

# Development Outcomes and Impact of Scaling-Up Aflatoxin Biocontrol in Africa

**Ranjit Bandyopadhyay,**

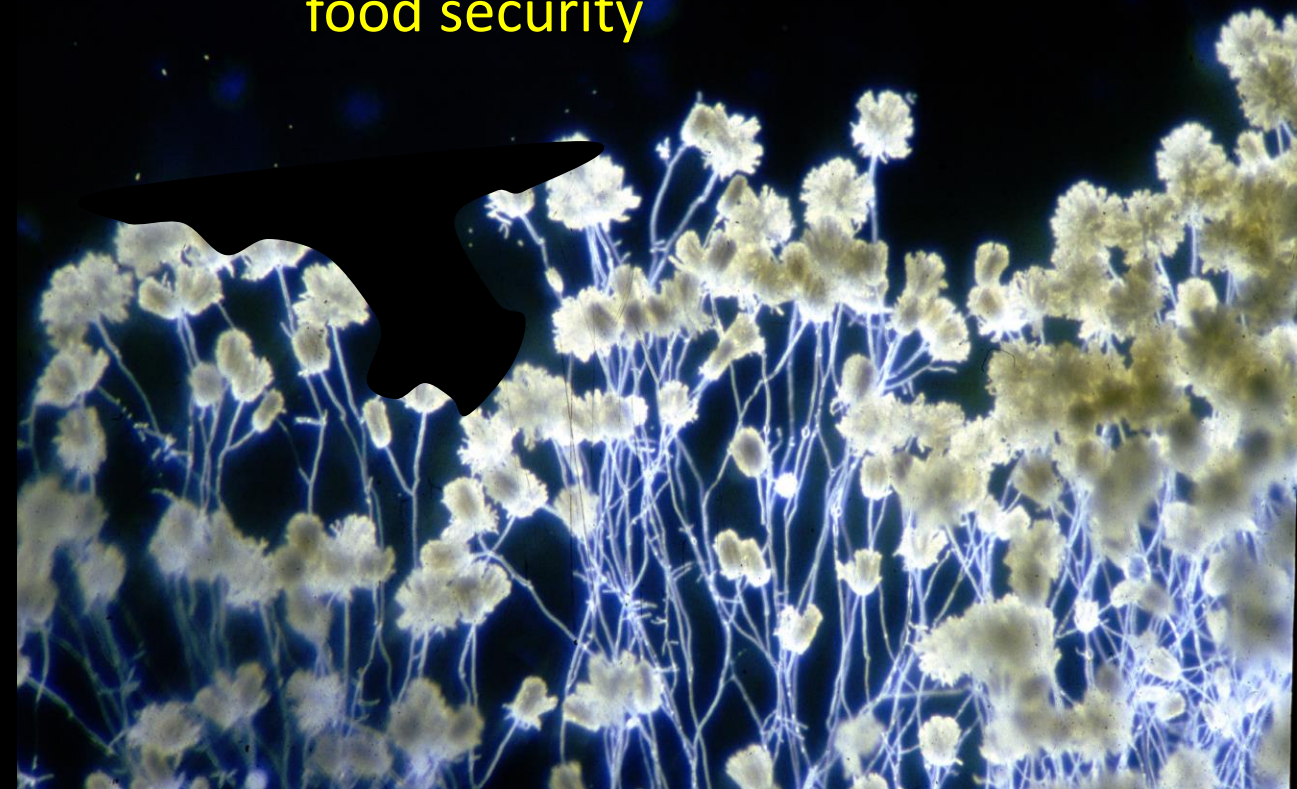
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*USDA-ARS*



# Aflatoxin Facts

- Highly toxic metabolite produced by the ubiquitous *Aspergillus flavus* fungus
- The fungus resides in soil and crop debris, infects crops and produces the toxin in the field and in stores
- Contaminates food, feed and milk
- Groundnut and maize highly vulnerable
- Potent at extremely low doses
- Death, liver cancer, immune-suppression, stunted growth
- Lowers animal productivity
- Negatively impacts trade and food security

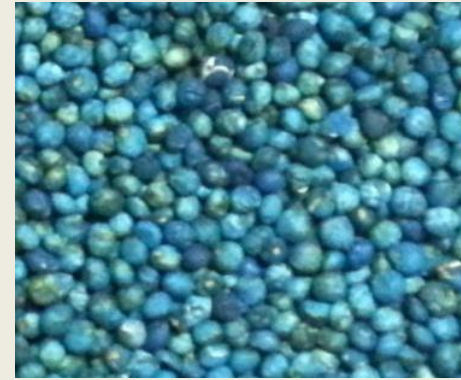


## In the laboratory (~5,000 strains):

- Does not produce aflatoxin
- VCG/SSR group with
  - Wide geographic distribution
  - No toxigenic member
- Defective in >2 aflatoxin & CPA genes
- Outcompetes toxigenic strains



**8-12 native strains  
selected for field tests**



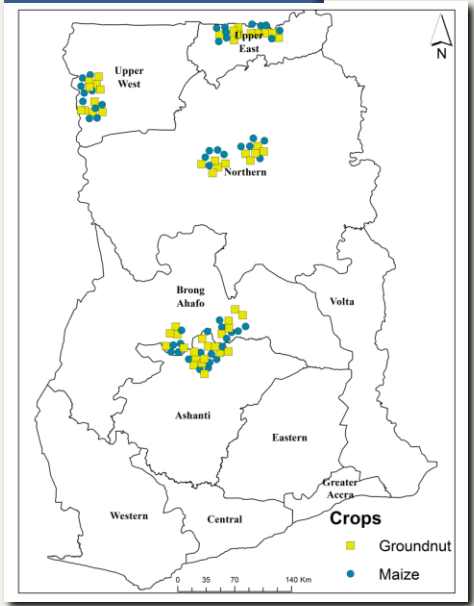
**4 native strains  
formulated into  
the final  
product**



## After field application:

- Superior capacity to colonize, multiply and survive in soil
- Superior frequency of isolation from grains
- Superior capacity to reduce aflatoxin

## Efficacy trials



**200 maize, groundnut fields**

2018
Total aflatoxin concentration (ppb)

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**Environmental Protection Agency**  
P. O. Box MB 326  
Ministries Post Office  
Accra, Ghana  
Website: <http://www.epa.gov.gh>

**Our Ref:** OP. 3577/18/02  
**Date:** 17<sup>th</sup> April, 2018

The Managing Director  
International Institute of Tropical Agriculture (IITA)  
Accra, Ghana

**PROVISIONAL CLEARANCE PERMIT**

The Environmental Protection Agency of the Republic of Ghana confirms that the pesticide product indicated below is with effect from the date of this letter, provisionally cleared with the Agