Furthermore, any other donor efforts that affect awareness about aflatoxins, implement programs to promote aflatoxin control or impact maize yields in the region, will also be important to track. The next section examines the organization of Nigeria's maize sector and sheds more light on these external factors.

1.3 Overview of Nigeria's maize sector

1.3.1 Description of the maize marketing chain

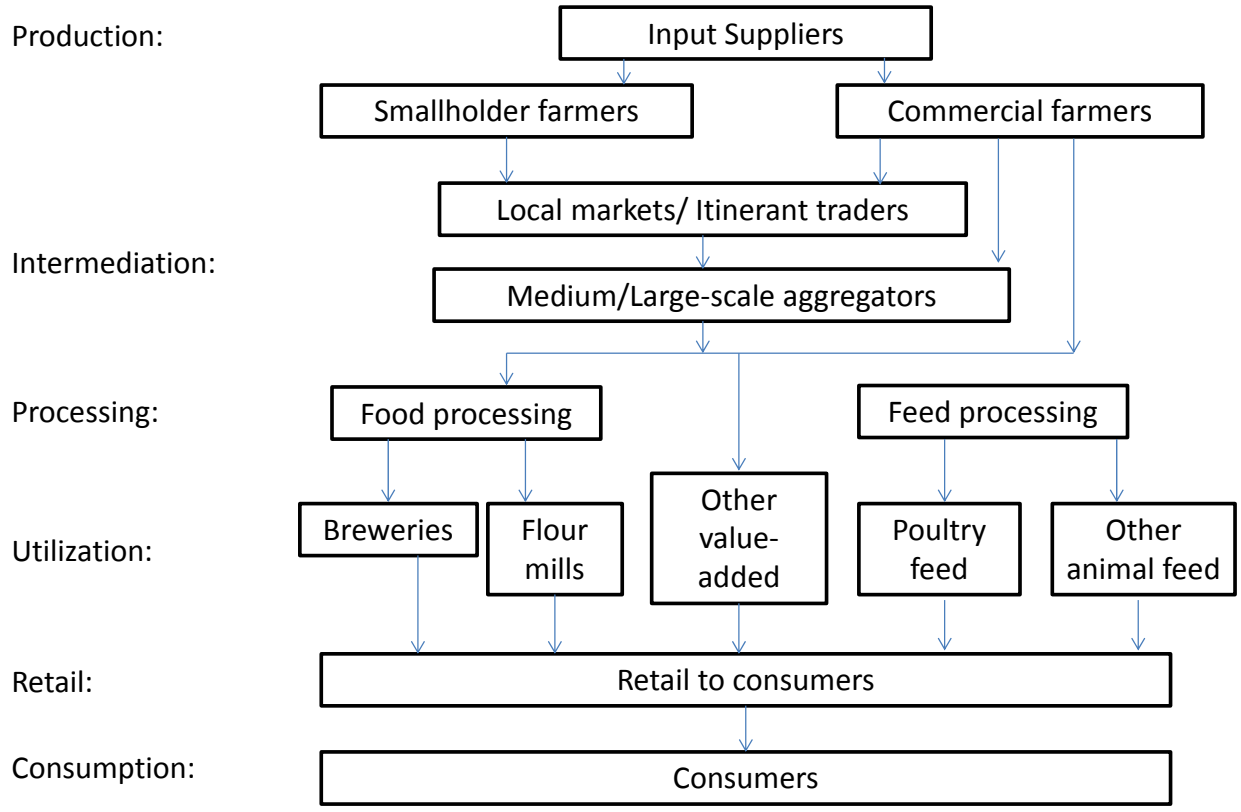
It is important to overlay the AgResults pilot requirements against the backdrop of the current organisation of the maize sector in Nigeria. Currently, only a few aggregators in Nigeria work

[4] These projections are approximate, as they are still being finalized by the Pilot Manager and Secretariat.

with smallholders in contract farming arrangements. Under these arrangements, aggregators provide extension support, credit support, and output buyback guarantees. The majority of the aggregators sell to the poultry feed sector, some of whose buyers have expressed a willingness to pay a premium price for aflatoxin-free maize. It is expected that most of these aggregators will seek to participate in the AgResults pilot. The question is what other entities will undertake aggregation because of the pilot—potentially, the actors in the Nigeria maize value chain with the greatest access to premium markets or the existing entities that procure and source grain for major processors such as seed companies.

Nigeria's maize marketing chain involves several major players: input suppliers, smallholders, intermediaries/traders (also sometimes referred to as aggregators), processors, retailers, and consumers. A diagram of the value chain is provided in Figure 1-3.

Figure 1-3. Nigeria maize value chain



Adapted from Dahlberg (2012, 70).

To support production at the start of the chain, smallholders obtain inputs such as seeds and fertilizers through three major avenues: the government's Growth Enhancement Support programme, a voucher-based input subsidy program; private agro-input dealers (operating in networks or as individuals); and outgrower schemes (or contract farming). There are then multiple levels of intermediation in the market post-production, reflecting varying scales and service offerings. Smaller farms sell to local traders, who either buy for their own retail stocks or who collect maize from local farms (either at the farm gate or at local collection points) for sale to larger traders in the market. Up to 40 percent of maize goes to these small traders, each of

whom typically operates with one to four trucks of 30 MTs capacity. As smallholders' marketable surpluses increase, smallholders themselves sell further downstream in the marketing chain to larger aggregators or even directly to processors. Likewise, intermediaries of differing sizes serve as aggregators at different scales and progressively "roll up" their sales to higher levels, with the maize ultimately being sold at the Kano market (which is the largest market in West Africa) or directly to processors. The largest traders and trade groups may transact as much as 10,000 MTs per year (Dahlberg, 2012).

As noted earlier, there are currently only a few instances where aggregators are engaged in contract farming with smallholders. The majority of these cases involve aggregators who sell to the poultry feed market. Overall, feed mills account for 60–70 percent of the grain that is processed in the country. Poultry farms consume 95 percent of the feed that is produced, with just nine large poultry smallholders accounting for 70 percent of that consumption. Both feed millers and poultry farms are largely concentrated in the southwest (Ibadan and Lagos areas) of the country. Breweries purchase 10 percent of processed maize, while millers producing branded flours for human consumption account for the other 20 percent of processed maize. The largest flour miller, Grand Cereals, is responsible for approximately 60 percent of all milled flour output (Dahlberg, 2012, 63–78).

While cash payment at delivery predominates aggregator–smallholder transactions, the less common contract farming arrangements involve advance purchase commitments and input provision by aggregators to the smallholders to enhance production. Price differentials at different levels of sale roughly reflect the services that are provided by the intermediary versus the smallholder (such as smallholders transporting the maize to a collection point versus the aggregators picking it up at the farm) as well as scale of production, with larger scale rewarded with better prices. Maize quality (often subjectively determined but based primarily on grain moisture levels and cleanliness) and smallholders' skill at negotiation also influence prices.

1.3.2 Gender roles in maize production and value addition

An array of characteristic gender roles influence participation in maize production and value addition (including marketing) in Nigeria.

At the farm level, land preparation is traditionally an activity performed by men, as it is considered heavy work. Land preparation is also the activity that is most likely to be mechanized, and is often hired out. Women are characteristically responsible for planting and weeding maize. Both men and women harvest maize (or this activity may be hired out), while women are responsible for post-harvest activities such as drying and shelling the maize. Men usually sell the maize. It is not yet clear whether women or men will be responsible for applying Aflasafe.

These generalized roles differ somewhat in Muslim families, as men undertake all activities (including seeding, weeding) that are field-based, and women only undertake activities (post-harvest) that do not require them to leave the family compound. In the North, Sharia Law introduces additional constraints, as unmarried women and men are not permitted to interact, which effectively precludes women from hiring out their labour.

An additional factor at the farm level is that women and men within a single household often take responsibility for cultivation of maize on different plots. This implies that, whether a

household head is a man or woman, maize production may be managed separately (and differently) by men and women. Implications of this for the pilot include that it will be important to identify who (men or women) applies Aflasafe, and to track Aflasafe application at the plot level. It will also be important to identify the managers of different plots and destination of production from different plots (in particular whether it will be sold or consumed by the household).

Women's participation in the maize value chain is typically focused on small-scale processing or retail, often undertaken on an informal basis, while large-scale aggregators, wholesalers, and processors are typically managed by men. Given the pilot's objective of generating an adequate volume of Aflasafe-treated maize for it to have a large-scale industrial impact, it is possible that female entrepreneurs will be *de facto* excluded. This potential tendency is reinforced by the fact that identification and preservation of the "Aflasafe-treated/aflatoxin-free" status of maize will require testing, certification, and segregation of the maize. This will make it difficult for small-scale retailers of maize, many of them women, to participate in the market. Because Aflasafe treatment cannot be determined visually, it will be difficult for them to convincingly convey to their clients that the premium product they are marketing is not counterfeit or contaminated with non-treated maize.

1.3.3 Hypotheses regarding pilot structure effects on implementation

Given this backdrop, strategic responses from the aggregators and smallholders may include the following actions that would affect pilot outcomes:

- Aggregators may have a natural proclivity to work with farmers who are more productive and have better access to inputs and resources (i.e., typically larger farmers). While the AgResults pilot requires aggregators to work with smallholders, it as yet does not have any clear mechanism to enforce this requirement. This may mean that larger farmers participate in the pilot, thereby reducing the pilot's benefits to the smallholders and their families.
- The focus on engagement of smallholders, with attendant limits on the maximum size of maize purchases for which aggregators will receive rewards, may, in some cases, lead some aggregators to contract smallholders at the sub-household level to supply maize from individual plots. For example, an aggregator who might not be able to contract a household with 20 hectares of maize could contract the male household head and female household head for 10 hectares each, thus qualifying for the per-unit award on those purchases. This could have the effect of increasing the inclusion—and empowerment—of women in the market if it directly engaged them in the training, negotiations, marketing, and other activities that otherwise might have engaged the male head of household by default.
- Aggregators may not sell the aflatoxin-free maize to premium markets if they face high transaction costs of accessing those markets or of storing and transporting aflatoxin-free maize separately from other maize, since the incentive payment is based on the amount of aflatoxin-free maize that is aggregated from smallholders, not the amount sold by aggregators to premium markets.
- Much, if not all, of the aflatoxin-free maize that does not get blended by aggregators into their overall stocks may get sold to existing premium markets—the export and feed sectors. Consequently, the pilot may have limited impact on increasing awareness and consumption of aflatoxin-free maize in domestic consumer markets in Nigeria.

- Smallholders may not retain any of the aflatoxin-free maize they produce for their own consumption if aggregators pass along incentive funds to smallholders in relation to the amount of Aflasafe-treated maize those smallholders deliver to the aggregator.
- Aggregators may not educate smallholders about the health benefits of consuming aflatoxin-free maize if aggregators perceive that smallholders without that knowledge will be willing to sell more of the aflatoxin-free maize they produce. Aggregators could provide Aflasafe as a stipulated crop additive as part of their contractual arrangements without revealing to smallholders that it makes the maize safer for human consumption. Even though it is not stipulated that aggregators raise awareness broadly about Aflasafe, it is an expectation of the pilot that such awareness is created to ensure adoption by smallholders.
- Smallholders not targeted by aggregators for participation in the pilot, particularly large smallholders with more resources of their own, may learn about the pilot's incentives, procure Aflasafe on their own (through smallholders in the pilot or directly from the market), and sell aflatoxin-free maize to aggregators. At a minimum, it is very likely that non-participating smallholders who live in the same villages as participating smallholders will become aware of Aflasafe and—if aggregators raise awareness of these issues with participating smallholders—about aflatoxins and their adverse health effects.

This set of complex potential interactions—and others that the discussion may not have anticipated—imply that the evaluation must collect extensive information on factors that may lead to the success or failure of the pilot in creating a sustainable market for aflatoxin-free maize. The rest of this document describes Abt Associates' proposed approach to assessing whether the AgResults pilot achieved its intended impacts and why—and if not, why not. The next section lists the evaluation questions to be addressed and the types of analytic methods—qualitative, quantitative, mixed—that will be used to address each question. Section 3 then presents details of the evaluation approach to be used in answering each question. Section 4 concludes by reviewing the evaluation's implementation timeline.

2. Evaluation questions and research methods

As noted above, the overarching objective of the AgResults Aflasafe pilot is to stimulate the development of a sustainable, private sector-driven market for aflatoxin-free maize, resulting in a reduction in adverse health impacts of aflatoxins.

The AgResults evaluation will answer seven questions that respond to this overarching objective using a mixed-method evaluation approach. Table 2-1 presents these evaluation questions along with the main method we will use to answer the question. Appendix A provides a more detailed mapping showing how each evaluation question corresponds to our data collection instruments.

Table 2-1. Evaluation questions and approaches

#	Evaluation Question	Evaluation Method
1	What has been the impact of the AgResults project/pilot on private sector engagement in the development and uptake of agricultural innovations?	Theory-based qualitative; Structure, Conduct, Performance (SCP)
2	What has been the impact of the AgResults project/pilot on smallholders' uptake of Aflasafe?	Impact evaluation using Randomized Control Trial (RCT) supplemented by qualitative interviews
3	What has been the impact of the AgResults project/pilot on smallholders' incomes?	Impact evaluation using RCT supplemented by qualitative interviews
4	What has been the impact of the AgResults project/pilot on poor consumers' demand for derivative food products (i.e., aflatoxin-free maize)?	*Study sample:* Impact evaluation using RCT *Urban consumers:* Qualitative point-of-sale surveys at retail outlets
5	What evidence exists that the AgResults pilot is scalable and that its effect will be sustainable in the medium to long term?	Combination of SCP, qualitative smallholder interviews, and demand analysis
6	What is the evidence on the scale of any effect on private sector investment and uptake and on the cost-effectiveness of AgResults as an approach?	SCP, with focus on market structure and per-unit cost effectiveness of key outcomes
7	What lessons can be learnt about best practices in the design and implementation of agricultural pull mechanisms?	Compilation of results from all AgResults pilot evaluations

We will also address, within each of the seven questions, whether the pilot's impact has had any gender-differentiated effects, and analyse the determinants of any such effects that are identified. Questions 1, 4, 5, 6, and 7 are related to the pilot's impact on the market and are perhaps the most important from the perspective of the contributions they make to the development policy learning agenda. To attribute a causal impact of the pilot on the market or private sector engagement, the evaluation has to contrast markets that are subject to the pilot pull mechanism with other markets that are not. Small numbers of market participants and multiple levels of interaction make it difficult to measure these consequences in a large, sample-based quantitative evaluation. Therefore, we will assess the market-level questions on the agenda (questions 1, 5, 6, and 7) using primarily qualitative methods—specifically, an SCP framework. We will

complement this market analysis with quantitative analyses of the effects of the mechanism on smallholder uptake of Aflasafe, incomes, and awareness and consumption of aflatoxin-free maize (questions 2, 3, and 4). But mixed methods will play a role in addressing all the questions; for example, we will use qualitative methods to help understand in depth the outcomes of the quantitative impact analyses of questions 2, 3, and 4 and assess the pilot's impact on consumer demand from urban households using qualitative methods.

In the next section, we present our evaluation approach for the specific evaluation questions posed.

3. Evaluation approach by question

3.1 Evaluation question 1: What is the impact of the AgResults pilot on private sector engagement in the market for aflatoxin-free maize?

Our evaluation of the impact of the AgResults pilot on private sector engagement in the market will analyse whether the pilot intervention enabled the emergence of a market for aflatoxin-free maize. It will document the structure of the market and the strategies of firms in the market, and will evaluate whether the pilot structure had a gender-differentiated effect on participation in the market or the accrual of gains from such participation.

We will use a theory-based qualitative approach—the Structure, Conduct, Performance framework—to analyse the effects of the AgResults pilot on the market for Aflasafe-treated/aflatoxin-free maize.[5] This framework delineates how the underlying conditions in a market influence the market's structure, which in turn influences individual firms' conduct in the market (such as decisions to invest in new market segments and technological and organisational decisions). Individual firms' decisions, at an aggregate level, lead to market performance outcomes of interest such as the adequacy of a product's supply in terms of volume and quality, prices, returns to investors, and responsiveness to consumer demand.

Building on the basic SCP framework, Sutton (1992) introduced the practice of examining how endogenous and exogenous sunk cost investments influence industry structure. This approach will be applied in the current analysis; it recognizes that firm strategic conduct is a direct response to market conditions and that aggregation of the outcomes of firm strategic behaviour gives rise to market structure. Thus, while the overall paradigm is referred to as SCP, the specific analytical model actually reflects a causal flow from Situation to Strategy to Structure to Performance (SSSP).

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

Individuals' and firms' strategic behaviours reflect their attempts to pursue profit and utility objectives given the constraints imposed by external conditions. Strategic behaviour includes such decisions as whether to invest in production facilities or a new venture, pricing and service

[5] The SCP paradigm is a product of the Industrial Organisation school of economics (Caves, 1987; Scherer & Ross, 1990). The use of SCP as an evaluation tool was pioneered by John Holtzman of Abt Associates (Holtzman, 2003).

delivery decisions, whether to register a company rather than to continue as an informal entrepreneur, and the choice of institutional arrangements between market actors such as the choice of contract structure.

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

The performance of a market can be understood in innumerable ways, but the main elements of interest for the AgResults pilot markets include whether a market for Aflasafe-treated/aflatoxin-free maize emerges and whether maize transacted in this market reflects the quality and volume preferences of maize buyers and is affordable to buyers while providing adequate returns to motivate suppliers to continue to engage in the market. In the case of the aflatoxin-free maize market in Nigeria, under-investment or no investment in production would lead to no or substandard products and services being generated. The result in terms of performance is a "missing" or "failed" market in which latent demand for aflatoxin-free maize is never expressed, while suppliers avoid investing in the production of such a product due to its risk and lack of promise. Table 3-1 summarizes the key evaluation method and the key outcome measures on which we will collect information to answer evaluation question 1. The following section presents the method, analysis plan, and data sources for qualitative analysis.

Table 3-1. Evaluation method and outcome measures for evaluation question 1

Evaluation Question 1: What is the impact of the AgResults pilot on private sector engagement in the market for aflatoxin-free maize?	
Evaluation Method	Outcome Measures
SCP framework that compares the baseline market situation, strategy structure, and performance for aflatoxin-free maize to the endline market situation strategy, structure, and performance, with baseline survey informing the hypotheses on expected changes in the market by endline.	• Market situation for aflatoxin-free maize Firm perceptions of : - Aflatoxins and potential solutions like Aflasafe - Supply and demand conditions for aflatoxin-free maize - Transaction costs and risk in acting in the market - Institutional environment and its implications for engagement • Market strategy for aflatoxin-free maize by value chain actors - Drivers for decisions to transact in aflatoxin-free maize - Procurement , distribution, and processing and merchandising strategy for aflatoxin-free maize • Market structure for aflatoxin-free maize - Flow of aflatoxin-free maize through the value chain - Number and types of private actors who participate in the market - Volume and share of volume transacted by different value chain actors - Difference in how women participate in the aflatoxin-free maize value chain • Market performance - Is there a market for aflatoxin-free maize? - Costs and benefits of participation in the market

3.1.1 Method

We will examine private sector engagement in the pilot using qualitative methods over the interval from early 2014 to late 2017. The baseline will be completed in early 2015, and the endline will occur during the last year of the pilot. The endline will cover all first-year aggregators of the pilot and aggregators from similar geography, covering Kaduna and Kano State in northern Nigeria and Ogun and Oyo State in southern Nigeria. In covering both the northern and southern states, the qualitative analysis will offer insight into the comparative impact of the pilot on private sector engagement in the two markets, differences in smallholders' responses to the opportunity to supply Aflasafe-treated maize to the market, and differences in consumer demand for Aflasafe-treated maize.

Our evaluation approach for evaluation question 1 will be organised around the SCP framework. The preliminary SCP framework, based on a qualitative assessment during the protocol design phase, will be the source of hypotheses that we will test regarding the baseline status of the market and the anticipated impact of the pilot on the market. We will adjust hypotheses for the endline survey on the basis of baseline results and any unanticipated adjustments to pilot implementation that might take place. We will also adjust hypotheses based on major developments in the market that might affect pilot impact but are not themselves presumed to be due to or influenced by the pilot (such as the entry of new players or policy changes).

As part of our hypothesis testing, we will conduct interviews with market actors who are engaged in the pilot and those who are not in order to elucidate factors that drive the decision to participate (or not) and implications of that participation (or lack thereof) for the development of the market for aflatoxin-free maize. To identify market actors who are not engaged in the pilot, we will work with the AgResults Pilot Manager to identify aggregators who were almost selected for the pilot but did not meet all the criteria. This will ensure that our comparative groups of market actors, particularly the aggregators, are as similar as possible to those who participated in the AgResults pilot. We will also examine the role of women in the market for Aflasafe-treated/aflatoxin-free maize, and explore how the emergence of this market has introduced opportunities or constraints to women, given their existing roles in the Nigerian maize markets in general. The next subsections present our hypothesized baseline scenario and the expected endline impacts.

Hypothesized baseline scenario

The basic conditions of the market for aflatoxin-treated maize in Nigeria include limited awareness on the part of consumers and most other market actors (with the exception of some poultry feeders and multi-national food companies) of aflatoxins as a threat to both human and animal health, non-enforcement of existing regulations about aflatoxin levels, limited demand for aflatoxin-free maize along the marketing chain, high information costs to determine the aflatoxin levels of maize that is transacted, and a lack of awareness or capacity for economical application of Aflasafe among smallholders, as well as severely limited availability of Aflasafe through commercial channels.

As a result of these conditions, smallholders, consumers, intermediaries, and processors do not actively engage in the market for aflatoxin-free maize. Market players such as large poultry smallholders, who are aware of aflatoxins as an issue, seek to mitigate them by rejecting feed that has high aflatoxin levels or through alternate methods such mixing clay binders into animal feeds. As a result of these factors there is no significant production of, nor trade in, aflatoxin-free

maize, such that a market for aflatoxin-free maize effectively does not exist. From a performance perspective, this is considered "market failure", as it is perceived that latent supply and demand exist and that market constraints impede the development of what would otherwise be a dynamic market for aflatoxin-free maize.

The baseline SSSP of the aflatoxin-free maize market are described in more detail below:

Situation

- Limited awareness on the part of smallholders and consumers of aflatoxins as a health threat (Dahlberg, 2012; Narayan et al., 2013):
  - "There is limited awareness among maize consumers, including smallholders, of the long-term adverse health effects of aflatoxin. Consumers do not demand aflatoxin-free food…because they do not perceive aflatoxin to be a problem". (Dahlberg, 2012, 12)
  - "Few maize-producing organisations and individual smallholders in Nigeria are currently aware of the aflatoxin problem. Those who are aware are unwilling to invest in reducing aflatoxin contamination without confidence that there will be a premium market for aflatoxin-free crops and without public sector enforcement of aflatoxin limits". (Dahlberg, 2012, 5)
- Regulatory limits on aflatoxin levels exist but are not enforced for maize intended for domestic consumption due to concerns over the food security impact of enforcement (Dahlberg, 2012; Narayan et al., 2013):
  - "According to IITA's estimates, 40–60 percent of Nigeria's maize crop would be deemed unfit for sale (if limits were enforced), jeopardizing perceived food security and the livelihoods of thousands of smallholders". (Dahlberg, 2012, 75)
- High information costs to determine the Aflasafe-treated and/or aflatoxin-free status of maize:
  - "Existing methods of aflatoxin, Aflasafe testing are expensive and time-consuming" (Dahlberg, 2012, 65)
  - "(A)n inexpensive and accessible testing method is not widely available to diagnose and monitor aflatoxin levels throughout the value chain". (Dahlberg, 2012, 12)
  - "The protocol for testing for Aflasafe is expected to involve a delay of several weeks between sampling and test completion…Participating organisations will receive payment as soon as Aflasafe prevalence in delivered maize has been verified" (Dahlberg, 2012, 18–19).
- Increased production costs means application of Aflasafe by smallholders is uneconomical at current yields:
  - "Higher levels of yield are therefore essential to reduce the cost of Aflasafe per MT of maize produced" (Dahlberg, 2012, 6)
  - Currently, yields are below 2 MTs/hectare, and business plan calculations estimate that a premium of $18.44/MT (3000 Naira) would be economical and attractive at yields of approximately 3 MTs/hectare (Dahlberg, 2012).

- Limited to no demand for Aflasafe by producers:
  - "No existing demand for Aflasafe..." (Dahlberg, 2012, 65)
  - "Smallholders, processors and other maize suppliers do not recognize that available aflatoxin control solutions, including biocontrol, are economical to use". (Dahlberg, 2012, 12)
- Limited supply of Aflasafe.

Strategy

- Retail companies do not monitor aflatoxin levels (Dahlberg, 2012, 65).
- Some poultry and other feeders test for aflatoxins and reject contaminated shipments and/or use clay binders to mitigate aflatoxin effects (Dahlberg, 2012, 65; Narayan et al., 2013).
- Maize traders and processors do not invest in serving aflatoxin-free markets.
- Smallholders do not use Aflasafe under current market conditions because to do so will increase their costs with no corresponding increase in price received—application of Aflasafe is uneconomical.

Structure

- Insignificant number of producers of Aflasafe-treated maize
- Insignificant volume of Aflasafe-treated maize produced and sold
- No differentiated market for aflatoxin-free maize, meaning no price premium or facilities to segregate Aflasafe-treated maize from mainstream maize.

Performance

- Market "failure" due to lack of information on the adverse effects of aflatoxins among consumers and producers that results in no provision of a product (aflatoxin-free maize) for which potential supply and demand could support market activity
- Human and animal health and productivity problems due to aflatoxins.

Hypothesized pilot impacts: endline scenario

Seen within this SCP framework, the AgResults pilot incentives are intended to "artificially" and temporarily alter the underlying conditions of the market by, for example, creating an expression of supply or demand where it would not otherwise exist, and through this change inducing private sector actors (such as millers, storage suppliers, or aggregators) to engage in the market. This engagement, if it is sustained and of adequate scale, should catalyse engagement by other parties (such as smallholders who take up a new technology to produce a product for which the millers or aggregators are offering premium prices). Eventually, if the reaction is sustained and of adequate scale, these responses will serve on aggregate to alter the structure and performance of the market to the point where its new configuration becomes self-sustaining.

The basic premise underlying the pilot intervention is that reducing the risk and increasing returns to transacting aflatoxin-free maize will unlock latent demand for it and stimulate the emergence of a market for it. That is, the pilot will "jumpstart the market by creating a surplus of aflatoxin-free maize" (Dahlberg, 2012, 6). It will also ensure that several necessary (but not sufficient) conditions for the establishment of a market are met. These include the availability of testing methods to determine the presence of Aflasafe in maize and a test for aflatoxin levels (or Aflasafe levels). Articulated within the SCP framework, the pilot will alter the basic conditions of the market, catalysing changes in firm strategy that, if significant, will lead to the emergence

of a differentiated market for aflatoxin-free maize. Thus, the hypothesized endline SSSP of aflatoxin-free maize market will be as described below.

Situation

Specific pilot interventions (each of which alters basic market conditions) include:

- Reward intermediaries who transact Aflasafe-treated maize
- Reduce costs of Aflasafe utilization by supporting activities to increase smallholders' yields
- Make Aflasafe available to smallholders
- Develop test for Aflasafe levels
- Develop test for aflatoxin levels.

Strategy

It is hypothesized that the changed basic conditions in the market will have the following effects on firm strategy:

- "Aggregator" firms (intermediaries/aggregators/traders) will respond to pilot incentives by engaging in the market for Aflasafe-treated maize. They will:
  - Supply Aflasafe to smallholders
  - Contract with smallholders for supply of Aflasafe-treated maize
    - Although the pilot seeks explicitly to create conditions for inclusion of smallholders in the market, aggregators may have a preference for working with larger farmers, who typically have better access to inputs and resources and can produce larger volumes of maize.
    - Pilot requirements that set a maximum farm size for aggregators to procure from while receiving the per-unit award may help to offset this proclivity. Meanwhile, the sustained interaction, yield enhancement, relationship building, and market expansion that take place throughout the pilot may create incentives for continued procurement from these smallholders once the restrictions on farm size are eliminated with the end of the pilot.
    - The limits on the smallholder size may also have unintended (and positive) effects on participation of women smallholders in the production of Aflasafe-treated maize if they lead aggregators to contract smallholders at the sub-household level to supply maize from individual plots. For example, an aggregator who might not be able to contract a household with 20 hectares of maize could contract the male household head and female household head for 10 hectares each, thus qualifying for the per-unit award on those purchases. This could have the effect of increasing the inclusion—and empowerment—of women in the market if it directly engaged them in the training, negotiations, marketing, and other activities that otherwise might have engaged the male head of household by default.
    - Although the pilot only pays its per-unit reward on Aflasafe-treated maize procured from smallholders, it does not prohibit procurement of Aflasafe-treated maize from larger farmers. This entry by large-scale farmers to the market could help bolster development of the market in general by increasing the availability of the product.
  - Link smallholders with yield-enhancing inputs.
  - Compensate smallholders for use of Aflasafe either through premium prices or advantageous contract conditions.

  - Invest in facilities to segregate aflatoxin-free maize.
  - Pursue linkages with buyers that demand aflatoxin-free maize. While there is existing demand for aflatoxin-free maize (detailed below), the pilot does not directly reward sales to those markets. Thus, aggregators, if motivated by short-term considerations and facing costs to develop markets, might choose to blend the Aflasafe-treated maize with their commodity maize rather than invest in the development of segregated markets.

- Large maize processors will buy Aflasafe-treated/aflatoxin-free maize if they perceive a market for it and adequate supply, and if costs of adapting current systems to aflatoxin-free maize are not perceived to be excessive relative to potential return.
- Some poultry producers and exporters have expressed demand for aflatoxin-free maize and may form the backbone of the downstream market for aflatoxin-free maize stimulated by the pilot.
- There is currently little awareness on the part of domestic consumers about aflatoxins, and so the potential end-market for aflatoxin-free maize for human consumption is latent; given existing demand for aflatoxin-free maize among other buyers and limited availability of Aflasafe-treated maize at the outset, there may be limited investment in developing the market for human consumption.
- Small-scale and informal actors in the market, such as open-air, market-based retailers of loose maize (many of whom are women), will not engage in the market for aflatoxin-free maize because they will lack means to verify and convey to their buyers that it is a different product from the visually equivalent commodity maize that they traditionally sell.
- Hypotheses regarding specific strategies for aflatoxin-free maize procurement include:
  - Reliance on contracts for suppliers of aflatoxin-free maize
  - Potential for multiple levels of intermediation (rather than smallholders supplying directly to processors) if intermediaries emerge with strengths in supplying aflatoxin-free maize
  - Prices for aflatoxin-free maize at the farm gate that will reflect the contractual package and may not include an explicit premium for being aflatoxin-free

- Hypotheses regarding specific strategies for value addition and merchandising of aflatoxin-free maize include:
  - Buyers will offer premium prices for aflatoxin-free maize at the intermediary/ processor level
  - Aggregators will invest in storage and recordkeeping facilities and training for employees to support segregation and identity preservation
  - Aggregators will have pre-arranged sales of value-added products to specialized clientele who are regular trade partners (rather than spot market sales)

Structure

The aggregate impact of these individual firms' engagement in the market is hypothesized to lead to the emergence of a market that will have the following structural features (Dahlberg, 2012, 31):

- A differentiated market for aflatoxin-free maize exists alongside the undifferentiated maize market (eventual 3 percent market share projected in business plan).

- An adequate number of producers are engaged to generate a significant volume of aflatoxin-free maize (35,000 smallholders producing Aflasafe-treated maize are anticipated by the end of pilot implementation).
- At the outset, transactions of aflatoxin-free maize are expected to take place between a limited subset of maize market participants who are already aware of aflatoxins as an issue, and who see a direct potential benefit to engagement in the market.
- The following types of market actors are expected to be early entrants to the market:
  - Smallholders who contract with pilot aggregators to produce Aflasafe-treated maize
  - Intermediaries (aggregators) who are either pilot aggregators or purchasing on their behalf
  - Large-scale poultry and livestock feeders
  - Multi-national value-added food companies
- Entry of other market actors will depend on the effectiveness of awareness raising about aflatoxins, perceptions of the benefits versus costs of transacting aflatoxin-free maize, and the availability of adequate volumes of aflatoxin-free maize to support demand that emerges.

Performance

The market performance outcome hypothesized to result from these changes is the emergence of a sustainable market for aflatoxin-free maize. Specifically sought is the "…emergence of reliable premium markets for aflatoxin-free maize, along with access to testing devices, Aflasafe, and yield-enhancing inputs" (Dahlberg, 2012, 28).

3.1.2 Analysis plan

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

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

Field data collection instruments for sector experts, traders, processors, farmers, and processed maize buyers (both animal feeders and retailers for human consumption), as well as data needs from the large-sample farmer survey, are presented in Appendixes B and C of this document.

3.1.3 Data sources

We will collect data on the structure of the aflatoxin-free maize market from several sources. Data on sales of aflatoxin-free maize and their destinations will be collected by project verifiers under the supervision of the AgResults Secretariat (a list of data needs is provided in Appendix B). The baseline and endline qualitative smallholder surveys (Appendix C) will provide data on the characteristics and activities of smallholders growing aflatoxin-free maize and the movement

of maize following sale. Complementary qualitative surveys of farmers, detailed under evaluation question 2, will provide further insight into farmer participation in the market for aflatoxin-free maize. We will use small-sample surveys with input suppliers, traders, processors, and retailers to estimate current and potential market flows of Aflasafe and aflatoxin-free maize. Here we anticipate conducting 200 phone interviews that are targeted to 20 types of actors with about 10 phone calls for each type of actor (including women actors where possible). We will use a lesser number of key informant interviews with those players to determine how aflatoxin-free maize fits into their overall business strategies and their perceptions of market conditions, and how these influence their strategies. We anticipate conducting approximately 80 such long interviews with three potential types of key informants (including women informants where feasible). We will interview sector experts to obtain overarching insight into the market as well as for triangulation of results coming from the market actor data collection interviews.

We will record the large majority of the qualitative data (for this and other questions) using verbatim notes, and where necessary we will record the interview. We will enter the data into Microsoft® Excel, and will clean and analyse them (for side-by-side comparison of responses), with different files for each of the three stages—data entry, cleaning, and analysis.

The evaluation of the pilot's influence on private sector engagement in the market and farmer uptake of Aflasafe will investigate the following questions, organised according to the logic of the SCP framework and responding to the hypotheses defined within that framework in its preliminary application to the market. The organizing logic of the inquiry will move from the most easily ascertained aspect of the market (its structure) to the firm strategies and conditions driving those, and indications of market performance. Collection of these data will be partly informed by the product flows identified in the analysis of market structure.

Performance

- Does a market for aflatoxin-free maize exist?
- Are the costs and benefits of participation in the market adequate to ensure its sustenance?

Structure

- How is the value chain for aflatoxin-free maize structured in terms of how aflatoxin-free product flows through the market?
- How many private sector actors of different types participate in the market?
- What volumes, and shares of volumes, are transacted by different types of actors?
- Does women's participation in the value chain for aflatoxin-free maize differ from their patterns of participation in commodity maize markets? In what ways? What factors drive these differences?

Strategy

- What drives the decision of whether or not to transact aflatoxin-free maize?
- What are procurement strategies for aflatoxin-free maize?
  - Sources
  - Organisation of procurement
  - Relationships with suppliers
  - Quality control
  - Pricing

- What processing and distribution strategies are employed?
  - Investment in facilities/equipment and human capital for processing and distributing aflatoxin-free maize
  - Product segregation and identity preservation relative to non-aflatoxin-free maize
- What merchandising strategies are employed?
  - Target markets for aflatoxin-free maize (defined by buyer characteristics and geography)
  - Packaging
  - Promotion
  - Pricing

Basic conditions: What are firms' perceptions of the following, and how do those perceptions influence their decisions and strategy around engaging in the market for aflatoxin-free maize?

- Perception of supply conditions
- Perception of demand conditions
- Perception of transaction costs and risk inherent in acting in the market
- Perception of institutional environment and its implications for engagement
- Awareness of aflatoxin as an issue and of potential solutions such as Aflasafe
- Perception of economics/effectiveness of available solutions to aflatoxin contamination
- Ability to realize conditions required for Aflasafe or aflatoxin-free maize to work as a solution for them

The in-country Agricultural Economist, under supervision of the impact evaluation team's Qualitative Lead, will undertake data collection and entry. With the exception of data collection using small-sample surveys, interviews will be held in person at the site of the respondent's maize-oriented operations (if feasible). Small-sample surveys, which are intended to provide information on flows of aflatoxin-free maize, may be conducted by telephone. The in-country Agricultural Economist will enter data into a template provided by the Qualitative Lead and will transmit them to the United States. Abt's Qualitative Lead will train the in-country Agricultural Economist in the SCP model and appropriate data collection methods prior to implementation of baseline data collection activities.

We will collect data from each type of market actor (except consumers, from whom data will be collected to answer evaluation question 4) identified in Figure 1-3 above. The in-country Agricultural Economist will begin by identifying listings of potential respondents among each of those groups, disaggregated by gender. Respondents among those groups will be selected on three bases: (1) ensuring that the largest players (of which there tend to be few) are represented; (2) randomly selecting from among remaining players (we will specify numbers following collection of information on possible respondents); and (3) specifically ensuring that women involved in the market are represented. We will seek two levels of response from different categories of respondents. First, we will conduct brief structured surveys with relatively small samples of each type of actor to collect data on their activities (if any) with aflatoxin-free maize during the baseline and endline periods. Second, we will select a separate, smaller sampling (again, including major actors) and request respondents to participate in extended key informant surveys. We will determine the number of surveys and questionnaires to be conducted following the identification of market participants by the in-country Agricultural Economist.

3.2 Evaluation question 2: What has been AgResults' impact on smallholders' uptake of Aflasafe?

Aflasafe is ultimately intended to improve the health of consumers. One of the challenges in measuring impacts on health is that aflatoxin prevalence depends on environmental factors such as rainfall, moisture, and temperature. It is possible that aflatoxin prevalence could be naturally low at the time of evaluation observations in both the intervention sample and in a comparison group against which impacts are measured—giving a potentially misleading impression that pull mechanisms have no impact or only a small impact on reducing aflatoxin presence in the maize since there was little room for improvement. In contrast, in a year in which farming conditions are favourable to aflatoxin accumulation, a substantial impact could be observed. Therefore, it is important to measure the impact of AgResults on an indicator that, over the course of many harvests and hence on average, will create crops with less aflatoxin and *in every year* has the potential for experiencing substantial impacts. The measure we have chosen for this purpose is the presence of Aflasafe in harvested maize. We will address evaluation question 2 on Aflasafe technology uptake by assessing whether smallholders applied Aflasafe at the right time and at the right application rate, and by testing for the presence of Aflasafe in harvested maize.

We will estimate impacts on these and other smallholder outcomes—including farming activities and on-farm consumption of Aflasafe-treated maize using the impact inference design described below. We also in this section describe our data analysis plan, the sampling plan, the power analysis, the supporting qualitative analysis, and data sources for the supporting qualitative analysis. We will use the same quantitative method to assess the impact on smallholder income (question 3) and the impact on smallholder demand for derivative aflatoxin-free food products (question 4). For this reason, the text below also serves as a general framework for evaluation questions 3 and 4. Table 3-2 presents in summary the key evaluation method and the key outcome measures to answer evaluation question 2. Subsequent sub-sections describe in more detail our method, data analysis plan, and data sources for the quantitative analysis (Section 3.2.1) and qualitative analysis (Section 3.2.2).

Table 3-2. Evaluation method and outcome measures for evaluation question 2

Evaluation Question 2: What has been AgResults' impact on smallholders' uptake of Aflasafe?	
Evaluation Method	Outcome Measures
• RCT: Villages listed by participating aggregators randomly assigned to receive the intervention or not. • Quasi Experimental Design (QED): For aggregators that do not agree to participate in the RCT, villages similar to those chosen by the aggregator will serve as comparison group.	• Smallholders' correct use of Aflasafe: dummy variable equal to 1 if smallholder applied Aflasafe at the right time and the right application rate with an acceptable range – measured at baseline and endline. • Presence of Aflasafe in smallholders' maize samples bound for sale: dummy variable equal to 1 if presence above 70% detected – measured at endline. • Presence of Aflasafe in smallholders' maize samples for own consumption: dummy variable equal to 1 if presence above 70% detected – measured at endline.

3.2.1 Quantitative analysis

Method

The impact of the intervention is expected to vary by aggregator because the aggregators differ in the contractual arrangements with the smallholders, particularly in how much training they provide to the smallholders and how much of the incentives they share with the smallholders—both of which can lead to potentially very different impacts. The overall focus of the evaluation is on the impact of the "average" aggregator; thus, the primary estimate of interest will be the average impact of the AgResults intervention across all sampled aggregators. Below is a list of the seven aggregators that we expect to evaluate, as well as their geographical zones of influence:[6]

- CADP Kaduna, which will work in Kaduna State in nine LGAs
- Nuhu Umar, formerly associated with CADP Kaduna, which will work in Kaduna State in the Giwa and Birnin-Gwari LGAs
- Danladi, which will work in Kano state in approximately eight LGAs
- Babban Gona Saulawa (Doreo Partners), which will work in Kaduna State
- Fantsuam Foundation, which will work with women in Kaduna State in the Jema'a, Kaura, Jaba, and Zangon Kataf LGAs
- Maslahaseeds, which will work in Kaduna and Kano States but has not yet determined the LGAs in which it will operate
- Ahalson Enterprises, which will work in Kano State across Doguwa and Tudun Wada LGAs.

Although the pilot offers incentives to aggregators for the promotion and use of Aflasafe, aggregators did not plan to begin encouraging the use of Aflasafe with all smallholders in the first few years of the pilot. Instead, all aggregators planned a "phased" engagement with villages: they planned to work with smallholders in some villages in 2014, additional villages in 2015, and still more villages in 2016. Within the selected villages, aggregators had also identified smallholders whom they expected to engage in the pilot.

To estimate the aggregators' impact on smallholder outcomes, we must compare the participating smallholders' outcomes to the outcomes they would have obtained in the absence of the Aflasafe pilot. To make this comparison, we must identify appropriate sets of comparison villages and smallholders. Villages and smallholders selected by aggregators will naturally differ from non-selected village and smallholders on a range of factors that we, the evaluators, cannot observe. The impact evaluation must account for these unobservable factors, so that these unobservable differences are not mistakenly attributed to the impact of the pilot—a phenomenon called "selection bias".

Recognizing our interest in eliminating selection bias and the aggregators' dilemma of fairness in selecting which villages to engage in which year, we worked with six of the seven aggregators to randomize villages that they would begin to work with in 2014 (Cohort A), 2015 (Cohort B), and 2016 (Cohort C). Just prior to the third year of pilot implementation in 2016, we can compare the villages in Cohort A and Cohort B ("treatment villages") to villages in Cohort C ("control

[6] This list names 7 of the 10 aggregators anticipated in the North. The evaluation has the potential to add a year 2 implementer from the South, if resources allow and there is sufficient time to develop the evaluation plan.

villages") in order to estimate the impact of aggregators' first and second year implementations.[7] The potential for selection bias arising from the aggregators' selection of villages is addressed, because the comparison group consists of villages that were selected in the same manner in which the treatment group villages were selected. Except by chance, the treatment and control groups will not differ on any factors affecting subsequent smallholder outcomes besides their exposure to the AgResults intervention. Once chance is ruled out as an explanation for the reason that measured outcomes differ on average between the treatment and control groups (through tests of statistical significance), any remaining difference has to be a consequence of the pilot's influence on the treatment group—an influence missing in the control group.

The second type of selection bias, the aggregators' selection of smallholders with whom to work, is addressed by our selection of the sample frame of smallholders. Within villages in each cohort, aggregators identified smallholders whom they expected to engage in the pilot. Because the aggregators identified targeted smallholders *prior to the randomization of villages*, we can carry out the division of the population into targeted smallholders and other smallholders for sampling purposes symmetrically in the treatment group villages and the control group villages. This feature preserves the comparability of the treatment and control components of the impact analysis sample, even in the presence of uneven sampling of subpopulations within the treatment group and within the control group. At this time we do not have precise estimates of the percentage of smallholders in the treatment and control villages that the aggregators are targeting for participation in the pilot, but we estimate this percentage to be roughly 5–15 percent. Of the targeted smallholders, we anticipate that 50–80 percent of the smallholders identified by the aggregators will participate in the pilot activities.

We will conduct the baseline survey for the evaluation in 2015 before Cohort B implementation begins. Abt had initiated a baseline survey in 2014 before Cohort A implementation began, but had to terminate that effort because of data quality concerns. We are using the lessons learnt from this effort to strengthen our data quality assurance in the 2015 round, given the security concerns in Nigeria. Of the six aggregators who agreed to the randomization design in 2014, only four aggregators reported success in adhering to the randomized design when we met with them after the planting was completed for the first year of the pilot: Danladi, Maslahaseeds, Nuhu Umar, and CADP-Kaduna. Although Ahalson Enterprises and the Fantsuam Foundation initially agreed to be part of the randomized evaluation, they had difficulty adhering to the randomized assignment of villages in the first year of the pilot (Cohort A). They have agreed to work with us to re-randomize the list of villages being engaged under Cohorts B and C, and thus we will be able to use our experimental approach to measure impacts on Cohort B. However, the non-random selection of Cohort A villages by these aggregators requires us to pursue a quasi-experimental matching approach to measure impacts on Cohort A for this minority portion of the sample.

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[7] As noted above, the pilot is expected to run for one more year, presenting an opportunity to assess impacts after an additional year's pilot implementation. Therefore, we hope to work with the implementers to keep Cohort C untouched until the fourth year of the pilot, but will be prepared to conduct our endline in the third year if implementers expect to roll out the pilot in Cohort C villages in the third year itself.

The seventh aggregator to be included in the impact evaluation, Babban Gona, from the onset wished to use an existing, well-defined selection procedure to identify the communities and smallholders it enlists into the AgResults pilot. Historically, the organisation has expanded its scale geographically in approximately concentric, ever-widening circles, and it is not open to a randomized process for selecting communities that would run counter to this approach. Moreover, because the village leader and smallholder screening and recruitment processes are time consuming and costly, the organisation is not willing to identify at the outset all of the communities and smallholders it will serve over the four years of the pilot. However, it can identify the overall geographic areas in which it expects to work by the end of the pilot. Hence, the study team can screen communities and smallholders in the treatment area to select a comparison group of "like" cases to those that Babban Gona selected through the same process in the baseline year—the treatment group. We examined villages in neighbouring LGAs, as they will be similar in terms of weather, maize markets, and other farming determinants. After consulting with Babban Gona representatives and analysing secondary data from these LGAs using the Living Standard Measurement Survey – Integrated Survey on Agriculture (LSMS-ISA) data, we have determined that villages in Bakori and Danja LGAs from Katsina state are the most suitable counterfactuals. Computing a "distance" metric using these data is of limited use due to the paucity of samples in the region of interest; however, using the 2010/11 LSMS data, we examined data on total land holdings, fertilizer usage, maize production, maize sales, and household expenditures in order to further refine the sample.

The selection of villages for the Babban Gona comparison group is not the only task. We have worked with Babban Gona to understand the criteria by which they select smallholders to participate in the Aflasafe pilot activities. Babban Gona works with smallholders with less than 2 hectares of land and those who have been growing maize for the last five years; thus, we will randomly sample smallholders meeting these criteria in the comparison villages. Moreover, the study team will check how accurately it succeeded in applying the selection criteria once Babban Gona begins its own recruiting in the final year's geographic bands.[8]

Given the current and potential issues with adherence to randomization and the seventh aggregator, which has not agreed to randomization, our evaluation reports will include impact estimates from the full set of aggregators, as well as separate findings for the set of aggregators that use the more rigorous random assignment design. Impact estimates that pool all aggregators will not be free from confounding factors arising from selection bias in the determination of treatment and control group villages for Babban Gona and the aggregators not adhering to the randomization assignments (Ahalson Enterprises and the Fantsuam Foundation).

Depending on when activities initiate in Cohort C villages (2016 or 2017) and therefore the timing of the endline survey, we will measure the impact of either two or three years' pilot implementation on smallholder outcomes by comparing smallholders in villages targeted by aggregators in spring 2014 (Cohort A) with smallholders in similar villages not targeted until the last year of the pilot (Cohort C). In addition, we will study the impact of either one or two years of pilot implementation on smallholder outcomes by comparing smallholders in villages targeted

[8] Unfortunately, we cannot wait for Babban Gona itself to make the selection of final year villages and smallholders since the evaluation needs to conduct baseline interviews with all farmers in the study sample.

by aggregators in spring 2015 (Cohort B) with smallholders in similar villages not targeted until the last year of the pilot (Cohort C). We thus have four contrasts depending on when the endline survey occurs:

2016 Endline Survey	2017 Endline Survey
• Two-year impacts in the RCT group (Cohort A versus Cohort C, four aggregators)	• Three-year impacts in the RCT group (Cohort A versus Cohort C, four aggregators)
• Two-year impacts in the entire group (Cohort A versus Cohort C, seven aggregators)	• Three-year impacts in the entire group (Cohort A versus Cohort C, seven aggregators)
• One-year impacts in the RCT group (Cohort B versus Cohort C, six aggregators)	• Two-year impacts in the RCT group (Cohort B versus Cohort C, six aggregators)
• One-year impacts in the entire group (Cohort B versus Cohort C, seven aggregators)	• Two-year impacts in the entire group (Cohort B versus Cohort C, seven aggregators)

We next discuss the data analysis method, sampling plan, and power analysis that support the quantitative analysis.

Analysis plan

A straightforward method to answer evaluation question 2 is to compare the mean outcomes for smallholders in the treatment group to the mean outcomes of the smallholders in the comparison group. This is a valid approach for the RCT contrasts, but it does not maximize statistical power for determining whether any apparent impact (i.e., outcome difference) is real or an artefact of chance (i.e., for running statistical hypothesis tests of the null hypothesis of zero impact). A better approach, which does more to rule out chance as the possible explanation, is to use a regression model that includes covariates such as baseline smallholder characteristics, including demographic variables, farm characteristics, and other measures of available labour and capital inputs for farming. The regression model is also preferred for the quasi-experimental contrasts, because the inclusion of baseline covariates will "control" for observed, systematic differences between the treatment and control groups that are not due to chance alone. The set of covariates will include a "fixed effect" for each aggregator. This fixed effect represents the average effect on smallholders of working with a specific aggregator: smallholders associated with the same aggregator are likely to experience similar market factors (e.g., local maize prices) as well as similar exogenous shocks that affect maize production.

We will conduct a statistical test to determine whether any regression-adjusted mean difference in outcomes is statistically significant. To conduct valid inference on the estimated impact, we will need to take into account that geographically proximate groups of smallholders might have correlated outcomes. In particular, we view smallholders in the same village as likely to have correlated outcomes because they share a knowledge network, common soil quality, aflatoxin risk, and possibly other common unobservable factors. We will account for this correlation by using *village-level random effects* in the regression impact estimation model.

To summarize, the regression model will have the form suggested in Equation [1], where the treatment indicator T_i is equal to one if the smallholder is in the treatment group, and zero otherwise. The estimate of β measures the average impact of the intervention on outcome *Y*. Each smallholder *i* obtains outcome Y_i, has *M* baseline characteristics x_{im} (where a_m is the estimated coefficient for each baseline characteristic *m*), and a random smallholder-specific factor ε_i. (Smallholder baseline characteristics will not be included for the RCT and whole-group contrasts between Cohorts A and C, due to lack of baseline for Cohort A smallholders.) There are *Q* aggregators, I_q is the aggregator indicator variable, and average outcomes vary by the aggregator the smallholder is working with (τ_q). Each smallholder shares a common village random effect γ_k with other smallholders in village *k*.

$$Y_i = \sum_{q=1}^{Q} \tau_q [I_q] + \sum_{m=1}^{M} a_m x_{im} + \beta T_i + \gamma_k + \epsilon_i \qquad [1]$$

We will estimate this regression model for all outcome measures regardless of the scaling of the measure (i.e., we will use Equation [1] as a linear probability model for the binary outcomes and as a linear regression for continuous outcomes).

For evaluation question 2, we will estimate Equation [1] using a linear probability model where the dependent variable is binary equal to one if the smallholder adopts Aflasafe as prescribed by the pilot and zero if the smallholder does not adopt it or adopts it with inaccuracies. We will work with the Pilot Manager and technology experts to determine the minimum application (and timing) of Aflasafe that can be considered as "adopted". In addition, we will estimate a linear model where the dependent variable is a continuous variable measuring the reported application of Aflasafe per hectare, and the prevalence of Aflasafe in the harvested maize. The coefficient on the treatment dummy, β, above will give us project impact on uptake of Aflasafe.

In order to understand the pathway to this final outcome, we will estimate variations of Equation [1] where the outcome variable is knowledge about the Aflasafe technology and access to that technology.[9] We will conduct these ancillary regressions particularly if we do not find a project impact on technology adoption. The results of these two estimations will tell us if the project had an impact on the smallholders' knowledge about the technology and their access to it.

As part of the quantitative analysis to assess awareness, we will also assess if smallholders' awareness translates to awareness among household members who are responsible for cooking (typically women). We will also assess whether the translation of awareness to consumption decisions occurs more easily when smallholders are women.

[9] It is important to note that several awareness programs are ongoing, most notably those of IITA and NAFDAC. In addition, some aggregators have initiated early awareness campaigns to recruit farmers. This implies that our impact estimates will provide impact of AgResults over and above the general awareness campaigns.

Baseline equivalence

We will report the mean and standard deviation of smallholder baseline characteristics in the treatment and comparison group for all of the regression models that we analyse (i.e., pooled across all aggregators, pooled across the aggregators that use a randomized controlled design, and separately for the aggregators that are not using a randomized controlled design). This "baseline equivalence" analysis will indicate which baseline characteristics differ between the treatment and control groups at a statistically significant level; we will discuss the implications of any that do. We will also include in the impact regression model any baseline variable that differs significantly between the treatment and control group for a given sample, in addition to including the baseline variables we expect to be important determinants of the outcome of interest in their own rights.

Differential impact on subgroups of smallholders, including women

In addition to reporting the overall average treatment effects, we propose to estimate the treatment effects for various subgroups of interest. The populations of interest include women and smallholders who at baseline are less credit-constrained, have a higher level of education, have a larger pool of potential labourers, or have more (or more advanced) farming inputs. All of these groups may experience different intervention impacts from smallholders not in these categories. We have not built the outcome survey sample at a scale providing for confident analysis of subgroup-specific effects, given that we can use only a portion of the data for each examined subgroup. But it will be feasible to detect impacts on subgroups of an important magnitude for outcomes concerning Aflasafe technology adoption (the same is not true for impacts on smallholder income or consumption by subgroup):

- Women smallholders
- The top 30 percent of smallholders in terms of farm area, versus all other smallholders
- The top 30 percent of smallholders in terms of baseline ownership of farming equipment, versus all other smallholders
- The top 30 percent of smallholders in terms of baseline farming revenue, versus all other smallholders.

Data sources

We will answer question 2 (and questions 3 and 4) using panel data collected at the baseline and endline of the pilot interventions using surveys of samples of smallholders drawn from the treatment and control group villages. Our survey instrument (see Appendix C) uses items from proven survey instruments and thereby takes advantage of questions and methods that have already been tested and have established test–retest reliability such as the World Bank's LSMS in Nigeria (Abt Associates, 2014). The survey instrument includes the following modules and key variables:

- Module 1: Household Identification, Demographics and Assets
  - Information on household location, members, education and demographics, and physical assets
- Module 2: Inputs to Production
  - Plot-level information on land usage, agricultural inputs, extension services, labour, and practices

- Module 3: Harvest and Marketing
  - Plot-level information on harvest amounts, storage practices, total costs, and revenues
- Module 4: Household Finances
  - Information on non-farm incomes, credit, and savings habits
- Module 5: Aflatoxin Awareness and Maize Consumption (asked of lead smallholder and primary person involved in preparing food for the household)
  - Information on knowledge and practices regarding aflatoxins and a complete roster of all children living in the household and their maize consumption in the last 24 hours.

In addition to the smallholder survey, we will conduct random sampling of smallholders' harvested maize to measure the prevalence of Aflasafe. Although the details have not been worked out, we anticipate that survey takers will collect small-volume samples of the smallholders' harvested maize for laboratory testing.

Sampling plan

The overall focus of the evaluation is on the impact of the "average" aggregator; thus, the primary estimate of interest will be the average impact of the AgResults project across all aggregators. As a result, the sample is stratified by aggregators. Villages selected by aggregators for the pilot will be the primary sampling unit, and smallholders identified by aggregators within villages will be the secondary sampling unit. The sample will be self-weighting because each AgResults village and each AgResults smallholder within the AgResults village will have equal probability of selection.

All aggregators (except Babban Gona) have agreed to provide a complete list of AgResults villages they plan to work with over the course of the pilot. This roster of AgResults villages for all six aggregators that agreed to the randomization constitutes the "population" of a given aggregator's villages, from which we will randomly assign a subset of villages to each cohort. However, the number of villages allocated to each cohort depends on the individual aggregator's preference and capacity to engage villages in each cohort, which they conveyed to us during an evaluation design workshop.[10] For each village the aggregators will also provide the list of smallholders they expect to work with, from which we will randomly select smallholders for interviews.

For Babban Gona, we have identified comparison group villages in the Bakori and Danja LGAs in Katsina state. We will randomly select villages from these LGAs and use systematic, random sampling to select smallholders within the LGA that meet the selection criteria used by Babban Gona.

Stratified sampling improves the chances of detecting aggregator-specific impacts. However, the chance of detecting aggregator-specific impacts is still low (i.e., the sample size is unlikely to be adequate to test for statistically significant differences in aggregator-specific impact estimates).

[10] If any implementer expresses the desire to require a specific village to be implemented in a certain year, that village is excluded from the sample.

The exception is Babban Gona, for which we have sampled adequately to detect aggregator-specific impacts. This is because Babban Gona has a very unique model, is expected to work with the largest number of smallholders, and may have the biggest impact.

In terms of geography, the study sample will be representative of the type of smallholders that typical aggregators may engage in contractual arrangements for maize procurement in the northern states of Nigeria because the study sample will cover the key states in the North: Kaduna, Kano, and Katsina. Since the northern states of Nigeria are the primary maize-growing belt, the results of the evaluation will provide generalizable results for this area. If we are able to include new aggregators from the South, the study results will have broader applicability. Our qualitative investigation that articulates the maize value chain in the North and the South will help us elaborate the potential conditions of success of the pilot, which are typically characteristics that are homogenous within the study sample.

Power analysis

We will administer the surveys to the smallest number of smallholders that will allow for detecting expected impacts with statistical confidence. Our power analysis focuses on the minimal detectable impact (MDI), where the MDI is the smallest impact that can be expected to be detected. We employ typical power parameters (i.e., an 80 percent chance that the evaluation will detect the MDI if the impact is as large as the MDI, a 5 percent chance that the evaluation will identify a statistically significant effect even if there is no true impact, and the plausibility that the impact may be positive or negative). Our calculations follow Schochet (2005) for a cluster-randomized experiment. Additional assumptions are detailed in Appendix D.

To determine the MDI, we took into account the pilot's business plan and the data we received from the 2013 pre-pilot implementation on expected impacts. In addition, when developing our samples we took into account our expectations about adherence to randomization by aggregators so that we account for likely contingencies for compliance and non-compliance and ensure adequate study power in all scenarios.

The pre-pilot implementation year, as reported by Deloitte, is believed to have achieved the following results in one year:

- An increase of at least 43 percentage points in the proportion of maize harvest treated with Aflasafe above the incentive threshold (>70 percent Aflasafe)[11]
- An increase in net annual revenue according to the Aflasafe business plan—i.e., of smallholder income—of $130 per acre.[12]

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[11] Based on data from the pre-pilot implementation (or year 0), "Process and Procedure for Aflasafe in 2013 – AgResults Project", the pilot engaged 1015 farmers across all aggregators of which 660 farmers applied Aflasafe and from whom the aggregators procured maize. Information was available on total maize production for these farmers (1691 MTs), but maize production data were not available for farmers from whom aggregators did not procure maize. Using average maize production per farmer, from farmers that aggregators procured maize from, we estimate that the total maize production for all 1015 farmers was about 3600 MTs in the 2014 planting season. Of this total, an estimated 47 percent (1691 MTs) of maize was aggregated, and 42.6 percent (1538 MTs) was deemed by the pilot verifiers to have a mean percentage of Aflasafe above the threshold (70 percent Aflasafe presence). In summary, in the pre-pilot approximately 43 percent of maize had Aflasafe levels above the threshold.

Proposed MDI

Recognizing that unforeseen challenges may arise, we adopt a conservative approach of designing a sample with MDIs of 12 percentage points in the proportion of maize treated with Aflasafe, and $65 in net revenue per acre among targeted smallholders. The latter would be achieved if a $130 revenue increase occurs among targeted smallholders even if only 50 percent participate. Since expected impacts are greater than these MDIs, we believe that the evaluation is well powered to detect success from the Aflasafe pilot should it occur.

Proposed sample size

Given our target MDI and power calculations, the planned baseline survey in early 2015 will include 1700 completed interviews with smallholders. To arrive at this total, we considered first the number of endline survey respondents needed to detect with confidence an average impact on net revenue per acre of $65 among targeted smallholders. Sample sizes needed to detect the expected changes in net revenue are higher than those to detect change in proportion of maize treated with Aflasafe; thus, the power analysis and the following discussion focuses solely on net revenue outcomes.

To account for imperfect adherence to random assignment of villages to implementation cohorts, we have planned a baseline survey that fits all likely contingencies for compliance and non-compliance over the course of the pilot. This is important because we cannot know ahead of time how all members of the endline survey sample will be used in the impact analysis. Therefore, the necessary size for the endline survey will depend on the distribution of a total sample size across aggregators that

- Adopt an experimental design and implement it faithfully
- Adopt an experimental design and achieve only partial adherence
- Do not adopt an experimental design.

We know one aggregator in this last category with certainty: Babban Gona. We also know with certainty the combined group of aggregators that will fall into the first two categories. What we do not know, and cannot know in time for baseline survey administration, is how the six experimental aggregators will divide into the adherent and non-adherent sets. We know neither the number of the six aggregators that will adhere to the new Cohort B and C randomization nor the number among four aggregators currently adhering to the original Cohort A and C randomization that will maintain that randomization for another year.[13]

Table 3-3 lists the needed endline sample sizes of completed smallholder interviews to obtain the desired statistical precision under different adherence scenarios. The four main panel rows of the

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[12] The Aflasafe pilot business plan notes an expected net revenue increase of $130 per acre (Dahlberg, 2012, 32), assuming that the pilot achieves yield of 4 MTs per hectare compared to baseline yields of 2 MTs per hectare with 1 MT of maize set aside for own consumption, and maize price of $18 per metric ton. The pre-pilot achieved yield close to 4 MTs (3.94 MTs/ha) and reported average premiums above the market price of $22 as noted in a PowerPoint presentation titled "AgResults Nigeria Aflasafe Pilot Intermediate Results Analysis", June 2014.

[13] We considered introducing incentives for smallholders to adhere to the randomization but determined that these could interfere with the performance of the pull mechanism and decided against using incentives.

table depict four adherence scenarios for the newly created Cohort B versus Cohort C experimental comparison. Within each panel appear different adherence scenarios for the existing set of intact experiments constituting the Cohort A versus Cohort C experimental comparison. For each of these scenarios, columns 2 and 3 give the count of Cohort B plus Cohort C interviews. Column 4 gives the number of needed interviews for the Babban Gona quasi-experimental impact comparison that is also powered to estimate Babban Gona level impacts with an MDI of $104.[14] For example, as displayed in the first panel of the table, if only three of the six experimental aggregators adhere to their randomization protocols that divided Cohorts B and C, then we will need to obtain 441 completed endline interviews from smallholders associated with those three aggregators and 252 completed endline interviews from smallholders associated with the three aggregators that do not adhere to randomization.

Table 3-3. Endline sample size requirements (successful interviews) for adequate statistical precision

Adherence to random assignment scenarios	Number of Cohort B and C interviews			Number of *additional* Cohort A interviews			Total
	Cohort B & C RCT sample	Corrupted Cohort B & C sample	Cohort B Babban Gona + compari-son sample	Cohort A RCT sample	Corrupted Cohort A sample	Co-hort A Bab-ban Gona	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
B vs C: 3 of 6 adhere	441	252	160				
A vs C: 2 of 4 adhere				189	135		1277
A vs C: 3 of 4 adhere				284	103	100	1339
A vs. C: 4 of 4 adhere				378	70		1401
B vs C: 4 of 6 adhere	588	168	160				
A vs C: 2 of 4 adhere				189	135		1340
A vs C: 3 of 4 adhere				284	103	100	1402
A vs C: 4 of 4 adhere				378	70		1464
B vs C: 5 of 6 adhere	630	84	160				
A vs C: 2 of 4 adhere				203	135		1312
A vs C: 3 of 4 adhere				297	103	100	1374
A vs C: 4 of 4 adhere				392	70		1436
B vs C: 6 of 6 adhere	630	0	160				
A vs C: 2 of 4 adhere				216	135		1241

[14] Babban Gona is the highest-performing aggregator so far with highest yield increases and premiums for aflatoxin-free maize ($240/MT premium over normal price).

Adherence to random assignment scenarios	Number of Cohort B and C interviews			Number of *additional* Cohort A interviews			Total
	Cohort B & C RCT sample	Corrupted Cohort B & C sample	Cohort B Babban Gona + compari-son sample	Cohort A RCT sample	Corrupted Cohort A sample	Co-hort A Bab-ban Gona	
A vs C: 3 of 4 adhere				311	103	100	1303
A vs C: 4 of 4 adhere				405	70		1365

We also distinguish within a given panel of the table three adherence scenarios for the Cohort A versus Cohort C comparison (column 1). For each of these scenarios, the table conveys in columns 5 and 6 the number of Cohort A interviews that will need to be added to the Cohort B plus C total in earlier columns to accomplish impact analyses involving Cohorts A and C. This depends on the extent of continued adherence to the original A-versus-C experiment. For example, as displayed in the last row of the first panel, if all four of the currently adherent Cohort A and C aggregators continue to adhere to their randomization protocols for the remainder of the study, we will need to add interviews with 378 Cohort A smallholders associated with those aggregators and 70 Cohort A smallholders associated with the two aggregators who never adhered to the randomized design. These Cohort A smallholders will be compared to the same Cohort C smallholders that are part of the Cohort B versus Cohort C comparison. Similarly, the Babban Gona Cohort A smallholders (column 7) will be compared to the same comparison group used to study impacts on the Babban Gona Cohort B smallholders. The final column of the table shows the total number of successful, completed endline interviews from all three cohorts and all seven aggregators, adding across the preceding columns for any given scenario.

The text below describes the origins of these numbers. For each of the scenarios above, the tables below also present the smallest true impact that we can expect to detect with an 80 percent probability from each of the cross-cohort comparisons—the minimum detectable impacts of the study. The actual sample design for the endline survey may vary slightly from what we describe here due to the potential inclusion of additional aggregators and consideration of Year 4 activities. While details may change pending this information, we will target the same MDIs under any scenario.

Adherence to random assignment in the second round, for measurement of Cohort B Versus C comparison

Table 3-4 lists the MDIs for each adherence scenario that we have considered. An MDI of $65 in net revenue per acre is not constant across all scenarios; some scenarios have higher MDIs because those scenarios are more constrained in the maximum possible sample sizing owing to smaller numbers of villages/smallholders participating in the corresponding sample frame. We arrived at our sample sizes by identifying combinations of villages and smallholders that would achieve an MDI as close to $65 as possible while still being both possible within the constraints of the scenario's sample frame, and reasonable in terms of the limited marginal benefit of incrementally increasing the sample size.

We propose a sample size that will allow us to detect rigorous (RCT-based) impacts on half of the aggregators that are currently agreeing to random assignment for Cohorts B and C. We do this instead of assuming that all six aggregators in that group will remain true to the design due to the possibility that some portion of the new randomization of villages into Cohorts B and C may be compromised in the future. This approach is conservative: for the study of Cohort A versus C, the random assignment design held up for more than half of the aggregators in the first year, and we expect for a number of reasons that the odds of adherence have improved in the latest cycle.

As protection against the loss of one or more aggregators from the intended random assignment design for the Cohort B versus Cohort C comparison, we will expand the number of villages included in the baseline survey for these cohorts.[15] At baseline, we will survey seven villages in the two cohorts for each of six experimental aggregators, completing interviews with 15 smallholders per village. This is a total of 84 villages and 1260 completed interviews.

In addition, we will interview 440 smallholders (with 308 successful interviews) from Babban Gona for the quasi-experimental analysis of Cohorts B and C. Although this number of Babban Gona smallholder interviews is not strictly needed in order to obtain a reasonable overall MDI, this large sample size allows us to estimate impacts specific to Babban Gona. Of 308 successful interviews, 160 interviews in 28 villages will serve as the sample to identify Babban Gona impacts with an MDI of $100. The 148 other successful smallholder interviews across 14 additional comparison villages will serve as "backup" in the event that aggregators do not adhere to the village random assignments and conduct their implementation in all of their treatment and comparison villages. This expanded sample provides us the flexibility to rely on a subset of Babban Gona's comparison group of villages as comparison groups for the aggregators originally planning to adhere to random assignment, in the worst-case scenario that the aggregators that do not adhere to their randomization protocol and instead conduct their implementation in all of their treatment and comparison villages.

From this starting point, we will survey the number of villages and smallholders at endline necessary to achieve the MDIs listed in Table 3-4, depending on the status of aggregators' adherence to the randomization protocol. All of the sample size numbers in this table are achievable using as the endline sampling frame the smallholders who completed baseline interviews under the design above. For example, if five aggregators adhere to the randomization protocol for Cohorts B and C, we will conduct an endline survey for these five aggregators in six villages per aggregator per cohort (see row "RCT (5)" in Table 3-4). This means that we will attempt 900 endline interviews, and—given the expected 70 percent attrition rate—we will achieve 630 completed interviews. As shown in the right-hand half of the table, this sample size is sufficient to detect an impact of $65 on net revenue per acre in the purely experimental analysis of baseline plus endline data for those 630 smallholders. Other scenarios, with three or four of the experimental aggregators adhering to the Cohort B versus Cohort C randomization protocol, are shown in the first two rows of the table.

[15] Villages in Cohort A can no longer be included in the baseline survey, having already entered the pilot in 2014.

Table 3-4. Endline survey sample sizes and MDIs for one-year impact analysis (Cohort B versus Cohort C)

Sample size for endline survey			MDI, Net revenue per acre	Net revenue per acre of participating smallholders			
Number of aggregators	Number of villages per aggregator per cohort	Total smallholders interviewed*		if 50% of targeted smallholders participate	if 65% of targeted smallholders participate	if 75% of targeted smallholders participate	if 85% of targeted smallholders participate
RCT (3)	7	441	$78	$155.49	$119.61	$103.66	$91.47
RCT (4)	7	588	$67	$134.66	$103.59	$89.77	$79.21
RCT (5)	6	630	$65	$130.10	$100.07	$86.73	$76.53
Whole Group (6)	5	630	$65	$130.10	$100.07	$86.73	$76.53
Whole Group + Babban Gona	(5-14)	790	$55	$110.82	$85.25	$73.88	$65.19
Babban Gona only	14	160	$104	$208.13	$160.10	$138.76	$122.43
Worst-case non-adherence to RCT, Whole Group + Babban Gona	4–5	676	$63	$125.57	$96.59	$83.71	$73.87

*We plan to attempt 15 smallholder interviews per village in all cases except the "Whole Group + Babban Gona" sample, for which we plan to attempt 10 smallholder interviews per village. We anticipate a 70 percent completion rate among attempted interviews, with the remaining 30 percent not successful due to nonresponse or attrition from the baseline sample; this expectation applied to the number of attempted interviews (not shown) obtains the total number of smallholders interviewed displayed in the third column.

The "Whole Group" row in Table 3-4 depicts an analysis of data from all six experimental aggregators. If all six adhere to the randomized design, this will yield fully experimental estimates of impact for the Cohort B versus Cohort C comparison from the largest possible sample. If instead one or more of the six aggregators do not comply with the randomization protocol, we will separately analyse those that do (per one of the top three rows of the table) and conduct a second analysis that pools the outcomes associated with all aggregators who initially agreed to random assignment (i.e., all aggregators except Babban Gona). The sample size and MDI for this six-aggregator analysis—whether entirely experimental or not—appear in the "Whole Group (6)" row. (For any aggregators that do not comply with the randomization protocol, we will survey 15 smallholders in five villages per aggregator per cohort at endline.) The MDI of $65 in the "Whole Group (6)" row applies regardless of all six experimental aggregators' adherence to the randomization protocol, although the resulting estimate will be subject to potential selection bias (introduced by non-adherence to the randomization protocol) in the latter scenario.

The last row of the table shows the sample size and MDI for a fully pooled analysis of all aggregators, including Babban Gona. This most statistically powerful analysis will be run regardless of circumstances and will incorporate non-experimental elements (for at least the Babban Gona data) under any scenario.

The RCT (3) row in Table 3-4 is helpful for understanding how we obtain the baseline sample size of 1700. In the case that only three aggregators adhere to the randomization protocol, we will need 441 completed smallholder interviews at endline and thus plan for 630 baseline attempts due to threat of nonresponse and attrition from baseline. However, we do not know which of the six aggregators will adhere to random assignment, so we double this baseline sample size from 630 to 1260. We add 440 interview attempts for Babban Gona, and thus arrive at a baseline sample of 1700.

Adherence to random assignment in the first round, for measurement of Cohort A versus Cohort C comparison

Currently, four of the six aggregators are complying with the year 1 randomization protocol, but there is a possibility that some will implement the intervention in Cohort C, the control group, too early (i.e., in 2015 rather than 2016). Table 3-5 displays the MDI for the two-year impacts under different scenarios for this design adherence. For example, row "RCT (3)" of Table 3-5 depicts the situation of three of the four aggregators adhering to the randomization protocol in the final year of the experiment. In this contingency, we will interview in seven villages per adherent aggregator per cohort, for a total of 567 smallholders, yielding an MDI of $76. There will be no baseline data for this contrast, as the baseline timeframe has already passed.

Table 3-5. Endline survey sample sizes and MDIs for Cohort A versus Cohort C

Sample size for endline survey			MDI, Net revenue per acre	Net revenue per acre of participating smallholders			
Number of aggregators	Number of villages per aggregator per cohort	Total smallholders interviewed*		if 50% of targeted small-holders participate	if 65% of targeted small-holders participate	if 75% of targeted small-holders participate	if 85% of targeted small-holders participate
RCT (2)	7	378	$93	$185.68	$142.83	$123.79	$109.22
RCT (3)	7	567	$76	$151.61	$116.62	$101.07	$89.18
RCT (4)	7	756	$66	$131.29	$101.00	$87.53	$77.23
Whole Group (6)	6	389	$65	$130.63	$100.48	$87.09	$76.84
Whole Group + Babban Gona	6-14	689	$56	$111.01	$85.39	$74.01	$65.30
Babban Gona only	14	160	$100	$199.90	$153.77	$133.27	$117.59
Worst-case non-adherence to RCT, Whole Group + Babban Gona	4.6	870	$61	$122.43	$94.18	$81.62	$72.02

*We plan to attempt 15 smallholder interviews per village in the villages associated with aggregators adhering to the randomized design. For the "Whole Group" and "Whole Group + Babban Gona" samples, we plan to attempt six smallholder interviews per village in the group that initially adhered to random assignment, and eight per Babban Gona village. We anticipate a 90 percent completion rate among attempted interviews, an expectation applied to the number of attempted interviews (not shown) in order to obtain the total number of smallholders interviewed displayed in the third column. We anticipate a higher completion rate among attempted interviews than we do for the one-year impact estimates because there are no baseline data for this contrast, and thus sample attrition is not a concern.

3.2.2 Qualitative analysis

Method

The evaluation of the pilot's impact on smallholder uptake of Aflasafe will rely predominantly on quantitative methods, while qualitative research will enrich the interpretation of results. Specifically, we will complement quantitative baseline and endline analyses of the factors affecting participation in the pilot and uptake of Aflasafe with qualitative inquiries into the smallholders' perspectives on how participation affected them and the issues underlying these perceived effects. We will include in our qualitative analysis questions about the participation of women in the pilot and the underlying factors influencing that participation.

We will carry out the qualitative research protocol in coordination with the quantitative research protocol, with actual implementation between one and two months after the large-sample smallholder survey. This delay will ensure that data needed from the smallholder survey for implementation of some aspects of the protocol are available, as well as allow more time for marketing of maize in the months following harvest than would be possible if the qualitative research were conducted simultaneously with the smallholder survey.

Data sources

We will collect data to answer this question from smallholder surveys. We will triangulate this information with interviews with the 12 aggregators. We will employ "best practices" to ensure the robustness of our qualitative methods. Best practices in qualitative research include using "naïve" questioning approaches (rather than "leading" questions that introduce bias), triangulation of data sources (for example, seeking information from multiple levels of the marketing chain to obtain diverse explanations of phenomena), and the careful documentation of the evidence supporting results (Yin, 2003). Much like quantitative research, the validity of qualitative research is also bolstered by leading with theory-based models (such as the SCP framework), as well as actively seeking out disconfirming evidence rather than confirming (much as statistical hypothesis testing can only result in the rejection or failure to reject a null hypothesis rather than its "acceptance").

We will interview smallholders who are representative of the diversity among Nigerian maize smallholders. We will use a cluster analysis of the LSMS data to identify predominant smallholder types to be characterized on the basis of their socio-economic and production/ marketing activities. We will draw from the smallholder survey sample to obtain a selection of smallholders representing each of these major types, and ensure representation of different aggregator modalities in our sampling. We anticipate conducting approximately 108 smallholder questionnaires based on the following assumptions: (1) we will identify three predominant smallholder types in the cluster analysis, (2) there will be 12 (4 more than those examined using quantitative methods) different aggregator modalities (modality defined as a characteristic way of interacting with the smallholders to procure Aflasafe-treated maize), and (3) we will interview three smallholders per smallholder type per modality including at least one woman smallholder. If major smallholder types are not accounted for among the selection available through the smallholder survey sample, we will seek out representatives of these types and interview them to explore factors that might underlie their decision not to participate in the pilot. We will also explore reasons that might underlie their ineligibility and the implications of these factors for potential participation of these smallholders in markets for Aflasafe-treated/aflatoxin-free maize

in the future. The questionnaire that will guide our smallholder interviews includes a mix of structured and semi-structured questions, and is presented in Appendix B.

Data collection and entry will be the responsibility of the in-country Agricultural Economist under supervision of the Qualitative Lead. The Qualitative Lead will analyse the results in collaboration with the in-country Agricultural Economist, and share them with the Quantitative Expert for integration into the reporting of results. We will analyse the data using pattern analysis to identify common themes on factors that aided or impeded smallholders in adopting Aflasafe, the types of contractual arrangements that were perceived as more suitable for adoption, and the characteristics of smallholders or aggregators that aided or impeded better adoption.

3.3 Evaluation question 3: What has been AgResults' impact on smallholder income?

Farmers who participate in the AgResults interventions are expected to benefit economically in various ways, including higher output prices, increased yields, reduced product loss/spoilage, and reduced food expenditures—all of which have direct impacts on farmer net revenues (or what we interchangeably call income in this document). While health benefits are also anticipated to result from uptake of the technology innovations, the question of health impacts for participating smallholder households is beyond the scope of the evaluation, and its inclusion would be prohibitively costly. It is useful to point out that one of the challenges in measuring impacts on health is that aflatoxin prevalence depends on environmental factors such as rainfall, moisture, and temperature. As discussed in Section 3.2, it is possible that aflatoxin prevalence could be naturally low at the time of evaluation observations, giving a potentially misleading impression that pull mechanisms have no impact or only a small impact on reducing aflatoxin presence in the maize. In contrast, in a year in which farming conditions are favourable to aflatoxin accumulation, a substantial impact could be observed. Therefore, it is important to measure the impact of AgResults on an indicator that, over the course of many harvests and hence on average, will create crops with lower levels of aflatoxins: the presence of Aflasafe in harvested maize. We will address this impact quantitatively in the analysis of evaluation question 2 on Aflasafe technology uptake.

Our analysis of income impacts will use outcome data for targeted smallholders (including targeted farmers who do not participate) and their counterparts in the control group with sample sizes and statistical power as described in the previous section. We will estimate Equation [1] described in Section 3.2.1 with a dependent variable, *Y*, that measures smallholder net revenue from maize cultivation. We will also assess the impacts separately on maize yields and sale price of maize to separate the impact of the pilot on yield increase and price premiums gained.

We will conduct subgroup analysis, focusing specifically on women farmers. We will complement quantitative baseline and endline analyses of the factors affecting income effects with qualitative inquiries into the farmers' perspectives on how participation affected them and the issues underlying these perceived effects, again focusing on women farmers and tailoring our questions based on the results we find. We will conduct the qualitative analysis on data collected from semi-structured interviews (as described in greater detail in Section 3.2.2) using pattern analysis to identify common themes on how participation in the pilot affected their incomes and key reasons why income increases were realized. We will triangulate these data with information

from the aggregators. Table 3-6 summarizes the key evaluation method and the key outcome measures to answer evaluation question 3.

Table 3-6. Evaluation method and outcome measures for evaluation question 3

Evaluation Question 3: What has been AgResults' impact on smallholder income?	
Evaluation Method	Outcome Measures
• RCT for subgroup of aggregators that agree to randomization and adhere to it • Minimum distance matching for other aggregators • Qualitative analysis	• Smallholders' net revenue from maize cultivation: continuous variable measuring gross revenue from maize net of input costs • Smallholders' sale price of maize: continuous variable measuring the final sale price of maize including any premiums passed on by aggregators • Smallholders' maize yields: continuous variable measuring the total volume of maize harvest divided by the total area planted

3.4 Evaluation question 4: What has been AgResults' impact on poor consumers' demand for derivative food products containing aflatoxin-free maize?

The Aflasafe pilot is intended to spur the development of a market for aflatoxin-free maize products, with the ultimate aim of spurring consumer uptake of these products in order to realize the health benefits they offer. The pilot will interact with two different groups of consumers in different ways—rural farming households that apply Aflasafe to their maize may choose to reserve some of the maize for household consumption, and non-farming households (whether rural or urban) may purchase maize for consumption. The latter's consumption will depend on the availability of aflatoxin-free maize in the market and their decision to purchase it, taking into account a number of factors. These include households' perceptions of its quality, convenience, and price relative to their own and their family's needs as well as relative to other maize products available.

Determining the pilot's general effect on consumer demand is a significant challenge because the pilot is likely to have a dispersed reach among consumers in both rural and urban areas and across socio-economic strata, and affect consumers with widely differing consumption patterns and taste preferences. This diversity means that a quantitative impact evaluation based on a consumer consumption survey in the general population would become cost prohibitive because the sample size needed to estimate the change would be quite large. Therefore, we will focus our quantitative analysis among only the smallholders participating in the pilot (evaluation question 4), and we will use qualitative methods to evaluate demand for aflatoxin-free maize among households that buy maize from the market.

The decision to purchase and consume an aflatoxin-free maize product can be evaluated from a "behaviour change" lens in which consumers' decision to purchase a product (or specific product attribute such as aflatoxin-free status) or not is an outcome of their knowledge and attitudes about it. Knowledge of and positive attitude towards aflatoxin-free maize is a necessary pre-condition for buying it. Thus, we will evaluate the impact of the AgResults pilot on consumer demand for aflatoxin-free maize by conducting a Knowledge, Attitudes, and Practice (KAP)

assessment of maize consumers. The quantitative survey will include a KAP module targeted to the smallholders, and the qualitative survey will be targeted to consumers who regularly purchase maize for their household consumption. The "knowledge" component will evaluate whether consumers are aware of aflatoxins as an issue and, if they are, the extent of their knowledge on the topic. The "attitude" component will assess the degree to which consumers are concerned about aflatoxins and their perceived ability to affect consumers' exposure to and health effects from aflatoxins. The "practice" component will focus on consumers' purchases of aflatoxin-free maize and the factors driving those purchases, such as income and credit constraints (see Section 3.4.2 for more details on qualitative data collection).

Given the currently low level of consumer awareness about aflatoxins in maize and the lack of aflatoxin-free maize on the market, we hypothesise that consumer demand for aflatoxin-free maize at baseline will be effectively absent. Implementation of the AgResults pilot could, however, lead to increased demand for aflatoxin-free maize among smallholders and less so among non-farm consumers (who buy maize from the market rather than producing it for their own uses). Necessary conditions for the demand to translate into purchase will be the establishment of marketing channels for maize for human consumption, as well as development of effective distribution and merchandising efforts by the private sector. (We will qualitatively address these aforementioned conditions in the course of the SCP analysis addressing private sector engagement in the market for aflatoxin-free maize.) Table 3-7 presents in summary the key evaluation method and the key outcome measures to answer evaluation question 4.

Table 3-7. Evaluation method and outcome measures for evaluation question 4

Evaluation Question 4: What has been AgResults' impact on poor consumers' demand for derivative food products containing aflatoxin-free maize?	
Evaluation Method	**Outcome Variables**
Impact on *smallholders'* demand	
• RCT for subgroup of aggregators that agree to randomization and adhere to it • Propensity score matching for other aggregators	• Smallholders' awareness of health impacts of aflatoxin and benefits of aflatoxin-free maize: analysis of survey questions (Likert, multiple choice, and binary variables), and some qualitative smallholder interviews. • Smallholders' consumption of maize treated with Aflasafe: total volume of maize set aside for consumption divided by total number of household members; maize consumption per person by 24-hour recall • Smallholders' proportion of maize consumed from own fields treated with Aflasafe compared to total maize consumption • Smallholders' willingness to pay a premium for aflatoxin-free maize: binary variable for willingness to pay a premium, and a continuous variable indicating the premium that farmers are willing to pay
Impact on *other consumers'* demand	
• Qualitative survey conducted at local maize markets	• Smallholders' awareness of health impacts of aflatoxins and benefits of aflatoxin-free maize: analysis of survey questions (Likert, multiple choice, and binary variables), and some qualitative smallholder interviews.

Evaluation Question 4: What has been AgResults' impact on poor consumers' demand for derivative food products containing aflatoxin-free maize?	
	• Smallholder's consumption of maize treated with Aflasafe: total volume of maize set aside for consumption divided by total number of household members; maize consumption per person by 24-hour recall • Smallholders' willingness to pay a premium for aflatoxin-free maize: willingness to pay a premium, and the premium that farmers are willing to pay

3.4.1 Quantitative analysis

For smallholders participating in the pilot, we will also measure impacts on consumption of Aflasafe-treated maize directly from self-reports on the outcome survey. In particular, we will estimate Equation [1], defined in Section 3.2.1 above, on the larger sample of all outcome survey respondents, where the dependent variable, *Y*, is a binary indicator for whether smallholders are aware of aflatoxins and whether they save any Aflasafe-treated maize for own consumption. The dependent variable will also include continuous measures of the amount of Aflasafe-treated maize the smallholders consume and the price premium they would be willing to pay for that maize if they were to acquire it from the market.

Our smallholder survey will include a KAP module on consumption behaviour that asks households about their awareness of aflatoxins and Aflasafe, their willingness to pay a premium, their access to aflatoxin-free maize, and finally their consumption of aflatoxin-free maize.

3.4.2 Qualitative analysis

Demand for aflatoxin-free maize among off-farm consumers is expected to be stimulated in areas where the product is available in the marketplace and where its suppliers market it with an effective "value proposition" such that consumers purchase it for its aflatoxin-free properties or other qualities that they associate with the branded product. It is also hypothesized that the product will have to perform well, relative to the alternative non-aflatoxin-free maize product they would otherwise have bought, with respect to both quality attributes and cost.

We will analyse the effects of the pilot on non-farmer demand by addressing the questions outlined in Table 3-7.

We will conduct the qualitative evaluation of consumer demand through point-of-sale surveys at retail outlets that are frequented by potential buyers of aflatoxin-free maize. These will include outlets identified through interviews with millers, whom we will also request to facilitate requests to survey consumers at select retail outlets. Following receipt of such permission, we will choose specific retailers as bases for interviews, with the selection aimed at having representation among (1) the different millers marketing aflatoxin-free maize to consumers, (2) geographic and socio-economic diversity (rural/urban, poor, and nutritionally vulnerable clienteles), and (3) major retail formats (e.g., supermarket chains, local retailers, open-air fairs). At each target retail outlet, the in-country Agricultural Economist will verify and collect data on the retailers' merchandising of aflatoxin-free maize (using the template in Appendix B) including brands, product forms, packaging, display/promotion, and pricing. Then the Agricultural Economist will approach consumers who are buying maize, verify that they are the primary

shopper for their family and that they regularly purchase maize for household consumption, and request their participation in the survey. We will also survey consumers at retail outlets in areas (such as villages with farmers participating in the pilot) where consumers may have been exposed to aflatoxin-free maize due to pilot activities. Even if there is no sale of aflatoxin-free maize in those areas, the pilot may have had an effect on consumer demand for the product by raising awareness about aflatoxins and stimulating interest in aflatoxin-free maize.

Analysis plan

The in-country Agricultural Economist, under supervision of the impact evaluation team's Qualitative Lead, will undertake data collection and analysis. Data will be collected in person, at the site of pre-selected retail operations. The in-country Agricultural Economist will enter the data into a template provided by the Qualitative Lead before transmission to her. The Qualitative Lead will analyse the data and report the results, communicating with the in-country Agricultural Economist for clarification and feedback as the analysis proceeds. The in-country Agricultural Economist will participate in finalization of the consumer survey and receive training in its implementation prior to conducting baseline data collection.

Data sources

The consumer survey will collect socio-economic data, data on maize purchases and preferences, both in general and specific to aflatoxin-free maize, as well as consumers' KAP regarding aflatoxins. We will interview 5 to 10 consumers per retail market outlet in rural, peri-urban, and urban areas that are identified as potentially having been influenced by pilot activities. Data to be collected and questions to be addressed (detailed in Appendix B) will include:

- Overview of maize purchases—sources, quantities, degree of processing, brand, cost/quality orientation
- Purchases and preferences with respect to aflatoxin-free maize
  - Has consumer ever purchased aflatoxin-free maize?
  - Overview of aflatoxin-free maize buying behaviour (sources, quantities, degree of processing, preferred brand)
  - Cost and convenience comparison with non-aflatoxin-free maize
  - What is unique/valuable about aflatoxin-free maize (why does consumer choose to buy it)?
  - How did consumer become aware of aflatoxin-free maize products?
  - How do consumer and family members like aflatoxin-free maize relative to non-aflatoxin-free maize?
  - Factors that drive decision to purchase aflatoxin-free maize
- KAP regarding aflatoxins
  - Awareness of and attitudes towards aflatoxins as an issue
  - Awareness of availability of aflatoxin-free maize
  - Preferences towards consumption of aflatoxins
- Socio-demographic data on shopper and household

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

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

Qualitative contributions to the evaluation of sustainability will come from the SCP, farm-level, and demand analyses, and will focus on whether the basic conditions that provide incentive for continued private sector, farmer, and consumer engagement in the market are present. These include:

- Whether there is adequate awareness of aflatoxins as a problem and Aflasafe as a potential solution among potential buyers to sustain the market
- Whether testing methods (for Aflasafe or aflatoxins) are developed and available for widespread use
- Whether farmer yields and/or market prices are high enough to permit economical application of Aflasafe
- Whether there is a reliable and accessible source of Aflasafe for those who demand it.

We will also evaluate market actors' perspectives on the viability of the market and their intentions for engagement in the market (through purchase, production, sale, and/or consumption of Aflasafe or Aflasafe-treated maize) following cessation of the pilot's activities. Specifically, we will:

- Ask aggregators about their interest and intentions around continued involvement in the market for Aflasafe-treated maize
- Inquire into the specifics of any plans they report to gain a sense of their nature and the aggregators' commitment to them
- Investigate what conditions are necessary to carry out their plans (such as purchase orders from buyers or greater availability of aflatoxin and/or Aflasafe testing kits) and their assessment of the likelihood of these conditions' being fulfilled.

We will ask farmers who have used Aflasafe in their maize production activities whether they are inclined to continue to use it following the cessation of pilot activities and what key variables determine whether or not they do (such as premium prices for Aflasafe-treated maize or subsidization of the Aflasafe input). We will also investigate other factors that could influence the sustainability of the market for Aflasafe-treated maize, such as a reliable source of Aflasafe input and the profitability of maize production.

We will explore with consumers their interest in continuing to consume aflatoxin-free maize given their exposure to it during the pilot period, and in the absence of any promotional or educational activities that might have been motivated by the pilot.

We will collect data during the course of the questionnaires, previously introduced, from private sector actors, farmers, and consumers. The in-country Agricultural Economist, who is

responsible for conducting the questionnaires, will compile the results. The Qualitative Lead will analyse and report the data in conjunction with the in-country Agricultural Economist. Table 3-8 presents in summary the key evaluation method and the key outcome measures to answer evaluation question 5.

Table 3-8. Evaluation method and outcome measures for evaluation question 5

Evaluation Question 5: What evidence exists that the effects of the AgResults pilots will be sustainable in the medium to long term?	
Evaluation Method	Outcome Measures
• Summary analysis from answers to evaluation questions 1, 2, 3, and 4 using both quantitative and qualitative results • Abbreviated structure-conduct-performance assessment using qualitative interviews two years after end of the pilot if requested by DFID	• Smallholders' awareness of health impacts of aflatoxins and benefits of aflatoxin-free maize: analysis of survey questions (Likert, multiple choice, and binary variables), and some qualitative smallholder interviews • Smallholders' correct use of Aflasafe: dummy variable equal to 1 if smallholder applied Aflasafe at the right time and the right application rate with an acceptable range—measured at baseline and endline • Presence of Aflasafe in smallholders' maize samples bound for sale: dummy variable equal to 1 if presence above 70% detected—measured at endline • Presence of Aflasafe in smallholders' maize samples for own consumption: dummy variable equal to 1 if presence above 70% detected—measured at endline. • Smallholder's net revenue from maize cultivation: continuous variable measuring gross revenue from maize net of input costs • Smallholder's sale price of maize: continuous variable measuring the final sale price of maize including any premiums passed on by aggregators • Smallholder's maize yields: continuous variable measuring the total volume of maize harvest divided by the total area planted • Smallholder's consumption of maize treated with Aflasafe: total volume of maize set aside for consumption divided by total number of household members; maize consumption per person by 24-hour recall • Smallholders' willingness to pay a premium for aflatoxin-free maize: willingness to pay a premium, and the premium that farmers are willing to pay • Value chain actors' perception of the reliability of Aflasafe supply • Value chain actors' market linkages and interest in continued use of Aflasafe • Presence and enforcement of regulations on aflatoxins in maize

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

The SCP qualitative analysis, particularly the documentation of market structure, will inform the calculation of the scale of the pilot's effect on private sector investment and uptake of Aflasafe (see Section 3.1). Documentation of the market structure will include estimates of the numbers and characteristics of market actors involved at different levels of the market, as well as volumes of aflatoxin-free maize transacted through different market channels.

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

A critical aspect of a cost-effectiveness study is to causally attribute the outcome or impact to the project. We address this aspect in evaluation approach described in Section 3.2. The second important component is obtaining the cost of the project. Cost-effectiveness is the ratio that gives the cost per unit of impact. We will estimate this ratio per unit of increased technology adoption (number of farmers that adopt Aflasafe), per unit of increase in production of Aflasafe maize, and per unit of increase in consumption of Aflasafe maize (kg/household). The cost-effectiveness analysis will calculate the gross and net cost of the Aflasafe treatment and use that as the numerator in a series of ratios where the denominator will be the measured impacts on project outputs and outcomes as estimated by the evaluation. Accordingly, we summarize for the cost per metric ton of Aflasafe-treated maize sold, cost per farmer who adopts Aflasafe, cost per dollar of net farmer revenue, and cost per metric ton of Aflasafe-treated milled maize consumed by smallholder farmers and apply these unit costs to the impact estimates in the cognizant areas. The gross cost of the Aflatoxin-control pilot will cover pilot-specific expenditures—including the payments to aggregators and the Aflasafe verification expenditures—and a share of the project-wide administration and management costs.

The total impact of the estimate is the product of number of farmers in the treatment group and the impact estimate. For example, to estimate the total income impact we will multiply the total farmers in the treatment group with the average increase in net revenue estimated from Equation [1]. We will divide this by the total cost of the project attributed to the treatment group. If the specific cost is not estimable for the treatment group, we will take the total project cost and multiply it by the ratio of smallholders in the treatment group to the total smallholders in the project. The gross costs of each pilot will be based on actual project expenditures from the start of the project through its conclusion using project monitoring data. These expenditures will cover incentive payments, verification procedures, and a variety of other types of expenses for individual pilots. This accounting will also include pertinent AgResults project administration and management costs, which will be distributed over all of the pilots and also discounted. Thus, comparisons of AgResults cost-effectiveness results to the findings for other interventions should

include discounting adjustments such that costs are expressed in terms of the same year. Net costs can be calculated as gross costs minus the tangible short-term economic output or savings generated by the pilot, which we will measure as part of the impact evaluation described above. We are also collecting information on income from other crops, so we can also assess the impact on total returns from farms in case introduction of Aflasafe impacts the crop allocation.

We will compare the cost-effectiveness ratio of a given pilot to that of other AgResults pilots in Kenya and Zambia. This will not be a cost-benefit analysis—that is, we will not assign a monetary value to technology adoption and will not compare the pilots' overall value to their costs. However, by calculating the net cost of the pilots (net of the increase in their returns) per smallholder adoption, as well as the gross cost per adoption, the proposed analysis will take account of the positive economic impacts of the pilots. In addition, the cost-effectiveness analysis will include sensitivity tests for alternative discount rates. We will also distinguish costs and benefits from different analytical perspectives including that for smallholders and aggregators.[16]

Finally, to compare the cost-effectiveness of the implemented projects to counterfactuals (e.g., a subsidy scheme that lowers the technology cost by 50 percent or a reward scheme that offers a premium equal to two times the typical market price for maize), we will use the estimates from the adoption regression equations estimated during our study of the impact on farmer uptake. One of the equations we estimate has market- and incentive-independent variables instead of the treatment/control independent variable, which allows us to "simulate" alternative incentive schemes and compare the cost effectiveness of those schemes to the cost effectiveness estimate for AgResults pilots. Table 3-9 presents in summary the key evaluation method and the key outcome measures to answer evaluation question 6.

Table 3-9. Evaluation method and outcome measures for evaluation question 6

Evaluation Question 6: What is the evidence on the scale of any effect on private sector investment and uptake, and the cost effectiveness of AgResults as an approach?	
Evaluation Method	Outcome Measures
Cost effectiveness	
• Cost-effectiveness analysis comparing cost against outcomes of the Nigeria pilot	• Cost per kg of maize treated with Aflasafe • Cost per kg of aflatoxin-free maize consumed • Cost per smallholder who adopts Aflasafe • Cost per dollar of increased smallholder income from maize
Scale of private sector investment and uptake	
• Qualitative market surveys • SCP market analysis • Synthesis of qualitative results from all 3 pilots	• Extent of involvement of value chain actors outside AgResults pilot in supply of aflatoxin-free maize • Perception of value chain actors (including those not directly engaged with AgResults) on the reliability of

[16] We will investigate whether all benefits and costs can be disaggregated in this way. For an example of such a disaggregated analysis, see David Long et al., "Evaluating the Benefits and Costs of the Job Corps" in *Cost-Benefit Analysis and Public Policy*, ed. by David Weimer (New York, NY: John Wiley and Sons, 2008).

Evaluation Question 6: What is the evidence on the scale of any effect on private sector investment and uptake, and the cost effectiveness of AgResults as an approach?	
	Aflasafe supply • Market linkages, interest, and investment in continued use of Aflasafe by value chain actors (including those not directly engaged with AgResults) • Presence and enforcement of regulations on aflatoxins in maize

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

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

The next step is to identify the "practice" that was instrumental in achieving the outcomes. The primary mechanism in a best practice is the ability or the means of achieving a goal in a cost-effective manner—in this case, the pull mechanism. The secondary mechanisms include implementing features (e.g., incentives for aggregators as opposed to other entities in the value chain); supportive features (e.g., training for aggregators); and optional features (e.g., differences in contract arrangements between aggregators and farmers). It can be very complicated to separate the functions in getting the mechanism to work from the features that support those functions. Therefore, it is important to identify the core essence of the practice while allowing flexibility for how it is implemented so it remains sensitive to local conditions. This aspect of identifying the best practices, what Bardach (2011) calls observing the practice, requires inputs from key stakeholders of the pilot—the Pilot Manager, aggregators, verifiers, and farmers. As part of this analysis, it is also important to assess the implementation fidelity, the extent to which the programme deviated from its plans, and if those deviations contributed to its success (or not). Therefore, we will conduct a final best practices workshop in which we will draw the key elements of the pilot, its implementing features, and supportive and optional features that made it successful. While examining carefully why the best practice might succeed, in this workshop we will also determine the potential vulnerabilities that could lead the pull mechanism, as designed in the Aflasafe pilot, to fail. Following Bardach (2011), the vulnerabilities could be general, such as that the pilot requires high management capacity without which it may fail. The vulnerabilities could also be inherent to the pull mechanism itself, such as the need for aflatoxin or Aflasafe testing capacity.

In addition, as part of the best practices workshop we will also assess the conditions of success that are necessary for the pilot to be successful in another context. The conditions of success may be understood from local characteristics that vary within the pilot setting, such as varying levels of education of the aggregator, or the variation in the contractual arrangements between farmers and aggregators. We may also examine the conditions for success through an analysis of

characteristics that do not vary within the pilot, such as the generation of new markets or cultural norms that are common to the entire pilot region. The analysis of market conditions will play a central role in assessing the success of each pilot individually and AgResults as a whole by showing whether or not pull mechanisms prove to be effective tools to address market failures. This discussion can also reflect on the support structures that, if put in place, maximize the likelihood of success of pull mechanisms to remedy market failures. As part of this analysis we will assess whether the key market failures that have hindered the development of a market for aflatoxin-free maize were addressed by the pilot.

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

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

We will use "fidelity analysis" to compare the interventions that were planned to the interventions that were actually implemented. We will also examine how implementation of the interventions changes over time in response to managerial decisions based on issues arising from earlier implementation experience or in anticipation of changing contextual factors. Table 3-10 presents in summary the key evaluation method and the key outcome measures to answer evaluation question 7.

Table 3-10. Evaluation method and outcome measures for evaluation question 7

Evaluation Question 7: What lessons can be learnt about best practices in the design and implementation of AgResults?	
Evaluation Method	Outcome Measures
• Process evaluation • Implementation fidelity analysis	• Perception of the Secretariat, Pilot Manager, aggregators, verifiers, and farmers of the pilot implementation and its evolution from its original design • Perception of the Secretariat, Pilot Manager, aggregators, verifiers, and farmers about the success of the pilot in achieving each objective—smallholder impact, awareness generation among value chain actors, creation of markets for aflatoxin-free maize, addressing key market failures—and the best practices and/or lessons learnt • Conditions of success for implementing this pilot in another geographical area or context

4. Implementation timeline and other considerations

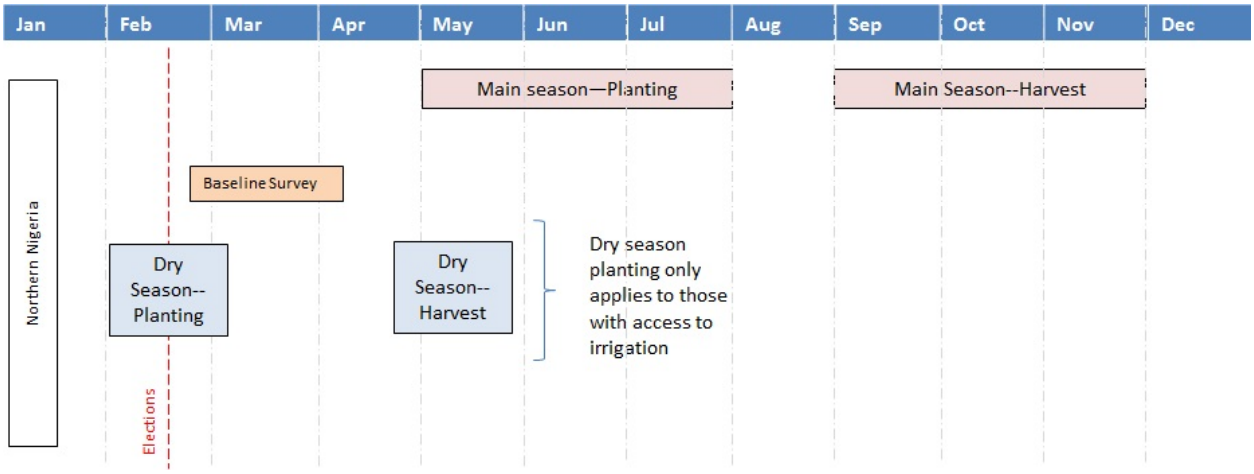
4.1 Implementation timeline

Our approach to implementing the evaluation of AgResults consists of collecting baseline and endline data in order to assess the impacts of the pilot. For both baseline and endline data collection, it is crucial to identify the ideal timing of data collection, which depends largely on the planting and harvest seasons. In order for the data collection to be most effective, there must be enough time to collect information on the entire maize harvesting, storage, and marketing process. The evaluation team has determined that one to two months would be a sufficient amount of time for farmers to harvest, process, and market their maize and also allows enough time for storage quality to be assessed.

However, after that point is reached, other factors create the need for rapid data collection: we want to minimize recall problems regarding events that have occurred over the previous season, especially regarding preparation, planting, and in-field tending of crops at early stages of the season. We will also ensure that data collection occurs before AgResults intervention activities begin each year in the spring (April-May). Furthermore, we also want to avoid conducting the survey too close to the preparation and/or planting season so that we do not interfere with pilot implementation and farmers have the time available to answer all survey questions. Most of the implementers have indicated that their farmers' villages typically harvest their crop between October and December. The majority of sales occur between November and February. Therefore, a good window for data collection is January to March, with data collection beginning in areas with an early planting season and moving to areas with a later planting season so that there is no risk of implementation activities beginning. As noted above, Abt had initiated a baseline in 2014 before Cohort A implementation began but had to terminate that effort because of data quality concerns. For the planned baseline in 2015 before Cohort B implementation begins, we also have to take into account presidential and local elections in February 2015, which will limit our ability to collect data at that time. Therefore, taking into account all aspects, we have identified March as the best time to conduct the baseline and endline surveys, with in-field survey preparation work beginning in January. Under this timeframe (see Figure 4-1) we will be able to capture more accurate sales and harvest data, without encroaching on preparation activities for the upcoming season, and we will avoid collecting data during election time.

When implementing the endline data collection, we intend to follow the same seasonal timing as the baseline survey in order to maximize the comparability of the data and mitigate any potential bias created by collecting data at different points in the harvest season.

Figure 4-1. Northern Nigeria planting and harvesting cycle



The timing of the qualitative baseline data collection on general market conditions needs to precede the time when pilot activities might impact the different market players and data sources consulted, but does not have to be as precisely timed as the quantitative data collection. As of October 2014, the evaluation team has already finished the Initial Qualitative Assessment (IQA), gathered some baseline qualitative data, and conducted two evaluation workshops with key stakeholders.

These two activities have allowed the market context and planned pilot implementation approach to inform decisions about evaluation design. The evaluation team has scheduled design workshop #3 as well as a smallholder survey instrument pretest in January 2015—before baseline data collection commences—in order to finalize randomization strategies with the implementers and to test the survey instrument's ability to collect the required information. This is the earliest date feasible because these workshops are not during harvest time, which continues until end of December. The following sections describe the key activities leading up to these baseline data collection activities and give an overview of the expected timeline for implementing subsequent qualitative and quantitative data collection for the evaluation.

4.1.1 Initial qualitative assessment

The evaluation team's Qualitative Specialist conducted the first phase of the IQA in September 2013. The IQA informed the evaluation design by assessing market conditions, characterizing the maize value chain, interviewing stakeholders, establishing key dates such as harvest times, and characterizing the planting and harvesting cycle depicted in Figure 4-1. The process of developing the evaluation design began when the evaluation team met with the Secretariat and Pilot Manager to determine when implementers will be chosen, what the geographical intervention zone would be, and when interventions would likely begin. The IQA also served to identify the key pilot stakeholders in order to invite them to the first evaluation design workshop. The second phase of the IQA took place in December 2013, in conjunction with the first evaluation design workshop.

4.1.2 Evaluation design workshop #1

The first evaluation design workshop took place in Abuja, Nigeria, on 16 December, 2013. The purpose of this workshop was to present the evaluation team's current understanding of the pilot

and, based on that understanding, explore how it could be evaluated and present initial evaluation design ideas to key stakeholders. The workshop provided an opportunity to check our understanding of the pilot and understand the heterogeneity that exists in the implementation areas, as well as to obtain feedback and suggestions from potential aggregators and other actors in the value chain on the design and potential challenges. The workshop attendees included the four pre-pilot implementers, verifiers, farmers, and IITA staff. At this workshop we were able to determine that the phasing plan of implementers provided an opportunity to randomize and that the majority of the potential pilot implementers were amenable to randomizing the villages for different phases of implementation.

4.1.3 Evaluation design workshop #2

The second evaluation design workshop was held from 3 March to 5 March, 2014, in Abuja, Nigeria, and focused on finalizing randomization. The evaluation team met individually with each implementer throughout a half-day workshop to explain the evaluation design, explain the randomization process, and implement our random sampling procedure (a "lottery" to randomly assign villages to Cohorts A, B, and C). Leading up to the workshop, we were in contact with all implementers to verify that they were willing to use a lottery to select villages and to determine the best way to implement the actual randomization process. Most implementers were in complete agreement with the lottery design and viewed it as a helpful addition to their plans since it would provide a sense of fairness for village selection. For Babban Gona, the one non-randomizing implementer, we used the half-day workshop to clearly establish their expected rollout plan and identify the criteria they will use for selecting future AgResults villages. This helped the evaluation team understand where viable counterfactual areas could be located to form the impact analysis comparison group. During this visit we also we vetted the counterfactual areas with all the implementers and key stakeholders.

4.1.4 Evaluation design workshop #3

The third evaluation design workshop will be held during January 2015, in Abuja, Nigeria, to finalize the randomization of villages for the quantitative analysis of each AgResults implementer. As a result of some implementers not adhering, in this workshop we will conduct the same activities as workshop #2, but with updated lists from those implementers who were not able to adhere to re-randomize their Cohort B and Cohort C villages. We will use this workshop as an opportunity to see if implementers are willing to delay the implementation in their Cohort C villages by one year in order to conduct the endline survey in 2017 (instead of 2016). At this point, we will take into account their willingness to do so and determine if a 2017 endline survey is possible. This workshop will also address the reasons why implementers did not adhere and work with them to ensure that the same problems do not recur during the 2015 planting season.

4.1.5 Smallholder survey instrument pretest

Abt's core evaluation team and the Nigeria-based survey firm will conduct a pretest of the baseline survey instrument prior to the start of field survey work. We have selected the survey firm (MRC) from among several candidate organisations through a competitive process.[17] The pretest questionnaire will be translated into Hausa and be electronically scripted into the firm's

[17] The Abt team has issued an RFP and received proposals from three firms on November 10, 2014.

smartphone software. The main objective of the pretest is to identify any weaknesses in the survey questionnaire design and to train enumerators in implementing the survey and field sampling methodology. To ensure quality and efficacy of the pretest, the Abt home office team will accompany the survey firm during both activities. If security concerns do not allow a trip to the northern states by Abt staff, we will conduct the pretest in areas where these security concerns do not limit our travel. This will allow the Abt team to respond to any problems encountered and ensure that the enumerators are interpreting the survey questions correctly. Based on our experience with our 2014 baseline attempt, this will be critical to ensuring quality of data. Ultimately, we will use the results of the pretest to finalize the survey instrument. The enumerators will then continue with the finalized version of the instrument for the remainder of the training and fieldwork under the guidance of Abt's in-country Survey Manager.

4.1.6 Baseline data collection—quantitative and qualitative

As mentioned above, we anticipate fieldwork for the baseline smallholder survey to commence in March and expect it to last four to five weeks. The evaluation team and the in-country Survey Manager will work closely with the survey firm to establish clear data management, processing, and cleaning plans, as well as create materials for training enumerators and implementing quality control measures. Lessons learnt from the pretest will be incorporated into the survey instrument and field administration procedures to ensure the highest quality data collection possible in the main survey. Based on our the lessons learnt from our 2014 baseline survey attempt, we propose that Abt team staff be in the field at the beginning of survey activities to take part in enumerator training and the first wave of data collection. During the entire data collection process, the in-country Survey Manager will manage all aspects of data collection and be in close coordination with the Abt team, providing weekly updates.

Qualitative baseline data collection has started and is expected to finish by December 2014. The qualitative data collection will follow the protocol outlined in Section 3.4.2 of this document and involve semi-structured interviews with a variety of actors in the maize value chain as described in those sections. We will report the results from both data collection efforts in our baseline survey and qualitative assessment report, which we will submit to DFID in mid-2015.

4.1.7 Ongoing qualitative assessment

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

4.1.8 Endline data collection

As discussed above, the timing of the endline is yet to be determined, as it requires close coordination with the implementers (which will occur during workshop #3). Given this uncertainty, we will conduct the endline data collection in either March 2016 or March 2017, depending on the ability of implementers to change the sequencing of their implementation. Regardless of the year, survey implementation will correspond to the baseline data collection timeframe to eliminate bias that might arise in collecting farmers' responses at different points in the planting and harvest cycle. Endline data collection must occur before implementation begins in Cohort C, since our impact analysis design relies on Cohort C villages as the control group.

We will also ensure that the same training materials and data collection methodologies are used during the endline survey in order to ensure comparability across surveys. Ideally, the same survey firm will conduct the endline survey to mitigate any potential bias.

4.2 Deliverables and communication plan

The evaluation design and other details will be made public through several channels: we expect to register the design on the American Economic Association registry of Randomized Control Trials and post all evaluation updates and reports updates at the AgResults website, and where relevant on the Abt Associates website and social media (e.g., Facebook, Twitter). We will also provide updates on the evaluation at Steering Committee meetings. We will submit the final baseline and endline reports to DFID for formal review, after which they will be posted on the DFID external website. As part of the evaluation results dissemination, the Abt team will also present the salient lessons learnt to the Steering Committee as a part of the dissemination workshop. The content of this dissemination workshop will be summarized in a one-page technical project summary, which will also be available on the Abt website and used as a tool to assist the Secretariat's efforts to further disseminate the evaluation results. We will submit evaluation reports to DFID on the approximate dates shown in Table 4-1.

Table 4-1. Projected submission dates of AgResults evaluation reports

Deliverable	Projected submission date
Baseline report	July 2015
Endline report	July 2017
Dissemination workshop report	TBD

We will further disseminate project progress and results through presentations, academic papers, or other means when opportunities arise, as deemed appropriate by both the evaluation team and DFID. After completing the baseline survey and report, the evaluation team will closely monitor the progress of pilot implementation and randomization adherence. In order to maintain frequent communication with the implementers, we will hold a brief meeting in Abuja, Nigeria, to ensure adherence to randomization and to address any issues the implementers might be facing in regard to the randomization or the pilot in general. Throughout the pilot, we will communicate evaluation updates to the Steering Committee on a biannual basis.

4.3 Evaluation risks and mitigation approach

The risks associated with the evaluation of AgResults primarily apply to the quantitative protocol, as the qualitative survey is more flexible and therefore presents fewer technical risks. The one overarching risk to both the qualitative and quantitative surveys is the security situation in Northern Nigeria. Security concerns during baseline surveys can delay our work and increase the risk that implementation occurs before the baseline surveys are completed. Any changes in implementation because of security concerns after the baseline survey is completed will reduce the number of usable observations for our analysis. The spread of Ebola virus had begun to present health risks, but on October 20, 2014, Nigeria was declared Ebola free. Although the spread of the virus is currently not a concern, the Abt team will monitor the situation closely.

Risk of Non-Adherence to Randomization: Aside from changes in the scope of implementation, the most significant risk to the quantitative protocol is the potential of implementers compromising the integrity of the random assignment. Our approach leverages the implementers' phasing plan, and implies that implementers commence the programs in the mutually agreed sequence. We have and will continue to identify the sequence of villages in close coordination with each implementer by identifying lists of villages they expect to work with over the next three years.

We employ several mechanisms to mitigate the risk of non-adherence to randomization: First, we will ensure that all implementers clearly understand our approach, are completely comfortable with the plan, and understand the alternative options if this approach does not work for them. Second, during our initial discussion we ran example randomizations to explain how village randomization works, and what it would mean when executed. Third, we are sharing the list of sampled farmers with the Pilot Manager and the implementers so that they have clear documentation showing which farmers belong to which group; and thus know not to intervene with Cohort C farmers until year 3 (or year 4, depending on the timing of the endline). Lastly, we have designed our sampling to purposefully oversample the control villages. This will protect against the risk of losing any control villages due to non-adherence. In addition, as a last measure should—in the extreme—no implementers adhere to the randomization, we have expanded the sample of comparison villages from LGAs that the AgResults pilot will not work in and would use these villages to implement a quasi-experimental analysis of impact in this contingency.

Even when implementers adhere to the randomized sequence of villages, there is a risk that they could begin implementation before the baseline occurs, as the planting season depends on rain. Early rains in some regions have led us to adjust the scheduling of our survey in order to prioritize those villages whose planting season has come earlier than expected. For this reason, we have decided to conduct the baseline as early as possible, in order to avoid this risk completely. Additionally, our baseline survey data analysis will conduct a check to see if responses from these farmers indicate that any AgResults interventions had begun before the data were collected.

Survey Data Collection Risks: Once the villages and farmers are randomized, survey firms may find it hard to locate the farmers on the lists. In the ongoing field operations, this issue has arisen several times. This risk is being mitigated by contractually obligating the survey firm to coordinate with the implementers before beginning the survey in a given village. This communication is meant to verify the farmer lists and also ensure that the appropriate village authorities are aware of our survey team's arrival. For the endline, the same risks apply since we must contact the same farmers for a follow-up survey. To mitigate this risk, we will collect mobile phone numbers of baseline respondents where possible. For all respondents, we are collecting GPS coordinates, which should significantly reduce the risks of high attrition.

Several risks can undermine collection of quality data. The timing of the survey presents some risks. Given the timeline for the implementation (begins during planting season, as opposed to harvest season); our surveys have to rely on farmer recall of the previous year's harvest. Insofar as farmers' recall of harvest quantities deteriorates over time, it presents a risk in the accuracy of responses. Conducting the survey in March mitigates this risk somewhat, since farmers will only have to recall harvest numbers from four months prior, and most sales would have taken place recently. The biggest risk of the baseline survey is that fieldwork cannot be done in February

because of the elections in mid-February. We anticipate increased political volatility and potential for violence in the northern states during the few days surrounding the election, and do not want to put our team at risk by conducting fieldwork during that time. Conducting the survey in March does not affect the data quality or suffer from increased recall bias, but does have a slightly higher risk of us pushing against the planting season and therefore the beginning of implementation. Whatever point in time we finally conduct the baseline survey, we will conduct the endline survey during the exact same time of year, in order to minimize any bias resulting from seasonality.

In addition, there are risks associated with the quality of data if enumerators and their supervisors do not understand the survey instrument, make mistakes in interpretation, or simply do not conduct the interview and enter fake data. To mitigate this risk, as part of our quality control protocol we will participate in enumerator training by convening the enumerators in a place where Abt staff can travel. We will also travel to the field to conduct the pretest at a location where security is not a concern. Overall, we will implement a data quality control plan that the evaluation team designed and integrated into the terms of reference for the survey. This plan lays out our expectations of how the survey firm will ensure that the data collected are of high quality by implementing various quality control measures, the most important being survey back-checks: we are back-checking 20 percent of all surveys in addition to the back-checks conducted by the survey firm. During the back-checks, we are ensuring that the data were not falsified or entered incorrectly. The survey firm is required to provide the evaluation team with weekly written updates, as well as the quantitative findings of all back-checks as well as other data quality controls implemented (e.g., documenting all data cleaning, corrections to questionnaires). The evaluation team will work with the survey firm so they can meet our rigorous data quality requirements and will encourage constant communications from the field to ensure we are able to respond to any quality issues in real time.

Given the importance of the baseline to the overall evaluation, data quality (in its various forms) represents a large risk and therefore is our highest priority. Collecting data using an electronic medium is both an advantage and a risk. Electronic data collection allows us to seamlessly review the data as they come and verify that the survey is proceeding as planned, and makes it easy to conduct quality checks remotely. However, if the electronic data system does not work accurately it can lead to systematic data issues. To mitigate this risk, we plan to carefully review whether the survey firm has capacity to deploy an electronic data collection system and has done so in the past. We expect to mitigate this risk by conducting the pretest in electronic format, and by being in the field during the initial wave of the survey.

4.4 Ethical considerations

To ensure that data collection is conducted in an ethical and responsible way, the team has submitted the data collection instrument and draft design report to Abt's Internal Review Board (IRB), which approved them and deemed them appropriate. As the design document becomes finalized and the survey firm is contracted, we will continually check in with the IRB via the project's data security plan. This is a continually updated document that tracks how data will be handled and by whom, and what security measures are taken in order to maintain respondent confidentiality.

4.5 Quality assurance

Quality assurance is an integral part of our evaluation. We will employ both internal and external quality assurance to review the data collection instruments, the study design, and all results. The Abt team has contracted three external evaluators: Dr Kelsey Jack from Tufts University, Dr Mushfiq Mobarak from Yale University, and Dr James Mbata from the World Bank to review the evaluation methodology and results. For internal quality control, Dr Stephen Bell—an Abt vice president and senior fellow—will be the team member responsible for the quality assurance of all evaluation documentation and methodologies. In addition, within our team we conduct cross-reviews of our work so that a more detailed level review occurs of our programs and analysis. In addition, Abt's Evaluation Method Center facilitates Evaluation Design Seminars where Abt's leading evaluation experts review our evaluation design protocols. Another seminar series—the Journal Author Support Group—convenes experts to review our evaluation results and also helps prepare the results for publication.

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Appendix A: Mapping of evaluation questions to survey instruments

#	Evaluation Question	Module	Variables
1	What has been the impact of the AgResults project/pilot on private sector engagement in the development and uptake of agricultural innovations?	Qualitative Instruments	
2	What has been the impact of the AgResults project/pilot on smallholders' uptake of Aflasafe?	Section 8: Aflasafe usage for maize	Q2,Q3,Q4
3	What has been the impact of the AgResults project/pilot on smallholders' incomes?	Section 9: Maize Harvest and Marketing	Q14, Q16
		Section 12: Other Harvest and Marketing	Q3
		Section 14: Non-Farm Income	Q4
4	What has been the impact of the AgResults project/pilot on poor consumers' demand for derivative food products, i.e., aflatoxin-free maize?	Section 17: Consumption of Aflasafe-Treated Maize	Q1-Q6
		Qualitative Instruments	
5	What evidence exists that the AgResults pilot is scalable and that its effect will be sustainable in the medium to long term?	Qualitative Instruments	
6	What is the evidence on the scale of any effect on private sector investment and uptake and on the cost-effectiveness of AgResults as an approach?	Qualitative Instruments	
7	What lessons can be learnt about best practices in the design and implementation of agricultural pull mechanisms?	Compilation of results from all AgResults Pilot evaluations	

Appendix B: Qualitative survey instruments

Data to be collected from aggregators (via secretariat)

- Information on sales and firms that purchase aflatoxin-free maize from aggregators
  - Type of firm
  - Firm name
  - Volume transacted
  - Transaction price
  - Contact information

Maize sector expert questionnaire

Awareness of and perspective on aflatoxins

- Are you familiar with aflatoxins as an issue affecting maize markets in Nigeria?
    - If so, please characterize your understanding of the issue and its influence on Nigeria's maize economy.
- Are you aware of any maize being marketed in Nigeria that is advertised to be "aflatoxin-free" or similar?
    - If so, please characterize (what organisations/projects if any are involved, location of such markets, who are suppliers, who are traders, who are buyers, contacts if available).
    - Is a premium paid for aflatoxin-free maize? If yes
        - How much is the premium?
        - Whose participation does the premium attract?
        - Is the premium too large for any buyers? Which?
- Do you think there is potential for a commercially viable market for aflatoxin-free maize to develop? If yes
    - What would such a market look like? (who would buy and sell, how would they organize their transactions)
    - Is there sufficient demand for aflatoxin-free maize?
        - Who are the best buyers? Why?
    - Is there adequate supply?
        - Who are the best suppliers? Why?
    - What challenges would exist to the development of the market, and how could they be addressed?
- If respondent is aware of aflatoxins as an issue
    - What means are available to verify aflatoxin-levels in maize in the market?
        - Which of these means are in use and by whom?
        - What is availability, technical requirements, and cost?
        - Are these means effective in giving buyers confidence that the maize is truly aflatoxin-free?
    - Is there any institution or organisation that certifies the aflatoxin-free status of maize?
        - To what extent is this certification employed?
        - What is involved in obtaining and maintaining certification?
        - What is the cost?
        - Are these certification programs effective in giving buyers confidence that the maize is truly aflatoxin-free?

Awareness of and perspective on Aflasafe

Do you know of a product called Aflasafe? (Aflasafe is a biological agent that is applied on maize fields during crop growth; it has been shown to reduce aflatoxin levels by an average of 80 percent.) If yes,

- Please share what you know about Aflasafe.
- Are you aware of any agricultural development projects that use or promote Aflasafe?

    - If so, please characterize (name and sponsor of projects, geographic scope and target beneficiaries, information on farm and market-level activities, contact information if available).
- Do you know of any agricultural input dealers that sell Aflasafe?
    - If yes, characterize and obtain contact information if available.
- Given that Aflasafe can reduce aflatoxins in maize by 80 percent or more, do you think that Aflasafe could contribute to the development of a market for aflatoxin-free maize?
    - Why or why not?
    - If yes,
        - Who would you expect to participate as suppliers or buyers?
        - What challenges would exist and how could they be addressed?
- If respondent is aware of Aflasafe:
    - What means are available to verify whether Aflasafe has been used on a maize crop?
    - Which of these means is in use and by whom?
    - What is availability, technical requirements, and cost?
    - Are these means adequate for buyers to have confidence that a crop was treated with Aflasafe?
    - Would it be more effective to test for/certify utilization of Aflasafe on maize or to test for/certify aflatoxin-free status? Why

Awareness of contract farming for maize (for respondents with knowledge of maize supply)

- Do you know about the use of contract farming/outgrower schemes for maize production? If yes,
    - What are the characteristics, if any, of the types of communities or areas where contract farming is more likely (e.g., better road access, better access to govt. extension and subsidies).
    - Do buyers prefer to contract with smallholders or larger farmers?
        - What is a typical maize area cultivated by a large farmer who might sell through contract?
        - What is a typical maize area cultivated by a smallholder farmer who might sell through contract?
        - Why do buyers prefer to contract with one or the other?
    - What is the typical number of smallholders that aggregators contract with?
    - What type of smallholders do the aggregators prefer to contract with?
        - What are the characteristics of these farmers?
    - Do aggregators change the smallholders they contract with often?
        - What is the average length for which aggregators contract with the same smallholders?
    - What are the types of farmers who prefer to enter into contract farming? Are there more smallholders who would like to contract than there are implementers to contract with?
    - How are prices determined when smallholders sell under contract to buyers?
        - Does the farmer have the ability to negotiate for incentive payments?
        - What factors are likely to increase farmers bargaining position?

Do you have questions or further comments on what we have discussed?

Short survey for agro-input dealers

Identifying information

- Firm name
- Firm location
- Interviewee name
- Interviewee position
- Contact information

Brief characterization of firm

- Do they buy direct from input manufacturers/authorized distributors or from intermediaries?
- Size of firm (number of full-time employees)
- Is firm part of a chain or franchise? How many stores?

Aflasafe

Have you ever heard of Aflasafe, a biological agent applied to maize fields during production that reduces aflatoxin levels?

- During the past year (2013 for baseline), did you carry Aflasafe? If yes,
  - How much Aflasafe did you sell in the previous year (for baseline, 2013)
  - How many farmers did you sell Aflasafe to?
  - How would you characterize those farmers in terms of their scale of operations, commercial orientation, organisation affiliation, or otherwise?

Agro-input dealer questionnaire

Identifying information

- Firm name
- Firm location
- Interviewee name
- Interviewee position
- Contact information

Brief characterization of firm

- Product/service offerings
- Are they authorized dealer of branded products?
- Do they buy direct from input manufacturers/authorized distributors or from intermediaries?
- Do they have any government or NGO training or certification?
- Size of firm (number of full-time employees)
- Is firm part of a chain or franchise? How many stores?

Aflatoxins and Aflasafe

- Are you familiar with aflatoxins as an issue affecting maize markets in Nigeria?
- If so, please characterize your understanding of the issue.
- Have you ever heard of Aflasafe, a biological agent applied to maize fields during production that reduces aflatoxin levels?
    - If yes, how did you hear about it?
        - Have you ever had a farmer express interest in buying Aflasafe from you? Describe
        - Have you ever had any firm or organisation ask about your interest in carrying Aflasafe in your product stock?
        - Have you ever carried, or do you currently carry, Aflasafe in your stock? If yes,
        - When did you first carry it?
        - Do you still carry it? (if no, why not)

- Do you have any further comments or questions about the topics we have discussed?

- How do farmers who enter into pull mechanism for Aflasafe differ from other farmers
- What is your perception of the pull mechanism? Is the incentive provided to the right actor?
    - Why?

Intermediary/processor short survey

No.	Topic	Question
1	**Interview information**	Interview date Interview start time Interview end time Interview location Name of person conducting interview Name of person recording notes Was interview sound recorded?
2	**Identifying information**	Firm name Firm location Interviewee name Interviewee position Contact info
	After recording PID, request permission to sound-record interview	
3	**Characterization of firm**	Type of firm — **Trader/Inte** / **Processor** Maize only / Feed mill Grains and / Flour mill Other (desc / Other (describe)
4	**Firm activities with maize** ***If no, terminate interview***	Do you buy or sell maize, or maize-based products? What is production capacity for maize-based products while at full employment of facilities (specify units and day/week/month)--is this an input or output value?
5	**Merchandising**	Who are firm's major clients? (Characterize) What is the geographic distribution of sales/service area (states and major cities) **Table: Locations Share of sales** **Most important sales areas**
6	**Procurement**	Where do you obtain maize from? **Table: Produced o Direct from f Intermedia Other (describe)** **Share from each type (in course of 1 year)**
7	**Perspectives on aflatoxins and aflatoxin-free (AF) maize** ***If "no" proceed to next section.***	Do you know what "aflatoxins" are?
8	**Purchases of aflatoxin-free (AF) maize**	Are you aware of there being any aflatoxin-free maize available for purchase in Nigeria? During the past year (2013 for baseline) did you purchase any maize marketed as "aflatoxin free"?
	If yes,	Volume purchased in preceeding year (2013 for baseline) Source Cost Bought on cash or contract? (describe) Was the maize produced with Aflasafe? (yes/no/don't know)
		How was it utilized? (sold, fed, other)
	If sold	What products What buyers was it targeted to? How did you price it (relative to non AF/AT maize)
	All	Do you plan to continue/Would you be interested in purchasing AF maize if it were available?

Intermediary/processor extended questionnaire

No.	Topic	Question
1	**Interview information**	Interview date Interview start time Interview end time Interview location Name of person conducting interview Name of person recording notes Was interview sound recorded?
2	**Identifying information**	Firm name Firm location Interviewee name Interviewee position Contact info
	After recording PID, request permission to sound-record interview	
3	**Characterization of firm**	Type of firm **Trader/Intermedian Processor** Maize only Feed mill Grains and oilseeds Flour mill Other (describe) Other (describe)
4	**Firm activities with maize** ***If no, terminate interview***	Do you buy or sell maize, or maize-based products? What maize-based/derived products/services does firm produce or transact What is production capacity for maize-based products while at full employment of facilities (specify units and day/week/month)--is this an input or output value? Number of full-time employees while at full employment of facilities Percent employment of facilities during high/busy season in 2013 Approximately what share of your input costs does maize represent?
5	**Merchandising**	Does the firm produce/market any ***branded*** maize-based/derived product? Describe Who are firm's major clients? (Characterize) What is the geographic distribution of sales/service area (states and major cities) **Table: Locations Share of sales** **Most important sales areas** **Secondary sales areas** Are relationships with your major clients contractual or at-will; ongoing or ad-hoc? Describe the nature of the relationship
6	**Procurement**	Where do you obtain maize from? **Table: Produced on firm's l Direct from farme Intermedia Other (describe)** **Share from each type (in course of 1 year)** **How many suppliers of type** **How many of these suppliers did you work with in previous year(s)?** **Rank sources by preference** **Why are benefits/drawbacks of each type utilized?** If buy direct from farmers: What is typical scale of their production (land area)? Are purchases on spot or arranged (e.g. contracted) in advance of production? Does firm provide any resources (e.g. finance, inputs) or services (e.g. drying) to farmers to facilitate supply? If buy through intermediaries: Do they work totally independently or do you contract them to procure on your behalf? Describe relationship/arrangement. If supply arranged in advance (contracted), what are expectations regarding: Product volumes Prices (ex. agreed in advance or based on market at harvest?) Services provided by supplier (ex. Drying, delivery) Services provided by buyer (ex. Finance, input supply, pick-up at farm) Other contract provisions What specific quality requirements do you have for maize, if any? How do you test/verify compliance with these requirements?
7	**Perspectives on aflatoxins and aflatoxin-free (AF) maize** ***If "no" proceed to next section.***	Do you know what "aflatoxins" are? What are they? How did you learn about aflatoxins? Are aflatoxins a problem? If yes, why? Are you ever aware of there being aflatoxins in the maize you buy/sell? If yes, how often/to what extent? If yes, what do you do with maize with aflatoxins? How did you learn about aflatoxins? Have you ever had a buyer express concern about aflatoxins? If yes Which buyer(s)? Describe situation (why was buyer concerned, etc.) What was result of their expressing concern? (any changes?) Do you think aflatoxins are a problem to your business or industry in general?
	Do not read list--let respondent raise issues and use list to record specifics. After respondent finishes, ask "naïve" follow-up questions about unchecked items, ex. "Do aflatoxins cause health problems?" and record detail of respondents answers if yes (ex what kind of health problems do they cause?"	
		Why or why not? **Table: Issues volunteered Issues commented on in follow-up** Reasons **Affect product quality** **Cause health problems** **Affect production efficiency** **Affect acceptability of product to buyers or potential buyers** Reasons **Don't occur often** **Don't have serious consequences** **It's possible to clean maize with aflatoxins** **Aflatoxins might cause problems but buyers don't care** Either ar **Other (describe)**
	If yes	Do you ever test the maize you purchase for aflatoxins? On a regular basis or ad hoc? How (how sample, what test used) What is the maximum level you will permit? How often do you detect aflatoxins and what levels are common? What do you do when you detect maize with aflatoxin levels above that limit? Do you reject the maize or discount it or other?
	If no	Have you ever considered testing maize for aflatoxins? Why or why not Have you ever tested in the past? Why or why not? Are you planning on doing anything to address issue in near future? If yes, ask questions to obtain further info as in point (i) above. Do you take any measures other than testing to minimize aflatoxin levels on the maize you purchase? (ex. Buying from specific suppliers, specific production areas)? Describe Overall, do you consider the measures you take (testing, avoidance, mitigation) to be adequate to address any aflatoxin issue? Describe

8	**Purchases of aflatoxin-free (AF) maize**		
		Are you aware of there being any aflatoxin-free maize available for purchase in Nigeria?	
	If yes,	From where can it be purchased?	
		During the past year (2013 for baseline) did you purchase any maize marketed as "aflatoxin free"?	
	If yes,		Volume purchased in preceeding year (2013 for baseline) Source Cost Bought on cash or contract? (describe) Was the maize produced with Aflasafe? (yes/no/don't know) How did you know the maize was really AF? (testing, certification, trust, etc.)
		How was it utilized? (sold, fed, other)	
	If sold		What products What buyers was it targeted to? How did you price it (relative to non AF/AT maize) How was it packaged and labeled to communicate its unique value (aflatoxin-free) Did you do anything in particular to promote it to buyers? How did you know it was truly treated with Aflsafe? (Did buyer test it, was it certified, etc.)
	If fed	How did you incorporate it into your feeding regime?	
	All	Do you plan to continue/Would you be interested in purchasing AF maize if it were available?	
	If yes,	Under what market conditions would be required for you to enter the market?	Under no conditions--not interested in product Would it need to be available in minimum volumes or account for a minimum share of your maize input? How much of a premium would you be willing to pay for AF maize? (%) Would you purchase it regularly or on an ad hoc basis (ex. when you perceive aflatoxin levels to be particularly high)? Would you contract—either direct with farmers or through an intermediary—to ensure consistent supply (but also be obligated to purchase)? Would you have any specific requirements (such as testing or certification) before trusting that the maize was truly "aflatoxin free"? What percentage of your maize purchases would you want AF maize to represent?
		What would be the primary benefits of aflatoxin-free maize?	**Table: First responses Secondary** **Cost savings** **Production efficiencies** **Entry to markets currently precluded by aflatoxin levels** **Respond to client concerns about aflatoxins** **Opportunity to tap "aflatoxin-free" market niche** **Avoidance of regulatory penalties** **Altruistic motivations** **Other**
		If you had a reliable source of aflatoxin-free maize (and wanted to purchase it), would with be the impact on/what adjustments would you anticipate making in terms of	Procurement (ex. number, identity, characteristics of suppliers, volumes purchased) Processing and logistics (ex. Management/facilities shifts, plant reconfiguration costs, separation/identity preservation of aflatoxin-free input) Merchandising (ex. would you enter new markets or promote your product as "aflatoxin-free" ?)
		Generally speaking, do you think there is a viable market for AF maize in Nigeria?	Why or why not? Where does the market have most potential? What will be required for it to develop to its potential?
9	**Perspective on market for Aflasafe**		
	If no, continue to conclusion	Have you ever heard of Aflasafe, a biological agent applied to maize fields during production that reduces aflatoxin levels?	How did you hear about it? Do you know any firms that are buy or sell Aflasafe-treated maize? Please describe what you know about the market.
		Have you ever had a supplier ask about your interest in buying maize treated with Aflasafe? Describe Have you ever had a buyer express interest in buying maize treated with Aflasafe? Describe Are you interested in buying or selling maize that has been treated with Aflsafe?	Why or why not? What market conditions would lead you to do this? **Table: First responses Second responses** **No market conditions could lead to this** **Assured commercial availability of Aflasafe** **Buyer requests or requires AF/Aflasafe-treated maize** **Market premium for AF maize (how much of a premium)?** **Government enforces aflatoxin limits** **Other (describe)**
		For firms that contract production and are not AgResults implementers	Would you consider asking that your farmers produce using Aflasafe in order to ensure a supply of AF maize? If yes, how would you organize the relationship/transaction to ensure Aflsafe was used?
10	**Conclusion**	Do you have any further comments or questions about the topics we have discussed?	

Retailer short survey

No.	Topic	Question
1	**Interview information**	Interview date Interview start time Interview end time Interview location Name of person conducting interview Name of person recording notes Was interview sound recorded?
2	**Identifying information**	Firm name Firm location Interviewee name Interviewee position Contact info
	After recording PID, request permission to sound-record interview	
3	**Characterization of firm**	Type of firm **Retailer** Market vendor of loose maize Kiosk outlet Independent permanent store Chain store Other (describe)
4	**Firm activities with maize** ***If no, terminate interview***	Do you buy or sell maize, or maize-based products? Number of full-time employees while at full employment of facilities
5	**Merchandising**	Does the firm market any ***branded*** maize-based/derived product? Describe How would you characterize your clients? (socio-economic status, rural/urban, etc.)
6	**Procurement**	Where do you obtain maize from? **Table:** **Direct from farmers** | **Market vendors** | **Industrial processors** | **Own mill** | **Dedicated supplier (e.g. broker, intermediary)** **Share from each type (in course of 1 year)** Do you know what "aflatoxins" are? If "no" proceed to next section.
7	**Purchases of aflatoxin-free (AF) maize** if not, proceed to next section If no, skip to Q8.6 If yes,	Are you aware of there being any aflatoxin-free maize available for purchase in Nigeria? During the past year (2013 for baseline) did you purchase any maize marketed as "aflatoxin free"? Volume purchased in preceeding year (2013 for baseline) Source Cost Bought on cash or contract? (describe) Was the maize produced with Aflasafe? (yes/no/don't know) How was it marketed? What products What brands What buyers was it targeted to? How did you price it How was it packaged and labeled to communicate its unique value (aflatoxin-free) Did you do anything in particular to promote it to buyers? How did you know it was truly treated with Aflsafe? (Did buyer test it, was it certified, etc.) Do you plan to continue to sell AF maize, assuming it is available in the market? Would you be interested in selling AF maize, assuming it were available in the market?

Retailer extended questionnaire

No.	Topic	Question
1	**Interview information**	Interview date Interview start time Interview end time Interview location Name of person conducting interview Name of person recording notes Was interview sound recorded?
2	**Identifying information**	Firm name Firm location Interviewee name Interviewee position Contact info
	After recording PID, request permission to sound-record interview	
3	**Characterization of firm**	Type of firm **Retailer** Market vendor of loose maize Kiosk outlet Independent permanent store Chain store Other (describe)
4	**Firm activities with maize** ***If no, terminate interview***	Do you buy or sell maize, or maize-based products? What maize-based/derived products/services does firm transact Number of full-time employees while at full employment of facilities Approximately what share of your sales does maize represent? Is store independent or part of a chain? If chain, how many stores does the chain have? If chain, how many stores is respondent accounting for in his/her responses? If chain, where are stores distributed geographically?
5	**Merchandising**	Does the firm market any ***branded*** maize-based/derived product? Describe How would you characterize your clients? (socio-economic status, rural/urban, etc.)
6	**Procurement**	Where do you obtain maize from? **Table: Direct from Market vend Industrial pl Own mill Dedicated supplier (e.g. broker, intermediary)** **Share from each type (in course of 1 year)** **How many suppliers of type** **How many of these suppliers did you work with in previous year(s)?** **Rank sources by preference** **Why are benefits/drawbacks of each type utilized?** If buy direct from farmers: What is typical scale of their production (land area)? Are purchases on spot or arranged (e.g. contracted) in advance of production? Does firm provide any resources (e.g. finance, inputs) or services (e.g. drying) to farmers to facilitate supply? If buy through intermediaries: Do they work totally independently or do you contract them to procure on your behalf? Describe relationship/arrangement. If supply arranged in advance (contracted), what are expectations regarding: Product volumes Prices (ex. agreed in advance or based on market at harvest?) Services provided by supplier (ex. Drying, delivery) Services provided by buyer (ex. Finance, input supply, pick-up at farm) Other contract provisions What specific quality requirements do you have for maize, if any? How do you test/verify compliance with these requirements?

7	**Perspectives on aflatoxins and aflatoxin-free (AF) maize**	
	If "no" proceed to next section.	Do you know what "aflatoxins" are?
		What are they?
		How did you learn about aflatoxins?
		Are aflatoxins a problem? If yes, why?
		Are you ever aware of there being aflatoxins in the maize you buy/sell?
		If yes, how often/to what extent?
		If yes, what do you do with maize with aflatoxins?
		How did you learn about aflatoxins?
		Have you ever had a buyer express concern about aflatoxins?
		If yes Which buyer(s)?
		Describe situation (why was buyer concerned, etc.)
		What was result of their expressing concern? (any changes?)
		Do you think aflatoxins are a problem to your business or industry in general?
Do not read list--let respondent raise issues and use list to record specifics. After respondent finishes, ask "naïve" follow-up questions about unchecked items, ex. "Do aflatoxins cause health problems?" and record detail of respondents answers if yes (ex what kind of health problems do they cause?"		
		Why or why not?
		Table: Issues volunt Issues commented on in follow-up
		Reasons **Affect product quality**
		Cause health problems
		Affect production efficiency
		Affect acceptability of product to buyers or potential buyers
		Affect product shelf life
		Reasons **Don't occur often**
		Don't have serious consequences
		It's possible to clean maize with aflatoxins
		Aflatoxins might cause problems but buyers don't care
		Either an **Other (describe)**
		Do you ever test the maize you purchase for aflatoxins?
		If yes On a regular basis or ad hoc?
		How (how sample, what test used)
		What is the maximum level you will permit?
		How often do you detect aflatoxins and what levels are common?
		What do you do when you detect maize with aflatoxin levels above that limit? Do you reject the maize or discount it or other?
		If no Have you ever considered testing maize for aflatoxins? Why or why not
		Have you ever tested in the past? Why or why not?
		Are you planning on doing anything to address issue in near future? If yes, ask questions to obtain further info as in point (i) above.
		Do you take any measures other than testing to minimize aflatoxin levels on the maize you purchase? (ex. Buying from specific suppliers, specific production areas)? Describe
		Overall, do you consider the measures you take (testing, avoidance, mitigation) to be adequate to address any aflatoxin issue? Describe
8	**Purchases of aflatoxin-free (AF) maize**	
	if not, proceed to next section	Are you aware of there being any aflatoxin-free maize available for purchase in Nigeria?
	If yes,	From where can it be purchased?
	If no, skip to Q8.6	During the past year (2013 for baseline) did you purchase any maize marketed as "aflatoxin free"?
	If yes,	Volume purchased in preceeding year (2013 for baseline)
		Source
		Cost
		Bought on cash or contract? (describe)
		Was the maize produced with Aflasafe? (yes/no/don't know)
		How was it marketed?
		What products
		What brands
		What buyers was it targeted to?
		How did you price it
		How was it packaged and labeled to communicate its unique value (aflatoxin-free)
		Did you do anything in particular to promote it to buyers?
		How did you know it was truly treated with Aflsafe? (Did buyer test it, was it certified, etc.)
		Do you plan to continue to sell AF maize, assuming it is available in the market?
		Would you be interested in selling AF maize, assuming it were available in the market?

	If yes,	What market conditions would be required for you to enter the market? Under no conditions--not interested in product Would it need to be available in minimum volumes or account for a minimum share of your maize input? How much of a premium would you be willing to pay for AF maize? (%) Would you purchase it regularly or on an ad hoc basis (ex. when you perceive aflatoxin levels to be particularly high)? Would you contract—either direct with farmers or through an intermediary—to ensure consistent supply (but also be obligated to purchase)? Would you have any specific requirements (such as testing or certification) before trusting that the maize was truly "aflatoxin free"? What percentage of your maize purchases would you want AF maize to represent? What would be the primary benefits of aflatoxin-free maize? **Table: First respor Secondary** **Cost savings** **Entry to markets currently precluded by aflatoxin levels** **Respond to client concerns about aflatoxins** **Opportunity to tap "aflatoxin-free" market niche** **Avoidance of regulatory penalties** **Altruistic motivations** **Other** If you had a reliable source of aflatoxin-free maize (and wanted to purchase it), would with be the impact on/what adjustments would you anticipate making in terms of Procurement (ex. number, identity, characteristics of suppliers, volumes purchased) Processing and logistics (ex. Management/facilities shifts, plant reconfiguration costs, separation/identity preservation of aflatoxin-free input) Merchandising (ex. would you enter new markets or promote your product as "aflatoxin-free"?) Generally speaking, do you think there is a viable market for AF maize in Nigeria? Why or why not? Where does the market have most potential? What will be required for it to develop to its potential?
9	**Perspective on market for Aflasafe** If no, continue to conclusion	Have you ever heard of Aflasafe, a biological agent applied to maize fields during production that reduces aflatoxin levels? How did you hear about it? Do you know any firms that buy or sell Aflasafe-treated maize? Please describe what you know about the market. Have you ever had a supplier ask about your interest in buying maize treated with Aflasafe? Describe Have you ever had a buyer express interest in buying maize treated with Aflasafe? Describe Are you interested in buying or selling maize that has been treated with Aflsafe? Why or why not? What market conditions would lead you to do this? **Table: First respons Second responses** **No market conditions could lead to this** **Assured commercial availability of Aflasafe-treated maize** **Buyer requests or requires AF/Aflasafe-treated maize** **Market premium for AF maize (how much of a premium)?** **Government enforces aflatoxin limits** **Other (describe)** For firms that buy Would you consider asking that your farmers produce using Aflasafe in order to ensure a supply of AF maize? If yes, how would you organize the relationship/transaction to ensure Aflsafe was used?
10	**Conclusion**	Do you have any further comments or questions about the topics we have discussed?

User/feeder short survey

No.	Topic	Question
1	**Interview information**	Interview date Interview start time Interview end time Interview location Name of person conducting interview Name of person recording notes Was interview sound recorded?
2	**Identifying information**	Firm name Firm location Interviewee name Interviewee position Contact info
	After recording PID, request permission to sound-record interview	
3	**Characterization of firm**	Type of firm **User/feeder** Poultry farmer Other livestock farmer Fish farmer Brewer Other (describe)
4	**Firm activities with maize** ***If no, terminate interview***	Do you buy or sell maize, or maize-based products? What is production capacity for maize-based products while at full employment of facilities (specify units and day/week/month)--is this an input or output value? Number of full-time employees while at full employment of facilities
5	**Merchandising**	Does the firm produce/market any ***branded*** maize-based/derived product (including meat etc. produced with maize)? Describe Who do you sell your product to?
6	**Procurement**	What is the form of the maize input you buy? (ungraded unprocessed maize, graded unprocessed maize, processed maize product, other) Where do you obtain maize-based inputs from? **Table:** **Direct from farmers** | **Market vendors** | **Industrial processors** | **Own mill** | **Dedicated supplier (e.g. broker, intermediary)** **Share from each type (in course of 1 year)**
7	**Perspectives on aflatoxins and aflatoxin-free (AF) maize**	
	If no proceed to next section. **if no, proceed to next section** **If no, skip to Q8.6** **If yes,**	Do you know what "aflatoxins" are? Are you aware of there being any aflatoxin-free maize available for purchase in Nigeria? During the past year (2013 for baseline) did you purchase any maize marketed as "aflatoxin free"? Volume purchased in preceeding year (2013 for baseline) Source Cost Bought on cash or contract? (describe) Was the maize produced with Aflasafe? (yes/no/don't know) How was it incorporated into your production regime? How did you know it was truly treated with Aflsafe? (Did buyer test it, was it certified, etc.)

No.	Topic	Question
1	**Interview information**	
		Interview date
		Interview start time
		Interview end time
		Interview location
		Name of person conducting interview
		Name of person recording notes
		Was interview sound recorded?
2	**Identifying information**	
		Firm name
		Firm location
		Interviewee name
		Interviewee position
		Contact info
	After recording PID, request permission to sound-record interview	
3	**Characterization of firm**	
		Type of firm
4	**Firm activities with maize**	
	If no, terminate interview	Do you buy or sell maize, or maize-based products?
		What maize-based/derived products/services does firm transact
		What is production capacity for maize-based products while at full employment of facilities (specify units and day/week/month)--is this an input or output value?
		Number of full-time employees while at full employment of facilities
		Percent employment of facilities during high/busy season in 2013
5	**Merchandising**	
		Does the firm produce/market any ***branded*** maize-based/derived product (including meat etc. produced with maize)? Describe
		Who do you sell your product to?
		What is the geographic distribution of sales/service area (states and major cities)
		Are relationships with your major clients contractual or at-will; ongoing or ad-hoc? Describe the nature of the relationship
6	**Procurement**	
		What is the form of the maize input you buy? (ungraded unprocessed maize, graded unprocessed maize, processed maize product, other)
		Where do you obtain maize-based inputs from?
		If buy direct from farmers:
		If buy through intermediaries: Do they work totally independently or do you contract them to procure on your behalf? Describe relationship/arrangement.
		If supply arranged in advance (contracted), what are expectations regarding:
		What specific quality requirements do you have for maize, if any?
		How do you test/verify compliance with these requirements?

7	**Perspectives on aflatoxins and aflatoxin-free (AF) maize**	
	If "no" proceed to next section.	Do you know what "aflatoxins" are?
		How did you learn about aflatoxins? Have you ever had a buyer express concern about aflatoxins? If yes
		Do you think aflatoxins are a problem to your business or industry in general?
	Do not read list--let respondent raise issues and use list to record specifics. After respondent finishes, ask "naïve" follow-up questions about unchecked items, ex. "Do aflatoxins cause health problems?" and record detail of respondents answers if y	
		Do you ever test the maize (or maize inputs) you purchase for aflatoxins? If yes
		If no
		Do you take any measures other than testing to minimize aflatoxin levels on the maize you purchase? (ex. Buying from specific suppliers, specific production areas)? Describe Overall, do you consider the measures you take (testing, avoidance, mitigation) to be adequate to address any aflatoxin issue? Describe

8	**Purchases of aflatoxin-free (AF) maize/maize-based products**	
	if not, proceed to next section	Are you aware of there being any aflatoxin-free maize available for purchase in Nigeria?
	If yes,	From where can it be purchased?
	If no, skip to Q8.6	During the past year (2013 for baseline) did you purchase any maize marketed as "aflatoxin free"?
	If yes,	
		How was it incorporated into your production regime?
		What market conditions would be required for you to enter the market for AF maize inputs?
		What would be the primary benefits of aflatoxin-free maize?
		If you had a reliable source of aflatoxin-free maize (and wanted to purchase it), would with be the impact on/what adjustments would you anticipate making in terms of
		Generally speaking, do you think there is a viable market for AF maize in Nigeria?
9	**Perspective on market for Aflasafe**	
	If no, continue to conclusion	Have you ever heard of Aflasafe, a biological agent applied to maize fields during production that reduces aflatoxin levels?
		Have you ever had a supplier ask about your interest in buying maize treated with Aflasafe? Describe
		Have you ever had a buyer express interest in buying maize treated with Aflasafe? Describe
		Are you interested in buying maize that has been treated with Aflsafe?
		For firms that buy direct from farmers
10	**Conclusion**	Do you have any further comments or questions about the topics we have discussed?

User/feeder

Poultry farmer
Other livestock farmer
Fish farmer
Brewer
Other (describe)

Table: **Locations** **Share of sales**
Most important sales areas
Secondary sales areas

Table: **Direct from** **Market vend** **Industrial p** **Own mill** **Dedicated supplier (e.g. broker, intermediary)**
Share from each type (in course of 1 year)
How many suppliers of type
How many of these suppliers did you work with in previous year(s)?
Rank sources by preference
Why are benefits/drawbacks of each type utilized?

What is typical scale of their production (land area)?
Are purchases on spot or arranged (e.g. contracted) in advance of production?
Does firm provide any resources (e.g. finance, inputs) or services (e.g. drying) to farmers to facilitate supply?

Product volumes
Prices (ex. agreed in advance or based on market at harvest?)
Services provided by supplier (ex. Drying, delivery)
Services provided by buyer (ex. Finance, input supply, pick-up at farm)
Other contract provisions

What are they?
How did you learn about aflatoxins?
Are aflatoxins a problem? If yes, why?
Are you ever aware of there being aflatoxins in the maize you buy/sell?
If yes, how often/to what extent?
If yes, what do you do with maize with aflatoxins?

Which buyer(s)?
Describe situation (why was buyer concerned, etc.)
What was result of their expressing concern? (any changes?)

es (ex what kind of health problems do they cause?"

Why or why not?

	Table: **Issues volunt Issues commented on in follow-up**
Reasons why a problem	**Affect product quality**
	Cause health problems
	Affect production efficiency
	Affect acceptability of product to buyers or potential buyers
	Affect product shelf/storage life
Reasons why not a problem	**Don't occur often**
	Don't have serious consequences
	It's possible to clean maize with aflatoxins
	Aflatoxins might cause problems but buyers don't care
Either answer	**Other (describe)**

On a regular basis or ad hoc?
How (how sample, what test used)
What is the maximum level you will permit?
How often do you detect aflatoxins and what levels are common?
What do you do when you detect maize with aflatoxin levels above that limit? Do you reject the maize or discount it or other?
Have you ever considered testing maize for aflatoxins? Why or why not
Have you ever tested in the past? Why or why not?
Are you planning on doing anything to address issue in near future? If yes, ask questions to obtain further info as in point (i) above.

Volume purchased in preceeding year (2013 for baseline)
Source
Cost
Bought on cash or contract? (describe)
Was the maize produced with Aflasafe? (yes/no/don't know)

How did you know it was truly treated with Aflsafe? (Did buyer test it, was it certified, etc.)

Under no conditions--not interested in product
Would it need to be available in minimum volumes or account for a minimum share of your maize input?
How much of a premium would you be willing to pay for AF maize? (%)
Would you purchase it regularly or on an ad hoc basis (ex. when you perceive aflatoxin levels to be particularly high)?
Would you contract—either direct with farmers or through an intermediary—to ensure consistent supply (but also be obligated to purchase)?
Would you have any specific requirements (such as testing or certification) before trusting that the maize was truly "aflatoxin free"?
What percentage of your maize purchases would you want AF maize to represent?

Table:	**First respor**	**Secondary**
Cost savings		
Production efficiencies		
Entry to markets currently precluded by aflatoxin levels		
Respond to client concerns about aflatoxins		
Opportunity to tap "aflatoxin-free" market niche		
Avoidance of regulatory penalties		
Altruistic motivations		
Other		

Procurement (ex. number, identity, characteristics of suppliers, volumes purchased)
Processing and logistics (ex. Management/facilities shifts, plant reconfiguration costs, separation/identity preservation of aflatoxin-free input)
Merchandising (ex. would you enter new markets or promote your product as "aflatoxin-free"?)

Why or why not?
Where does the market have most potential?
What will be required for it to develop to its potential?

How did you hear about it?
Do you know any firms that buy or sell Aflasafe-treated maize? Please describe what you know about the market.

Why or why not?
What market conditions would lead you to do this?

Table:	**First respons**	**Second responses**
	No market conditions could lead to this	
	Assured commercial availability of Aflasafe-treated maize	
	Buyer requests or requires AF/Aflasafe-treated maize	
	Market premium for products produced with AF maize (how much of a premium)?	
	Government enforces aflatoxin limits	
	Other (describe)	

Would you consider asking that your farmers produce using Aflasafe in order to ensure a supply of AF maize?
If yes, how would you organize the relationship/transaction to ensure Aflsafe was used?

Appendix C: Quantitative survey instrument

AgResults Nigeria Household Survey

Submitted to:

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Prepared by:

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March 31, 2014

AgResults Nigeria Household Survey

Section 1: Household Identification

1	Zone		
2	State		
3	Local Government Area		
4	Village		
5	AgResults Farmer	1…Yes 2…No	
6a	AgResults Aggregators (if applicable)		
6b	Household No.		
7	GPS Coordinates of Dwelling	Lat: Long:	
8	Name of Household Head		
9	Address of Household *(if no address, please record physical attributes so we can find the household again)*		
10	Name of Interviewer		
11	Name of Supervisor		
12	Date of Interview		
13	Interview start/end time	Start: End:	
14	Household ID*		

Which group does this household belong to?

Treatment ☐ Control ☐

S1: Screening question if non-Agresults farmer: Did you mainly grow maize in the 2013 April to June planting season? Skip household if no.

Section 2: Household Demographics

Enumerator Instructions: *Begin the interview by identifying who in the household is responsible for managing the maize farming. This is the individual that will answer most of the questions in the survey. If there are multiple individuals managing the maize farms, ask for the person who is responsible for most of the farms, particularly the maize farms.*

Enumerator Prompt: To begin, we want get information on the composition of the household and its occupants. Please refer only to individuals who are considered to be a part of the household. NOTE: A household consists of all the people who live in the same housing unit.

1.	2.	3.	4.	5.	6.	7.	8.
Are you the person who manages the maize farming? 1…Yes No→*(ask to speak with the person who manages the maize farming.)*	How old are you? (years)	Sex Male ☐ Female ☐	What is your relationship to the head of household? 1…head 2…spouse 3…son/daughter 4…parent 5…brother/sister 6…niece/nephew 7…relative 8…Other (specify)	What is your Martial Status? 1…Married(monogamous) 2…Married (polygamous) 3…Informal union/cohabitation 4…Divorced 5…Separated 6…Widowed 7…Never married	Highest Level of education competed? 1…No formal education/illiterate 2…Some primary 3…Completed primary 4…Some secondary 5…Completed secondary 6…Some university/Higher 7…Completed university/Higher 8…Post Graduate 9…Others (specify)	Can you read and write? 1…Yes 2…No→(Q9)	In what Languages? 1…Hausa 2…English 3…Yoruba 4…Igbo 5…Other (write in)

Section 2: Household Demographics						
9.	10.	11.	12.	13.	14.	15.
What is the main economic activity of the enterprise that you are working in or of your own business? 1…Agriculture 2…Mining 3…Manufacturing 4…Professional, Scientific or technical activities 6…Electricity 7…Construction 8…Transportation 9…Buying and selling 10…Financial services 11…Personal services 12…Education 13…Health 14…Public admin 15…Other, specify	What is your main religion? 1…Christianity 2…Islam 3…Traditional 4…Other (list)	What would you say your ethnicity is? 1…Gbagyi 2…Hausa 3…Yorubi 4…Fula/Fulani 5…Igbo 6… Bazazagi 7…Other (write in)	How many adults consistently live in the household? *(Ask about adults who consider the housing unit their primary living unit)*	How many members of each age group consistently live in the household? a. 0 to <3 years old ☐ b. 3 to < 6 years old ☐ c. 6 to < 18 years old ☐ d. 18 to < 45 years old ☐ e. 45 + years old ☐	How many pregnant women live in the household? *Enter number, enter zero if none:* ☐	How many children and/or adults are able to work full time and/or part time on the agricultural fields? a. Full time ☐ b. Part time ☐

Section 3: Household Composition and Assets

Enumerator Instructions: *Questions 1-4 are based on what the respondent tells you after asking the question. Do not read out the options.*				5.	6.	7.	8.	9.
1.	2.	3.	4.	Does this house belong to you or your family?	What is the main source of water for the household?	What cooking fuel does the household use primarily?	What type of lighting does the household have?	How many separate rooms (other than bathrooms) does the household have?
What is the HH's toilet facility? 1...flush 2...pit latrine 3...other	What is the house roof made of? 1...thatch 2...corrugated steel 3...tiles 4...aluminum 5...cement 6...mud 7...other	What are house walls made of? 1...thatch 2...mud and poles 3...raw bricks 3...burnt bricks 4...cement blocks 5...stone 6...wood 7...other	What is the floor made of? 1…Earth/mud 2…Straw 3…Cement 4…Tile 5…Wood 6…other	1…Yes 2...No	1…piped 2…public tap 3…bored hole 4…wellspring 5…rain 6…tanker/truck 7…river/lake/stream 8…other (specify)	1...gas 2...electricity 3...charcoal 4...firewood 5...kerosene 6...other (specify)	1...electricity 2...paraffin or kerosene lantern 3...candle 4...firewood 5...solar 6...gas 7... other (specify)	*Enter number*

Section 3: Household Composition and Assets

Q10. How many of the following items do you own?

Item		Number of Items *Enter 0 if none*	Item		Number of Items *Enter 0 if none*
1.	Radio		6.	Bicycle	
2.	TV		7..	Motorcycle	
3.	Cellphone		8..	Tractor used for planting/harvesting	
4.	Draft Animals		9..	Irrigation pump	
5.	Other livestock		10.	Pickup Lorry	

Section 4: Farm Roster

Enumerator Prompt: This section contains questions about the farms of land you are currently using to cultivate crops. We are interested in knowing what areas you are currently using for production and their size. Please list all farms that you or anyone in the household has cultivated since last June.

1. What is the total number of individual farms (or plots) that are contiguous that you cultivate crops on?

2. What is the FARMABLE area of [FARM]?

Enumerator Instructions: *Ask the farmer to estimate the area. Ask farmer to first list all the maize plots. Also ask the farmers to start with their biggest farm and go the smallest. PLEASE PRINT A COPY OF THIS PAGE TO HELP REFER.*

Units:
1…heaps
2…ridges
3…stands
4…farms
5…acres
6…hectares
7…square meters
8…Other (specify)_____

FarmID #	a. Farm Name	b. Estimated Area*	c. Unit	d. Distance from market where they sell the crops		c. Did you cultivate maize in the last season, when planting is in April to June of 2013? 1…Yes 2…No
				1. Qty	2. Unit a. Kilometers b. Miles c. Other (specify)	
P1						
P2						
P3						
P4						
P5						
P6						
P7						
P8						
P9						

Farm ID#	Section 5: Land usage and inputs								
	1.	2.				3.	4.	5.	6.
	Do you rent or does this farm belong to your family? 0…Rent 1…belongs to family 2…Other (specify)	What are the two main crops that are cultivated on this farm during the last year 2013, including crops planted in April –June 2013? *Enter crop code(s). if farm is left fallow, put a "0" and move to next farm. If more than one, please note top 2 crops.* *For each crop, also ask the farmer to estimates the percent of the farm this crop represents.*				Is the farm irrigated? 1…Yes 2…No →(Q6)	Is irrigation seasonal or year round? 1…seasonal 2…year-round	What is the source of irrigation on this farm? 1…rain 2…river 3…well 4…other	Type of cropping used 1...inter-cropping 2...mono-cropping 3…relay-cropping 4…mixed 5…alley cropping 6…strip cropping 7…other
		a.Crop1	b.%	c.Crop2	d.%				
P1									
P2									
P3									
P4									
P5									
P6									
P7									

Section 6: Inputs to Production—Maize

Enumerator Instructions: Please ask farmers only about the farms on which they planted maize in the last season (harvest of October/November 2013). *Be sure that the respondent understands that the following questions refer to the harvest season from last June's planting. This harvest season should have been in October/November of 2013. Also, these questions only refer to the maize that was harvested during this time.Ask ONLY about the farms on which maize was grown.* ***Do not read the options out loud, just ask and note the response.***

Enumerator Prompt: Now I am going to ask you questions about your activities regarding the farms in which you harvested maize in October/November of last year. Please answer about the farms starting with the largest one.

Farm ID#	1. What date did you begin planting maize on this farm in the last late March to June 2013 planting season? (*Please work with farmers to get an exact date*)			2. *How well does the farmer remember this date?(please answer based on your assessment and directly asking the farmer)* 1…very certain, he remembers both the day and month easily 2…somewhat certain; he remembers the month and the week of planting 3…uncertain, he can remember the month only 4…uncertain, he remembers the season but not the month or day	4. Did you use fertilizer on this crop? 1…Yes 2…No →(Q11)	5. What kind of fertilizer was used? 1…NPK 2…UREA 3…composite manure 4…Other (specify)	6. How much fertilizer was applied on this farm? Unit codes: 1…kg 2…liter 3…gram 4…other (specify)		7. How did you acquire fertilizer for this crop? (*do not read the options*) 1…purchased (cash) 2…gifted→(Q9) 3…produced on farm→(Q9) 4…purchased (in kind) 5…provided by trader 6. ..provided by aggregators through contract agreement 7…provided by AgResults aggregator 8…other	8. How much was spent on fertilizers for this farm? Naira. (*If purchased in kind, ask respondent to estimate value in naira.)*	9. What price did you pay for this fertilizer? Unit codes: 1…kg 2…liter 3…gram 4…other (specify amount and unit)	
	1.MM	2.DD	3.YY				1.Qty	2.Unit			1.Price	2.Unit
P1												
P2												
P3												
P4												

Section 6: Inputs to Production--Maize

Enumerator Instructions: *Do not read response options to respondent. Mark the code that most closely corresponds to his/her answer.*

Farm ID #	10. Did you use pest control on this farm? 1…Yes 2…No →(Q16)	11. What kind of pest control did you use on this farm? 1…insecticide 2…herbicide 3…both	12. How much insecticide and/or herbicide was applied on this farm? Unit codes: 1…kg 2…liter 3…gram 4…other (specify)		13. How did you acquire the insecticide and/or herbicide for this farm? (*Do not read options)* 1…purchased (cash) 2…gifted→(Q15) 3…produced on farm→(Q15) 4…purchased (in kind) 5…provided by trader 6. ..provided by aggregators through contract agreement other 7…Provided by AgResults aggregator 8…Other (specify)	14. How much was spent on insecticide /herbicide for this farm? Naira *(If purchased in kind, ask respondent to estimate value in naira.)*	15. What price did you pay for this insecticide/herbicide?		16. How much seed was used on this farm? Unit codes: 1…kg 2…gram 3…other (specify)		17. What seed type was used for planting on this farm? 1…yellow maize 2…white maize 3…red maize 4…Other (specify)	18. What quality seed was used for planting on this farm? 1…Hybrid 2…Open Pollinated Variety 3…Local 4…Other (specify)
			1.Qty	2.Unit			1.Price	2.Unit	1.Qty	2.Unit		
P1												
P2												
P3												
P4												
P5												

Section 6: Inputs to Production—Maize

Enumerator Prompt: What were the FOUR machines, pieces of farming equipment, or animals for traction that were used MOST on each maize farm? *Reminder: This is limited to the time between last Junes planting and the corresponding harvest. Ask questions 24-26 for each of the four pieces of machinery/animal.*

Equipment Codes:
1…tractor 6…carts 10…Other (specify)
2…harvester 7…grinder
3…ridgers 8…drier
4…planters 9…animal for traction
5… wheel barrow

Farm ID #	20.	21.	22.	23.	24.				25.				26.			
	1st *Entercode*	2nd *Entercode*	3rd *Entercode*	4th *Entercode*	Do you own this equipment or animal? 1…yes 2…no *Write for each of the four. Leave blank if no code was entered.*				Was this equipment/animal rented? 1…Yes 2…No→(go to next equipment) *Write for each of the four. Leave blank if no code was entered.*				How much was spent on renting all equipment/animals for this farm? Naira *Write for each of the four. Leave blank if no code was entered.*			
					1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.
P1																
P2																
P3																
P4																
P5																

Section 7: Hired Labor used for Maize						
Enumerator Instructions: *For this section. We want to know about any hired labor that was used specifically for **MAIZE PRODUCTION**. For each farm that produced maize, ask the following questions. If no hired help was used, proceed to next section.*						
	1.	2.	3.	4.	5.	6.
FarmID#	Did you use any hired labor for maize production for the last harvest? 1…Yes 2…No→(next section)	How many people were hired for labor? #	For how long did you hire this labor – *please enter total labor for all people?* #	Unit of time 1…hour 2…day 3…week 4…month 5…quarter 6…half year 7…annual	How did you pay for this labor? 1…cash 2…in kind 3…Other (specify)	What was the total cost of this labor? Naira(*If purchased in kind, ask respondent to estimate value in naira.)*
P1						
P2						
P3						
P4						
P5						

Farm ID #	Section 8: Aflasafe Usage for Maize								
	Enumerator Instructions: *This section pertains to the use of Aflasafe on maize crops. Ask the following questions for maize farms only.*								
	1.	2.	3		4.	5	6.	7.	8.	
	Do you know what Aflasafe is? 1…Yes 2…No →(next section)	Did you use Aflasafe on this farm? 1…Yes 0…No →(Next Section)	How much aflasafe was applied to this farm? Unit codes: 1….kg 2…liter 3…gram 4…other (specify)		How many days after planting did you apply Aflasafe?	How did you acquire aflasafe for this farm? 1…purchased (cash) 2…gifted→Q8 4…purchased (in kind) 5…provided by trader 6...provided by AgResults aggregators through contract agreement 7…Other (specify)	How much was spent on aflasafe for this farm? Naira (*If purchased in kind, ask respondent to estimate value in naira. Write zero if it was free)*	Did you use hired labor to apply aflasafe? 1…Yes 2…No →(next section)	What were the total hours and cost for this hired labor? hours	
			1 Qty	2 Unit	Days				Hours	Naira
P1										
P2										
P3										
P4										
P5										
P6										

FarmID #	Section 9: Harvest and Marketing—Maize												
	Enumerator Instructions: *Remind the farmer that this question is about last April/June's planting and October/November 2013 harvest. Ask these question by plot/farm. Make sure that information on each plot is answered correctly, and not mixed across plots.*												
	1.		2.		3.	4.				5.		6.	
	What is the total quantity of maize harvested on this farm? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)		How much of the harvest was lost? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)		Why was the harvest lost? 1…mold 2…insects 3…transportation 4…weather 5…rodents 6…theft 7…other (specify)	How much of the harvest was used for own consumption by person, or for feed and for seed for the next planting season? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)				How much of the harvest was given away as a gift or payment? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)		How much of the harvest was used saved/used for input for the next planting season? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)	
	1.Qty	2.Unit	1.Qty	2.Unit		1.Food	2.unit	1.Feed	2.unit	1.Qty	2.Unit	1.Qty	2.Unit
P1													
P2													
P3													
P4													
P5													

Section 9: Harvest and Marketing—Maize

Enumerator Prompt: Now we are going to talk about the total yields you have received across all your maize farms or plot. Remember, these yields refer to the same harvests season as before, which means the yields from last Junes planting season.

12.	**Enumerator Instructions**: *For these questions 13-28, we want to ask about each buyer individually. Using the list generated by Q12, fill out the answers for each buyer in their respective row.*															
	13.		14.		15.		16		17.				18.	19.	20.	21.
Did the harvest from this farm have multiple buyers? 1…Yes 2…No (go to Q 14 and only fill our information in buyer 1 row) *Ask about each buyer separately, starting with the biggest buyer.*	Who are the different buyers and what type are they? Types: 1…Local aggregator 2…Neighbor 3…Medium aggregator 4…Large aggregator 5…Consumer 6…Retailer 7…AgResults Aggregator 8... Other (specify)		How much of the harvest was sold to this buyer? Unit codes: 1…kg 2…bunch 3…piece 4…None (go to next section) 5…other (specify)		How long after harvest did you wait before selling? Unit of time: 1…hour 2…day 3…week 4…month 5…quarter 6…half year 7…annual		At what total price was the maize sold to this buyer? Naira *(If purchased in kind, ask respondent to estimate value in naira.)* Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)		Was any part of the payment made later? Yes – 1 No – 2 - Skip If yes, enter amount paid later? *Buyers can sometime provide premiums or other payments later after they have sold the maize.*				Do you have a contract with this buyer? 1…Yes 2…No →(Q20)	What is the length of time the contract is valid for? *Enter number of days*	Was any portion of the yield rejected by the buyer? 1…Yes 2…No→ (Q22)	Reasons for rejection: 1…size 2…mold 3…color 4…other (specify)
	1.name	2.type	1.Qty	2.Unit	1.Qty	2.Unit	1. Naira	2. Unit	Yes = 1	1. Naira	2. Qty	3. Unit				
Buyer 1																
Buyer 2																
Buyer 3																
Buyer 4																
Buyer 5																

Buyer ID#	Section 9: Harvest and Marketing--Maize								
	22.	23.	24.	25.	26.	27.	28.		29.
	How does the buyer pay you? 1…Cash→(Q25) 2…In kind 4…Mixture of cash and in kind 5…Other (write in)	How much of the payment was in kind? %	What goods are used for in kind payment? Write in	Does the buyer guarantee purchase every harvest? 1…Yes 2…No →(Q29)	Does this guarantee come with any conditions? 1…Yes 2…No→ (Q28)	What are the conditions? 1…use of aflasafe 2…harvest amount 3…quality 4…other (specify)	How much does the buyer guarantee to purchase each harvest? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)		Where does the Maize go after you sell it to the buyer? 1…Don't know 2…local markets 3…regional markets 4…poultry markets 5…export markets 6…other (write in)
							1.Qty	2.Unit	
Buyer 1									
Buyer 2									
Buyer 3									
Buyer4									
Buyer 5									

Section 10: Maize Storage (on-farm and off-farm)

Enumerator Instructions: *The following questions are only in regard to MAIZE storage only. For each question ask about maize storage for consumption and for commercial use (selling or trading) separately. If the answer is the same for both, mark the same coded response in both rows.*

Note: A=Consumption B=Commercial Use

	1. How do you dry your maize? 1…Sun drying 2…Oven dry 3…Store in Silos 4…Stalk drying 5…Fire/smoke drying 6…Others (specify)	2. Do you measure moisture before storing? 1…Yes 2…No	3. How much of the harvest is being stored by your household? Unit codes: 1…kg 2…Bunch 3…piece 4…other (specify)		4. What type of storage do you use? 1...metal silo 2...plastic silo 3...hermetic bag 4...plastic bag 5...open air 6...ground 7...raised platform 8...other *In second column put any additional protection used*. 1…spraying 2…smoking 3…hired guard 4…other		5. On average, how long can you store maize using this type of storage? (days)	6. Do you sort maize before storage? 1…Yes 2...No→(Q8)	7. Based on what characteristics do you sort maize? 1…Mold 2…Smell 3…Taste 4…Physical damage 5…Age 6…Color 7…Source 8…Other	8. Do you use off-farm storage? 1…Yes 2...No→(Q11)	9. What type of off-farm storage do you use? 1...warehouse receipts 2..other (write)	10. How much do you spend per kg for storage off-farm? In naira *(If owned warehouse, ask respondent to estimate value in naira.)*	11. In general, what is usually the main purpose for storing? 1…food for household 2…to sell at a higher price 3…seed for planting 4…render payment in kind 5…wait for arrival of buyer 6…Other (specify)
			1. Qty	2. Unit	1.	2.							
A													
B													

Section 11: Inputs to Production--Other

Enumerator instructions: *Now ask the respondent about the farms which **DO NOT** have maize, but are used to cultivate other crops.*

Enumerator Prompt: We now want to know similar information about the other crops planted on these same farms. The following questions refer to all crops besides maize that were planted on these farms

Farm ID #	25. What month was the farm planted? 1…January 2…February 3…March 4…April 5…May 6…June 7…July 8…August 9…September 10…October 11…November 12…December	26. What crop was cultivated on this farm? *(See crop codes below)*	27. How much money was spent on seeds for this farm? Naira *(If purchased in kind, ask respondent to estimate value in naira.)*	28. How much was spent on equipment rental for this farm? Naira *(If purchased in kind, ask respondent to estimate value in naira.)*	29. What is your estimate of the total cost hired labor cost of planting and harvesting [CROP]?	30. How much did you spend on fertilizer and pest control for this farm?? Naira	
						Fertilizer	Pest Control
P1							
P2							
P3							
P4							
P5							
P6							
P7							
P8							

Crop Code	Section 12: Harvest and Marketing—Other Crops				
	Enumerator Instructions: *these questions are for all crops **EXCEPT** for maize. Note that these question **ARE NOT BY FARM**, they are **BY CROP**. For each question, please obtain the information for all farms that the household use to produce the CROP**.** See crop codes table for appropriate code.* **Enumerator Prompt:** Now we want to know about other crops you have produced on all of your farms. Please answer the following questions with total numbers for each crop. **All harvest related questions refer to the most recent harvest for each crop**				
	1.		2.		3.
	What was the total harvest of [CROP]? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)		How much of the [CROP] was sold? Unit codes: 1…kg 2…bunch 3…piece 4…other (specify)		What was the total value of the [CROP] sold? Naira
	1.Qty	2.unit	1.Qty	2.Unit	

Household ID #	Section 13: Extension Services							
	Enumerator Prompt: For household ID, enter number on the cover page.							
	1.	2.	3.	4.	5.	6.	7.	8.
	Have you or any member of the HH received advice or training on farming, harvesting, marketing or storage techniques? 1…Yes 2…No→(Next Section)	From what organization did you receive this training/advice? 1…NGO 2…Government Extension officer 3…Friend/neighbor 4…Farmers association 5…Aggregator 6…Media 7…AgResults aggregator 8…Other (write in)	What type of advice was received? 1...seed varieties 2...pest control 3...fertilizer use 4...storage technologies 5...crop sales 6...irrigation 7...composting 8...access to credit 9...other	In what form was the advice received? 1...formal training (on-farm) 2...formal training (off-farm) 3…word of mouth (expert) 4...word of mouth (family/neighbor 5...Written text 6...radio	Did you pay for these Services? 1…Yes 2…No	Have you received training/advice on how to use aflasafe or prevent aflatoxins in maize? 1…Yes 2…No	From what organization did you receive this training/advice? 1…AgResults Aggregator 2…NGO 3…Government 4…Friend/neighbor 5…Other buyer 6…Other Aggregator 7…Other (write in)	In your opinion, did this advice help to increase the yield on this farm? 1…Yes 2…No

Section 14: Non-farm Income

Enumerator Instructions: *The definition of a household member is any adult or child that has been consistently living in the dwelling. For Household's ID, enter the number on the cover page.*

Enumerator Prompt: Now we want to know about any income, goods or services the household received as a result of off-farm employment. The next few questions are going to ask about the household as a whole, so please include the incomes, goods or services received by any member of the household.

Household ID#	1.	2.	3.	4.
	Do you or anyone in the household receive any payment in the form of goods services or cash for work done off the farm in the last year? 1…Yes 2…No →(go to Section 15)	What was the primary activity in this work? (write-in, will be coded after)	In what sector was this main activity? 1…Agriculture 2…Mining 3…Manufacturing 4…Professional, Scientific or 5…technical activities 6…Electricity 7…Construction 8…Transportation 9…Buying and selling 10…Financial services 11…Personal services 12…Education 13…Health 14…Public admin 15…Other (specify)	What was the total value of goods, services or cash received by the household in the last year (what was your income from this activity)? (Naira)

Section 15: Credit and Savings				
Enumerator Prompt: *For Household's ID, enter the number on the cover page.*				
Household ID#	1.*	2.*	3.*	4.*
	What type of institutions have you used to save money in the past 12 months? 1…microfinance 2…savings association 3…cooperative 4…informal savings groups 5...Buyers 7..Banks 6…none of the above	In this past 12 months have you used any entity to borrow money? 1…Yes 2…No→(nest section)	What type of entity did you use? 1…Bank 2...Savings group 3…Cooperative 4…adashi 5…esusu 6…ajo 7…relatives 8…money lenders 9…buyers 10…AgResults Aggregator	What was the total value of borrowed money from all entities in the last 12 months? Naira

Section 16: Knowledge of Aflasafe andAflatoxin.

Enumerator Instructions: *This section should be filled out by 2 people. First, continue interviewing the **"farmer"** or manager of the farm for this household. NOTE: this should be the same person that has been interviewed throughout. After finishing with the "farmer" ask to speak with the individual in the households who is responsible for cooking and feeding the family ("**Preparer of Food**") For this individual, only ask questions 1-7.*

***IMPORTANT!** For this set of questions, do not read the answer options aloud to the respondent. Allow them to respond and mark the code corresponding to their answer, if there is not corresponding code; please write in the answer to be coded later.*

	1.	2.	3	4.	5.	6.	7.	8	9	10	11	12	13.
Individual ID #	Have you ever heard of Aflatoxin? 1…Yes 2…No →(go to Q8)	From whom did you hear about Alfatoxin? 1…IITA 2…Neighbor/Friend 3…Village leader 4…AgResults Implementer 5…Radio 6. Spouse 7…Other (specifiy)	If you suspect maize has alfatoxin contamination, what do you do with it? 1…consume 2…give to animals 3…Sell anyways 4…throw away infested parts 5…make flour 7…save for adult consumption only 8…save for days of food	What concerns do you have about aflatoxin contaminated maize? 1…health 2…taste 3…ability to sell 4…Ability to store 5…other (specify)	What health risks does it pose? 1…immediate health problems(weeks) 2…long term health problems(months) 3…life-long health problems (years) 4…death 5…cancer 6…Other (specify)	How can you prevent aflatoxin from forming on maize? 1…timing of planting 2…seed variety 3…insecticide 4….herbicide 5…off-field drying 6….improved storage 7…Aflasafe 8…keeping fields clean 9…other (specify)	How can you identify alfatoxin? 1…color 2…Smell 3…Taste 4…Lab test 5…Other	*Have you ever heard of Aflasafe?* 1…Yes 2…No →(SECTION 18)	*Only complete the following questions to the farmer if the respondent said he knew what Aflasafe was in Section 8.* ***Ask the women/preparer of the food regardless.*** How does aflasafe work? 1…like pesticide or	How much needs to be applied in order for aflasafe to be effective? Unit codes: 1…kg 2…liter 3…gram 4…other (specify	Is Aflasafe easily available to you for purchase? 1…Yes 2…No	In the November planting season, did you have all the aflasafe you wanted? 1…Yes 2…No	How much more did you want/need to completely protect your crops? Unit codes: 1…kg 2…liter 3…gram 4…other (specify

			scarcity 8…Other(specify)						herbicide 2…is a bacteria that outcompetes other toxic bacteria 3…don't know 4…other (specify)	1.qty	2.unit			1.Qty	2.unit
1.	Farmer														
2.	Preparer of Food														

Section 17: Consumption of Aflasafe treated maize

Enumerator Instructions: *This section is only to be filled out by households who are aware of aflatoxin and knowingly consume afla-safe treated maize. If the household does not fit these criteria, then skip to section 17. If the household does qualify,* ***only ask the individual responsible for cooking and feeding the family.*** *For Household's ID, enter the number on the cover page.*

Household ID #	1. Do you consume aflasafe treated maize in this household? 1…Yes 2…No →(next section)	2. Do you have stocks of aflatoxin free or aflasafe treated maize for consumption? 1…Yes 2…No→(Q5)	3 Do you keep this maize separate from other maize? 1…Yes 2…No	4. Is this stock adequate for all maize consumption needs? 1…Yes 2…No	5. Is aflasafe treated maize available in the market for purchase? 1…Yes 2…No	6. What is the highest price you are (or would be) willing to pay for that amount of aflasafe treated maize?		7. If you did not have aflasafe treated maize or your own supplies ran out, what would you do? 1…consume regular maize from own farm 2…purchase regular maize from market 3…travel to purchase aflasafe treated maize 4…other (specify)
						1.Price	2.Unit	

Section 18: Child Roster and Maize Consumption in the last 24hours (children less than 5 only)

Enumerator Instructions: *For this section, **only ask for the individual in the household who is responsible for the cooking and feeding the children**. The following questions should be asked to him/her only. Be sure to reminder him/her that the following questions refer to consumption by each child under the age of 5 in the last 24 hours.*

Child ID #	1. Please list the ages of all children that are less than and equal to 5 that live in this household *Enter age* *Make sure number of children here matches the number of children reported in Section 2, Q13* Age	2. How much maize has this child consumed in the last 24 hours? *Enter Quantity*	3. Unit of measurement *Write in: provide options, grams, cups etc.*	4. Where did the maize come from? 0…own farm→(Q6) 1…purchased 2…gifted→(Q6)	5. How much did you spend on the maize? naira	6. Was the maize consumed treated with aflasafe? 1…Yes 2…No→(Q8) 3…Don't know	7 What was the quantity of Aflasafe-treated maize consumed by the child? *Use same unit of measurement as in Q3*	8. In what form was the maize consumed? 1…Cooked or Roasted 2…pap or other porridge 3…Tuwo, dumplings, fritters 4…ground maize or flour 5…other (specify)	9. Was the maize separated by quality before cooking? 1…Yes 2…No **If farmer is AgResults farmer, END INTERVIEW.** **If non-AgResults, go to Section 19.**
1									
2									
3									
4									
5									
6									
7									

Agresults Aggregator	**Section 19: Intrapersonal Connection Matrix** **Enumerator Instructions:** *The questions are only to be asked to farmers who did not participated in AgResults. We want to understand how well known the Agresults farmers are to other farmers within a village.*						
	1	2.	3.	4.	5.	6.	7.
	Do you know or have your heard of any of the following maize aggregators?1 …Yes 2…No (do not ask Q2-Q7) *If farmer does not know of any, then end the interview.*	How well do you know and how often do you interact with this aggregator? 1…Very well; interact 5+ times a week 2…Well; interact 1-3 times a week 3…somewhat; interact 1 time every 2 weeks 4…Not very well; interact 1 time amonth 5…Only know by name; interact less than 5 times a year	What is your relationship with this aggregator? 1…immediate family 2…Extended Family 3…Neighbor 4…Friend 5…Business (you sell to them or receive inputs form them) 8…Employer 9…Employee 10…Other (specify) *Mark all that apply.*	Do you know any farmers in your village who work with this aggregator? 1…Yes 2…No (if answer is no for all aggregators, END OF INTERVIEW)	Approximately how many farmers do you know that work with this aggregator ?	How well do you know and how often do you interact with these farmers? *(if he knows multiple farmers, ask about the farmer who he knows best)* 1…Very well; interact 5+ times a week 2…Well; interact 1-3 times a week 3…somewhat; interact 1 time every 2 weeks 4…Not very well; interact 1 time amonth 5…Only know by name; interact less than 5 times a year	For the farmer you know best, how do you know him? 1…immediate family 2…Extended Family 3…Neighbor 4…Friend 5…Community Group or Association 6…Agricultural cooperative 7…Village leader 8…Employer 9…employee 10…share farming advice 11…Other (specify)
Maslahaseeds							
Fantsuam Foundation/Professor Dada							
CADP-Kaduna							
Danladi mohammed							
Shehu Mohammed							
Ali Ahmed Ali							
Babban Gona							
Nuhu Umar							

Crop Codes:

Crop	Code	Crop	Code	Crop	Code
BEANS/COWPEA	1	GINGER	38	CHILLI	75
CASSAVA	2	GINGER PEELED	39	COCOA	76
COCOYAM	3	GINGER SPLIT	40	COCOA POD	77
COTTON	4	VANILLA	41	COCOA BEANS	78
COTTON SEED	5	GUM ARABIC	42	COCONUT	79
COTTON LINT	6	OKRO	43	COFFEE	80
GROUNDNUTS	7	ONION	44	COFFEE ARABICA	81
UNSHELLED GROUNDNUTS	8	PEPPER	45	COFFEE ROBUSTER	82
SHELLED GROUNDUTS	9	SWEET PEPPER	46	DATE PLAM	83
SORGHUM	10	SMALL PEPPER	47	GRAPE FRUIT	84
MAIZE	11	ATARE	48	GUAVA	85
UNSHELLED MAIZE (COB)	12	PIGEON PEA	49	JUTE	86
SHELLED MAIZE (GRAIN)	13	PINEAPPLE	50	KOLANUT	87
POP CORN MAIZE	14	PLANTAIN	51	KOLAUNT UNSHELLED	88
MELON	15	POTATO	52	KOLANUT SHELLED	89
UNSHELLED MELON	16	SWEET POTATO	53	BITTER KOLA	90
SHELLED MELON	17	PUMPKIN	54	LEMON	91
WATER MELON	18	PUMPKIN LEAVE	55	LIME	92
MILLET/MAIWA	19	PUMPKIN FRUIT	56	LOCUST BEAN	93
RICE	20	PUMPKIN SEED	57	MANDARIN/TANGERINE	94
UNSHELLED RICE (PADDY)	21	GREEN VEGETABLE	58	MANGO	95
SHELLED RICE (MILLED)	22	DRY LEAVES (KUKA)	59	ORANGE	96
YAM	23	RIZGA	60	OIL PALM TREE	97
WHITE YAM	224	SHEA NUTS	61	FRESH FRUIT BUNCH	98
YELLOW YAM	25	SOYA BEANS	62	FRESH NUT	99
WATER YAM	26	SUGAR CANE	63	PALM OIL	100
THREE LEAVE YAM	27	TEA	64	PALM KERNEL	101
ACHA	28	TOBACCO	65	AGBONO(ORO SEED)	102
BAMBARA NUT	29	TOMATO	66	OIL BEAN	103
BANANA	30	WALNUT	67	PAWPAW	104
BEENI-SEED/SESAME	31	WHEAT	68	PEAR	105
CARROT	32	ZOBO	69	AVOCADO PEAR	106
CUCUMBER	33	ZOBO SEED	70	RUBBER	107
CABBAGE	34	APPLE	71	RUBBER LUMP	108
LETUS	35	CASHEW	72	RUBBER SHEET	109
GARDEN EGG	36	CASHEW FRUIT	73	CHERRY (AGBALUMO)	110
GARLIC	37	CASHEW NUT	74	ERU	111
				IYERE	112

Appendix D: Power analysis assumptions

Net maize revenue per acre in U.S. Dollars ($)	Estimated value	Source or description of logic used to derive estimated value
Standard deviation of outcome measure	$158.7	Kibet, N., et al. (2011)
Intra-class correlation (ICC)	0.25[1]	1. Morris, Saul Sutkover (2000) 2. De Allegri, Manuela et al. (2008)
Attrition (Cohort A)	10% refusal rate in Cohort A	Based on our prior experience conducting household surveys in West Africa.
Attrition (Cohorts B and C)	30% attrition/refusal rate in Cohorts B and C	Based on our prior experience conducting household surveys in West Africa.
Correlation between baseline and endline	20%	Oladejo J., Lapido O. (2012) Olarinde, et al. (2007) Badu-Apraku , et al. (2012)

[1] We did not find ICCs in the literature for the outcome of interest. Estimates of ICCs for per-capita household expenditure and food share in developing countries vary from .09 - .67, with highly urban areas exhibiting higher ICCs. Health care spending, household socio-economic status (SES), health care outcome ICCs in West Africa are around .04.

Proportion of smallholder maize treated with Aflasafe	Estimated value	Source or description of logic used to derive estimated value
Baseline proportion	10%	Based on our experience with Harvest Plus.
Intra-class correlation	0.25[1]	1. Morris, Saul Sutkover (2000) 2. De Allegri, Manuela et al. (2008)
Attrition (Cohort A)	10% refusal rate in Cohort A	Based on our prior experience conducting household surveys in West Africa.
Attrition (Cohorts B and C)	30% attrition/refusal rate in Cohorts B and C.	Based on our prior experience conducting household surveys in West Africa.
Correlation between baseline and endline	20%	1. Oladejo J., Lapido O. (2012) 2. Olarinde, et al. (2007) 3. Badu-Apraku , et al. (2012)

[1] We did not find ICCs in the literature for the outcome of interest. Estimates of ICCs for per-capita household expenditure and food share in developing countries vary from .09 - .67, with highly urban areas exhibiting higher ICCs. Health care spending, household SES, health care outcome ICCs in West Africa are around .04.

AgResults Memorandum

Date 19 January 2017

To DFID

From AgResults External Evaluation Team, Nigeria

Subject AgResults Nigeria Aflasafe Pilot – Redesign

This memorandum presents the revised evaluation design for the AgResults Nigeria Pilot. This pilot is being implemented in select Northern and Southern states of Nigeria to increase smallholder adoption of Aflasafe in maize cultivation to control the prevalence of aflatoxins – naturally occurring toxins that cause liver cancer. As described in our evaluation design report, our original plan was to conduct a randomized control trial (RCT) for six out of seven first-year implementers (Ahalson, Albarka, Fansuam Foundation, Tukun yan Gwari, Mashala Seeds, and CADP Kaduna), and a quasi-experimental design for Babban Gona, which was poised to be one of the largest implementers but did not want to participate in the RCT.[1] All seven implementers are the first few implementers who joined the program and operate in the Northern states of Kaduna, Kano, and Katsina.

For the six implementers in the RCT study, we had leveraged their staged roll-out plans for expanding to more villages each year. With their agreement, we randomly assigned villages to the different roll-out years. The villages randomly assigned to the fourth or the last year of treatment (the 2017 planting season) were the control villages, and the villages randomly assigned to Years 2 and 3 (2015 and 2016 planting season) were the treatment villages.

However, the randomized experiment is no longer feasible. As of the 2016 planting season, only 15.6 percent of treatment villages had received treatment, and 13 percent of control villages had received treatment ahead of schedule. Due to the low treatment rate in the treatment group and the comparable treatment rate in the control group, the internal validity of the randomized control trial no longer holds. The difference in smallholder outcomes between those assigned to treatment and those assigned to control will not be an unbiased measure of the magnitude of impact of the pilot compared to no pilot because the pull mechanism will have affected about one-eighth of the control group. In addition, the difference in smallholder outcomes between those assigned to the treatment and those assigned to control will have virtually no chance of showing up as statistically significant even if AgResults' impact on treated farmers was large (since such impacts will be present in the treatment and control groups alike).

In place of the experiment, we propose a quasi-experimental design for all seven implementers that will answer the research question: "What is the impact of AgResults on the farmers most likely to be recruited by solvers to participate?" We will compare outcomes of households

[1] Abt Associates, *AgResults Baseline Report: Nigeria Aflasafe Pilot,* January 2016.

actually treated by AgResults implementers to outcomes of households selected by the implementers ex-ante as likely candidates for participation but that did not receive the treatment. We will select the latter comparison group from the pool of farmers in our RCT study that were *not* actually treated by AgResults. Using external data sources and relatively static household characteristics such as farm size, we will calculate analysis weights for the farmers in the comparison group. We will do this such that weighted characteristics for that group are very similar to the means of the characteristics of farmers in the treatment group. This quasi-experimental analysis will be representative of farmers treated by Babban Gona and the remaining six RCT implementers, although two of the six implementers, Mashala Seeds and CADP Kaduna, recently dropped out of the pilot because of financial constraints. Endline survey data collection will involve 622 farmers in RCT villages that were not treated, up to 257 farmers in the RCT villages that did receive treatment, and 600 farmers who received treatment but who do not live in RCT villages.

In addition, we propose an analysis that will help us understand the "reach" of AgResults and its potential for ever being taken to scale. We will assess reach and scale by estimating the proportion of farmers that are most like the types of farmers who have participated in AgResults thus far and the number of farmers in the Kaduna and Kano states that would likely participate in AgResults if implementers reached out to them. We will compare these estimates with the actual number and proportion of farmers that were reached by AgResults through the 2016 planting season to gauge how much of the pull intervention's potential had been realized by that point. This exercise involves collecting data from an additional 400 randomly selected farmers.

Section 1 summarizes the unsuccessful implementation of the randomized experiment. Section 2 presents our proposed quasi-experimental analysis. Section 3 describes the proposed additional analysis of the potential scale of the Nigeria pilot, and Section 4 concludes with the timeline for the endline survey needed to support all of these analyses.

1 Implementation of the original design

Description of original evaluation plan: In late 2012 during our evaluation design trip we learned that six AgResults implementers were planning a staged roll-out of their AgResults activities across villages. Those implementers were willing to have us randomize which villages they would begin to engage with each year. Exhibit 1 describes the timeline for this randomized experiment, up to the present.

Exhibit 1 Timeline of randomized experiment

Planting Season	Activity
2013 Planting Season (Year 0)	Prior to planting, Abt randomized villages to be treated in this year, or in subsequent years. Most implementers did not succeed in reaching and/or promoting Aflasafe adoption at the scale they hoped, and we observed some contamination in our control villages.
2014 Planting Season (Year 1)	Prior to planting, we re-randomized villages based on the implementation plan going forward. We conducted a baseline survey just prior to the planting season

Planting Season	Activity
2015 Planting Season (Year 2)	A few control villages were contaminated in the 2015 planting season (i.e., were engaged in the pilot by implementers), and only a few treatment villages were treated. Therefore, implementers agreed to hold off implementation in the villages assigned to Year 3 (the control group) until Year 4, to allow for one extra year of treatment. The pilot manager reinforced messages to all implementers to not work in control villages until the 2017 planting season. Simultaneously, the in-country evaluation survey manager worked with implementers to encourage RCT adherence.
2016 Planting Season (Year 3)	A few additional control villages were contaminated in 2016. More treatment villages were treated, but not the majority.

In addition to the random assignment evaluation, we planned to conduct a quasi-experimental analysis of Babban Gona's activities in Kaduna state. Babban Gona was not interested in being a part of the randomized experiment. However, they were amenable to participating in a quasi-experimental analysis in which we would compare their farmers to farmers in unaffected areas in a neighbouring state, Katsina, the designated comparison area.

Monitoring of RCT implementation: Of the 126 villages in the RCT that were assigned to receive treatment between the 2014 and 2016 planting seasons, monitoring data from the International Institute for Tropical Agriculture (IITA) indicate that only 19 villages were treated[2]:

- *Sixteen were visited by implementers only once: 3* were visited in only the 2014 planting season, *8* were visited in only the 2015 planting season, *5* were visited in only the 2016 planting season.
- *Three received treatment (i.e., were visited by implementers) in two years: 3* received treatment in both the 2015 and 2016 planting seasons but not the 2014 planting season.
- *None* received treatment in all three planting seasons, 2014, 2015, and 2016
- *Four other villages* were visited by implementers in the 2013 planting season. We learned after December 2013 that these villages should not have been included in the 2014 re-randomization. Therefore, we consider these villages lost to attrition.

Overall, farmers in 19 of 122 remaining villages, or 15.6 percent of all treatment villages, received treatment over three years, for a total of 473 farmers.

Owing to the multi-stage roll-out (or "step wedge" design), there are more villages in the treatment group (two cohorts) than the control group (one cohort). Of the 64 villages assigned to the control group:

- *Eight* villages received treatment, of which 2 were contaminated in the 2016 planting season and 1 was contaminated in the 2015 planting season. The remaining 5 villages were first contaminated in the 2013 or the 2014 planting season.
- *Two* additional villages were visited by implementers in the 2013 planting season. We learned *after December 2013* that these villages *should not have been re-randomized.* Therefore, we consider these villages lost to attrition leaving 62 control villages.

[2] Of the 19 villages, Tukun yan Gwari treated 10 villages, Ahalson and CADP Kaduna treated 3 villages each, and Maslaha, Ahalson, and Fansuam Foundation treated 1 village each.

Overall, farmers in 8 of 62 remaining villages, or 13 percent of all control villages, received treatment over three years, for a total of 112 farmers.

For the separate quasi-experimental Babban Gona analysis we were planning, Babban Gona gave us advance notice of plans to work in many villages. At baseline, we conducted 150 interviews of farmers in 45 of those villages. Between 2014 and 2016, Babban Gona worked in only 23 of those villages (51 percent). The treatment rate within the pre-specified Babban Gona villages is not large enough to detect impacts in the originally planned quasi-experimental analysis. Therefore, we propose a re-design for this analysis also.

Reasons for nonadherence to implementation plan: Contamination of the control villages did occur—8 out of 62 control villages were treated. But the core issue in adherence to the experimental design was the low treatment of villages that the implementers intended to treat—only 19 RCT treatment villages were treated, and only 23 Babban Gona villages in the quasi-experimental sample were treated. We interviewed implementers to understand (1) what led them to not treat some of the villages that they intended to treat; (2) how those villages were different from the villages that they did treat; and (3) what led them to treat the villages that they did treat, including the control villages. The reasons reported for low treatment include:

- Two implementers in our RCT study—Maslaha and CADP Kaduna—dropped out of the AgResults program, which meant that all the villages they intended to engage were not treated.
- Several implementers noted that in some cases they attempted to treat intended villages, but did not end up doing so because the farmers did not want to participate in the program or because of lack of accessibility of the village in the rainy season. (Only one implementer cited this reason.) The reasons for non-participation ranged from not liking the offer from implementers, to the perception of risk of the unknown, to a general lack of interest by farmers.
- Security concerns were mentioned as a reason to not treat in the 2015 planting season.
- Also in the 2015 planting season, several implementers noted droughts as a reason they did not go to treatment villages.

The reasons implementers gave for treating villages that they had not intended to treat included:

- Villagers expressed a high level of interest in the program based on a radio advertisement or initial village meetings and the expectation of receiving a higher market premium for Aflasafe maize.
- Proximity to treatment villages was an important factor for Babban Gona, whose business model is to expand in concentric circles.

Overall, the implementers appeared to be motivated by their business interest to expand their aggregation of Aflasafe-treated maize. If the villages that they initially intended to treat were not interested in participating, they found other, more willing villagers, villages with better soil fertility or villages that were more easily accessible. This raises a challenge that any RCT might face in a pull design, where the implementers act in their business interests to achieve their goals. Particularly, we should expect that the percentage of treatment may not be high, and that the implementers may shift more organically in choosing their participants.

2 Revised evaluation design

Given that the RCT is not feasible, we propose a quasi-experimental design to measure the impact of the Aflasafe pilot. The main research question will still ask “What is the impact of

AgResults on the farmers most likely to be recruited by solvers to participate"? We will compare outcomes for the farmers treated by the implementers to outcomes for the farmers in the villages that did not receive treatment. The 2014 baseline survey respondents will be a very useful pool for us to draw from for this analysis. All the baseline survey respondents, treated and untreated alike, have an important trait in common: they all live in villages selected by the seven original implementers. We will use the baseline survey respondents who do not reside in a treated village as the comparison group. Although we will still have to create analysis weights to match their characteristics to those of the farmers who actually received treatment, we are in a much better position to achieve comparability because of their common selection by implementers, making the untreated farmers more similar to the treated farmers than would be a random sample of Nigerian maize farmers. The precise composition of the proposed comparison and treatment groups is described below; we will attempt endline interviews for all members of both groups.

Comparison group: For comparison farmers, we will interview at endline farmers (in both the untreated control villages and the untreated treatment villages) that were *named by the implementer prior to baseline data collection* as farmers they planned to recruit. To summarize, we will draw the sample of comparison group farmers from:

- [A] The 361 farmers in the (39 – 12 = 27) villages assigned to treatment that were not treated, and for whom we have baseline survey data. (We have not included villages assigned to treatment that were not treated, but for whom we do not have baseline data, because we think this is not necessary.)
- [B] The 417 farmers in the (39 – 7 = 32) villages assigned to control that were not treated, and for whom we have baseline survey data. (We have not included villages assigned to control but for whom we do not have baseline data, because we think that this is not necessary.)
- [C] The 90 farmers in the (51 – 23 = 28) villages listed by Babban Gona that were not treated, and for whom we have baseline survey data.
- [D] The 286 farmers who live in Katsina for whom we have baseline survey data. Katsina is the state from which we anticipated drawing a comparison sample for the original Babban Gona quasi-experimental analysis, which we selected based on Babban Gona's selection criteria for maize farmers.

To summarize, our comparison group will consist of up to 1,154 farmers (if a 100 percent response rate were feasible; an 80 percent response rate will provide 923 cases for endline analysis) for whom we have baseline data and who reside in villages that have not yet been affected by AgResults.

Treatment group: For treated farmers, we will interview at endline farmers (in both the treated treatment villages and the treated control villages) that were treated and *named by the implementer prior to baseline data collection* as farmers they planned to recruit and for whom we collected baseline interviews. This group is small, implying that the majority of our treatment group will consist of farmers we will interview for the first time at endline. The sample of treatment group farmers will consist of:

- [E] An as-of-yet unknown number (maximum 120) farmers in the villages assigned to treatment that were treated, and for whom we have baseline survey data. In January 2017, we expect to receive monitoring data with farmer names from IITA so that we finalize how many farmers are in group E.
- [F] An as-of-yet unknown number (maximum 84) farmers in the villages assigned to control that were treated, and for whom we have baseline survey data. In January, we

expect to receive monitoring data with farmer names from IITA so that we finalize how many farmers are in group F.

- [G] The 7 farmers in the Babban Gona villages that were treated and for whom we have baseline survey data.
- [H] A new set of farmers treated by the original RCT implementers and Babban Gona for whom we do not have baseline survey data. We will determine the size of group H based on the power analysis. The total number of farmers in this group will equal the total number of farmers in the treatment group from the power analysis (1250, to yield 1000 completed interviews with an 80 percent response rate at endline) minus the number of farmers in groups E, F, and G.

While we have 264 farmers in our baseline survey that reside in villages that received treatment, the first three listed groups (E, F, and G) will likely be a small subsample of those farmers. Farmers who can actually be used in the impact analysis depend on the number of farmers who actually participated in AgResults. As of this point, we know that 53 farmers in treatment villages were not treated and we only know of 7 farmers who were treated. Our quasi-experimental analysis will be representative of farmers treated by Babban Gona and all of the original six RCT implementers. Four of the original RCT implementers (Ahalson, Albarka, Fansuam Foundation, and Tukun yan Gwari) are still actively participating. We wish to include the treated and pre-specified control villages associated with the two other implementers, Maslaha Seeds and CADP Kaduna, even though they are no longer participating in AgResults, because they did treat several villages prior to dropping out.

To summarize the usefulness of the baseline survey, up to 1,154 households interviewed at baseline could be sampled for inclusion in the comparison group of the revised design. Some number—though just 7 with certainty—can be part of the treatment group. The remaining sample for whom we collected baseline data (257) may be useful if the farmers actually received treatment, which we will verify from the monitoring data. At a minimum we will use 82 percent (= (1154+7) /(1154+7+257)) of the baseline sample in this revised design.

Analysis plan: An important issue our analysis needs to address is the lack of baseline data for most farmers in the treatment group. Baseline data can allow us to "control" for factors that affect the outcomes in addition to the AgResults pilot, so that we can better estimate the impact of the pilot itself. As we do not have baseline data for the full sample, we propose to gather information on relatively static characteristics in the endline survey, characteristics such as farmer education, religion, land owned, poverty indicators (building material of the house, roof material), and distance to markets.[3] Fortunately, our efforts to include in the impact analysis as many farmers with baseline data as possible will help us verify our assumptions and guide our selection of static characteristics. Therefore, we can be more assured that our choices of static characteristics are indeed static. In addition, we will gather baseline values for variables that affect maize outcomes from secondary GIS data. These variables include soil type, temperature, rainfall, and distance to nearest market (see Appendix).

In addition covariates can help us improve and evaluate the comparability of the treatment and comparison samples. Ideally, the sampled treatment and comparison farmers would be equivalent on all factors influencing maize production, except for their exposure to AgResults.

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[3] We will also re-ask the same questions to households interviewed at baseline and analyse the consistency between baseline and endline responses to determine which of these characteristics are truly static.

We plan to assign analysis weights to each farmer in our sample, such that the weighted covariates of the comparison farmers reflect the distribution of unweighted covariates in the group of treated farmers.

The analysis weights will not fully remove the threat of selection bias which is inherent in any quasi-experimental analysis. However, the internal validity of our study will be greatly improved by balancing the treatment and comparison group, especially along the dimensions known to potentially differentiate these two groups. These factors include:

- *Rain/drought season*: A couple implementers mentioned that weather/rainfall guided their selection of villages, so we will consider temperature and rainfall in the construction of analysis weights;
- *Soil fertility*: One implementer mentioned that soil fertility guided their selection of villages so we will consider soil type in the construction of analysis weights;
- *Farmer interest*: While we cannot perfectly measure farmer interest, we believe several measurable characteristics of farmers may be correlated with their appetite for adopting new agricultural technology: education, land owned, distance to market; membership in a farmer cooperative at endline and before the pilot began; engagement with AgResults maize aggregators at endline and before the pilot began; and the number of farmers in the vicinity that a given survey respondent knows and whom they believe worked with an AgResults maize aggregator in the past.
- *Security*: Our survey enumerators will not be able to conduct data collection efforts in areas with very severe security concerns, just as implementers found those areas unreachable. Hence, coverage of the treatment and comparison samples should be similar on this factor.

Using analysis weights will affect the statistical power of our analysis. To assess how the weights will affect statistical power, we generated a set of plausible analysis weights and tested how they altered statistical power. Using the baseline data, we estimated the distribution of the analysis weights that we will ultimately use for the comparison sample. We did this by estimating a logit model (propensity score) for whether or not a farmer resides in a village that actually received treatment (regardless of its random assignment condition). The farmers in villages that received treatment were assigned a weight of 1, while the farmers in the villages that did not receive treatment received a weight of $p/(1-p)$, where p is their propensity score.[4] We then estimated the ratio of the weighted versus unweighted variance for several outcome variables. This shows us the possible gains/losses to statistical power for the impact analysis. The ratio of the weighted variance to the unweighted variance is displayed in Exhibit 2 for a range of characteristics.

Exhibit 2 Ratio of weighted variance to unweighted variance, by outcome

Outcome	Weighted variance/unweighted variance
Aflasafe adoption	1.144
Heard of Aflasafe	1.169
Has access to Aflasafe	1.381
Net maize sales revenue per hectare[1]	1.669
Maize revenue per hectare	1.113
Revenue of maize as percentage of gross revenue	1.045

[4] These weights make the sample of farmers in villages that did not receive treatment look more comparable to the farmers in villages that did receive treatment.

Outcome	Weighted variance/unweighted variance
Average maize yield	1.053
Maize harvest (volume)	0.816
Maize price	0.813
Revenue from non-maize crops	0.973
Revenue from farm animals	0.655
Maize consumption per person	0.813
Maize consumption per child age 5 and under	0.756
Proportion of consumed maize treated with Aflasafe	0.917
Notes: [1.] Does not included imputed value for maize set aside for consumption	

The variance penalty from using weights to make the comparison group look like the treatment group is highest for the outcome of "net maize revenue per hectare" (1.669). Therefore, we propose to use maize revenue per hectare (instead of net maize revenue per hectare)—which is a product of maize yield and maize price—and proportion of consumed maize that was treated with Aflasafe as our primary outcomes to determine the sample size. These outcomes are well-aligned with the AgResults Aflasafe pilot's expected impact on smallholder welfare, and the research questions about impact on smallholder income (as measured by maize revenue per hectare), adoption of technology, and consumer demand (as measured by consumption of Aflasafe-treated maize). We will use a variance penalty of 1.144 (the highest among the primary outcomes just listed) in planning the sample sizes for our analysis.

Sample size calculation: The power analysis seeks to determine the number of farmers that need to be interviewed at endline for the quasi-experimental design to have reasonable minimum detectable effects (MDEs). Exhibit 3 presents the MDEs for various outcomes across a range of sample sizes. For example, the last row indicates that a sample of 923 comparison farmers and 1000 treatment farmers has an 80 percent chance of revealing a statistically significant impact on maize price per MT if the true impact on maize price per MT is at least $11.53. A maximum of 1154 farmers (groups A–D) are available as comparison households, but due to sample attrition we expect to be able to collect data on 80 percent of them (923). Alternatively, we also consider excluding the Katsina farmers from the comparison group, and Exhibit 3 presents the MDEs for this scenario. Excluding Katsina, we would have a maximum of 868 farmers to draw from (groups A–C), but due to sample attrition we would expect to be able to collect data on 80 percent of them (695).

We focus on the main outcome with the highest variance: maize revenue per hectare and the components of revenue, maize price and maize yield. The baseline survey data suggest that the variance of the maize revenue measure will be very high, implying that the sample size required for a reasonable MDE is too large to be realistic. That said, if we are able to reduce the noise in the endline survey measure of net revenue through additional quality assurance measures, it will increase the likelihood of detecting an impact on maize revenue.[5]

[5] During data collection we will automatically re-ask questions that receive implausible answers, such as 10 metric tons of maize produced on one hectare. During data cleaning efforts, we will top- and bottom-code extreme outliers should they enter the dataset despite our best efforts in the field to minimize measurement error.

Based on variance of maize prices in our baseline survey,[6] we expect to be able to detect a true difference in average maize price between the treatment and comparison groups at endline that is equal to or larger than US$12-14 per metric ton. At baseline, the median farmer received a price of US$175 per metric ton, so this MDE corresponds to a 7 to 8 percent increase in price. AgResults monitoring data suggest that implementers received average price premiums ranging from 13 percent to 17 percent above the price of maize not treated with Aflasafe, over and above the $18.75 per metric ton premium that AgResults provides.[7] Depending on a farmer's own direct access to these premium markets, or the extent to which aggregators share the market premiums, a 7 to 8 percent increase in price for farmers is plausible. One can argue that a premium smaller than 7 to 8 percent, even if detected, might not be large enough to have an important economic impact on farmers in any case.

The AgResults pilot is also expected to have an impact on maize yield. Based on the variance of maize yield in our baseline survey, we expect to be able to detect a true difference in maize yield between the treatment and comparison groups at endline equal to or larger than 0.40 to 0.47 metric tons per hectare.[8] At baseline, the median farmer was producing 1.27 metric tons per hectare, so this MDE represents a large percentage increase in yield. However, commercial growers obtain yields between 3 and 4 metric tons per hectare. Furthermore, AgResults pilot data report average yields of 2.6 metric tons per hectare compared to an average yield target of 3 metric tons.[9] In this context, a yield increase between 0.40 and 0.47 metric tons per hectare seems plausible.

In addition to the outcomes that affect farmer maize revenue, price and yield, the pilot is expected to increase awareness and adoption of Aflasafe. When measuring the pilot's impact on adoption, where the treatment group by definition consists of farmers who participated in the pilot and used Aflasafe, we will assess the extent to which the farmers adopted Aflasafe accurately. Specifically, we will assess whether farmers applied Aflasafe in the right quantity and at the right time, compared to other farmers who may have received Aflasafe as part of the ongoing push interventions by IITA. We will also measure the extent to which the family members who prepare meals, typically the wives, are aware of aflatoxins. The AgResults pilot's impact on awareness among household members who prepare meals is not assured. Therefore, it will be interesting to see how this measure for the treatment group differs from the comparison group, which may have received some push interventions from IITA that more directly raised awareness of all household members. We will also assess the pilot's impact on the share of consumed maize treated with Aflasafe in the face of high premiums for the same maize in the market. For these outcomes we expect to be able to detect very small impacts, as Exhibit 3 illustrates for the share of consumed maize treated with Aflasafe.

Please note that we can also assess the pilot's impact on aflatoxin levels in maize sold and maize consumed. This may be valuable because Aflasafe application may not fully control

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6 We looked only at maize prices in the baseline survey that fall between the 5th and 95th percentile range (between US$100 and US$361 per metric ton).

7 Nigeria Pilot Update final notes and presentation, AgResults Steering Committee meeting, September 2016, AgResults Secretariat.

8 We looked only at maize yields in the baseline survey that were less than 10 metric tons per hectare (roughly the 96th percentile of reported maize yields).

9 Nigeria Pilot Update final notes and presentation, AgResults Steering Committee meeting, September 2016.

aflatoxins if the maize storage practices are not appropriate, or if the households mix other maize with Aflasafe-treated maize. However, aflatoxin testing will require significant additional resources, which we are sending separately along with our request for approval of the endline survey firm.

Exhibit 3 Minimum detectable effects by sample size[1]

Com-parison group farmers	Treat-ment group farmers	Average maize price per MT (USD)	Maize yield (MT per hectare)	Maize sales revenue per hectare (USD)[2]	Net maize revenue per hectare (USD)[3]	Proportion of consumed maize that was treated with Aflasafe	Cook awareness about aflatoxins and their health impact
695	700	$13.72	0.47	$247	$59	3.5%	1.3%
695	800	$13.37	0.46	$241	$58	3.3%	1.2%
695	900	$13.15	0.45	$237	$57	3.2%	1.2%
695	1000	$13.01	0.45	$234	$56	3.0%	1.1%
923	700	$12.51	0.43	$225	$54	3.4%	1.3%
923	800	$12.06	0.41	$217	$52	3.2%	1.2%
923	923	$11.70	0.40	$212	$51	3.0%	1.1%
923	1000	$11.53	0.40	$208	$50	2.9%	1.1%

Notes:

1. All MDE calculations assume that:
   - We will estimate treatment effects using linear regressions with village random effects
   - We face a 1.144 variance penalty due to the use of analysis weights in the comparison group.
2. Includes only maize sales, and does not include any imputed value for maize production set aside for consumption.
3. Includes imputed value for maize production set aside for consumption.

In summary, we recommend the largest sample size in the table for the comparison sample: 923 (i.e., including the Katsina farmers). Choosing this larger sample size for the comparison group is especially important in case our estimate of the design effect (owing to sample weights) proves inaccurate. For the treatment group, we considered sample sizes ranging from 700, 923 (same sample size as comparison), and 1000. The advantage of sampling 1000 treatment group farmers is that we have a better chance to detect effects, but it is not impacted materially if we sample 923 farmers which keeps the treatment group sample size the same as the comparison group. One reason to choose a sample size of 700 for the treatment farmers is that the business plan offers no strict hypotheses to suggest the MDIs associated with a larger sample size are more reasonable expectations of impacts than the MDIs associated with 700. Even so, having a larger number of farmers in the treatment sample will increase the chance of detecting differences in impacts between different demographic groups (e.g. female-headed households, poor households) and between farmers who received different incentives from implementers. Given these considerations, we recommend the larger sample size of 923 for the treatment group, which is the largest sample size at which the treatment sample equals the comparison sample. Therefore, we recommend a total sample size of 1,846.

However, a benefit of reducing the treatment group sample to 700 is that we can save resources for the scale survey proposed below. This reduction in sample size—from 1,000 to

700—can fund a part of the scale survey but not all of it. Therefore, if DFID feels that additional resources will be available to fund the rest of the scale survey it would be worthwhile to forego some benefits of the larger endline survey. However, if the likelihood of funding the scale survey is low, then we prefer increasing the chance of detecting effects from our endline survey, particularly the differentiated impacts.

A final consideration in defining the endline sample size is the language in our consent script and whether it promised the households that we will come back for an endline survey. Although we note, that given the length of the survey if anything the survey is a burden on the households, we are confirming that our consent script did not promise the households that we will come back in the endline for another interview.

3 Potential scale of the pilot

To complement the impact analysis of the quasi-experimental design, we propose to estimate the potential reach of the AgResults pilot in Kano and Kaduna states, our main study areas. Note that this analysis will require additional resources beyond our current budget. We are submitting a separate request explaining the additional costs, along with our request of approval for the survey firm. This analysis will answer two questions: How many farmers are being treated by AgResults? How many farmers seem 'suited' to be brought into Aflasafe-based maize farming, given the characteristics of the farmers actually selected by solvers for participation?

To answer these questions, we need to know all of these three things:

- The total number of farmers/households/general population in Kaduna and Kano (available from external data sources)
- The number of farmers involved in AgResults (available from monitoring data)
- The proportion of farmers suited for Aflasafe-based maize farming (requires original data collection and analysis).

To estimate the proportion of farmers suited for Aflasafe-based maize farming, we propose to interview a random sample of farmers in a random sample of villages across Kaduna and Kano and gather information on their static characteristics—the same set of characteristics that we will use to weight the sample of comparison farmers. We will then estimate the 'propensity' of a farmer to be treated by AgResults based on those characteristics and study the distribution of the propensity scores to estimate the proportion of farmers who are suited for Aflasafe-based maize farming. We will then select a threshold of the propensity score above which we consider a farmer to be a likely adopter, and report the proportion of farmers with scores above that threshold.

Exhibit 4 displays some possible sample sizes and the corresponding width of confidence intervals around the estimated proportion of farmers suited for Aflasafe-based maize farming. For example, the last row of the table indicates that if we survey a random sample of 600 farmers (10 farmers in each of 60 villages), our estimate of the proportion of farmers who are suited for Aflasafe-based maize farming would have a confidence interval of +/- 6.3 percentage points.

Exhibit 4 Sample size for scale study

N, all farmers	N, villages	Confidence interval around estimated proportion who are suited for Aflasafe-based maize farming
200	20	11.5%

300	30	9.2%
400	40	7.9%
500	50	7.0%
600	60	6.3%

Notes: We used baseline data to estimate the intra-cluster correlation (ICC) and the variance of the proportion of farmers who are suited for Aflasafe-based maize farming. We estimate that 34 percent are truly suited, and that the ICC is 0.188. This is based on an analysis of baseline data to predict the likelihood of a village receiving treatment, as known to us from the monitoring data.

4 Timeline for the surveys

Timing of the endline survey: Another factor to consider in finalizing the evaluation design is the timing of the endling survey. Under the RCT design, the control group villages would be treated (or, available for treatment) in the fourth year. This plan led us to consider conducting the endline one year before the pilot end, or in year 3 However, for a quasi-experimental design in which the comparison group can be picked from any villages that were not treated, we do not necessarily have to conduct the endline survey one year before the pilot ends. Therefore, the question arises of whether to conduct the survey in Spring 2017 at the end of the third year of the pilot, or in Spring 2018 at the end of the fourth and last year of the pilot, in Spring 2018. Recognizing as well that the pilot could be extended to five years, the question also arises whether to conduct the endline in Spring 2019.

When considering the pros and cons of these options, we assume that we will not protect the comparison areas so that implementer can procced in coming years to engage villages and farmers without any constraints on the areas in which they operate.

Based on a range of considerations, we recommend conducting an endline survey in Spring 2017. The first and most important consideration is to maximize the internal validity of the quasi-experimental design. As implementers bring more villages into the pilot, the remaining villages *not* selected to participate become a more skewed subset of all villages and hence less suitable to serve as a counterfactual comparison group. This will make it particularly difficult to identify—following another year or two of implementation—good *replacement* comparison villages (villages not already sampled) in the event that we have to expand data collection outside of the comparison villages for which we have baseline data. The comparison villages currently available to us (as of Spring 2017) are especially valuable because implementers identified these villages as ones they expected to treat (this is true in all cases except the Katsina sample where we identified the villages and households based on Babban Gona's selection criteria). If we have to expand data collection outside of these villages, we will not be able to perfectly mimic the ex-ante selection of villages by the implementers themselves.

The additional advantage of conducting the endline in Spring 2017 is that we will get evaluation results earlier. Early results will be especially valuable given the delays in the implementation of other pilots. They will also provide useful learning to inform the extension of Nigeria pilot.

Still, we acknowledge the advantages of waiting to field the endline survey. Those advantages are:

a) Ability to provide a summative picture on the outcomes after the pilot ends. This gain from postponing the endline survey would be diminished by the fact that we are conducting qualitative evaluation at the end of the pilot to understand the pilot impact on

the market for Aflasafe-treated maize. As part of this research we will conduct in-depth interviews with value chain actors, including smallholders at the end of the pilot.

b) Ability to have more households in the treatment group with baseline data, if implementing in Years 4 and/or 5 engages more of the existing baseline respondents in AgResults. This advantage is diminished by the fact that the comparison group will then contain fewer cases with baseline data and be less like the treatment group due to more extensive selection.
c) The potential to add two more years of follow-up, if the intervention is extended to Year 5. We are concerned, however, that attrition may be much greater if we conduct the endline survey in 2019. Further, such a design would result in evaluating the impact of the pilot after additional changes occur in the design (should such design changes be proposed), and leave us without the ability to tease out the impact of the design that was in place for the majority of the pilot. Most importantly, it is not clear if the extension will occur, further diminishing the importance we should give to conducting the endline in 2019.

Overall, we feel that the advantages of conducting the endline survey in Spring 2017 outweigh the advantages of waiting until the pilot ends. We therefore recommend proceeding with the endline in Spring 2017, finishing before the 2017 planting season begins. If our recommendation is adopted, the survey would begin in early March and finish by early April 2017. We have sole-sourced the survey contract to MRC, the firm that completed the baseline survey satisfactorily.

Timing of the scale survey: We recommend conducting the scale survey along with the endline survey as it will be cost efficient to do so and the percentage of farmers that are suitable for AgResults will not change in later years.

APPENDIX – GIS DATA

Exhibit 5 Market access

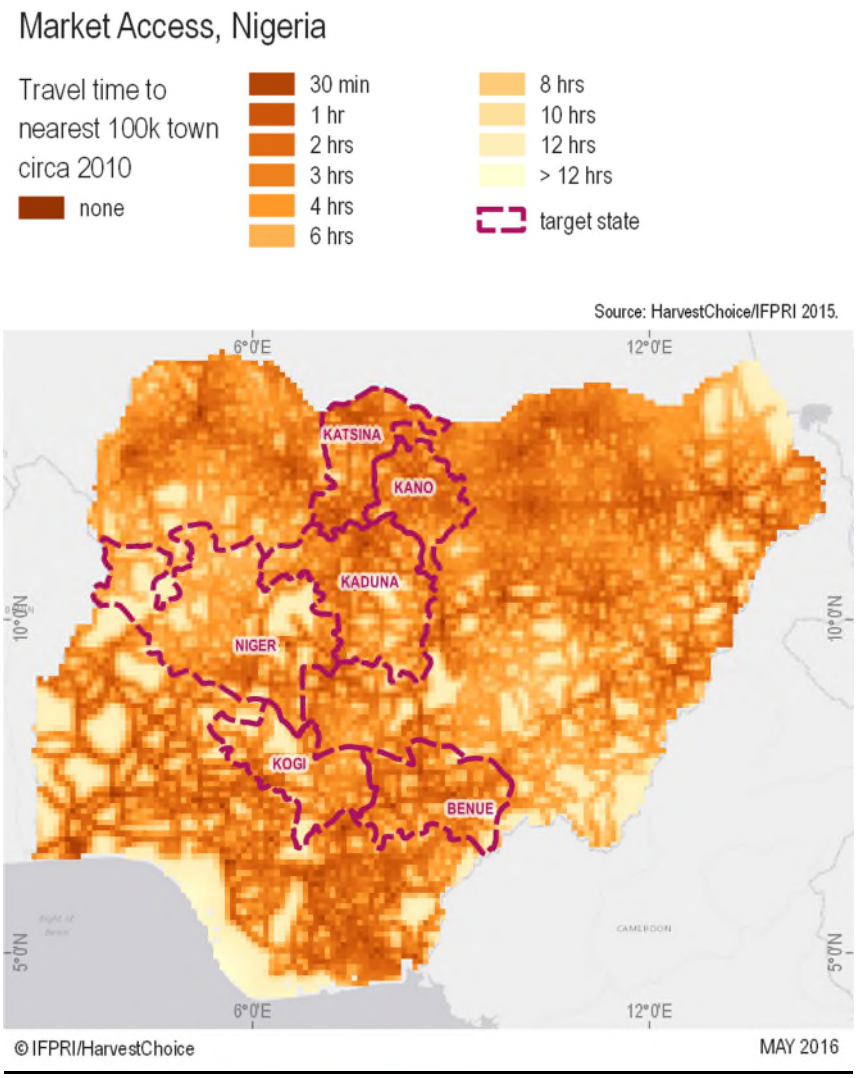

Exhibit 6 Soil Type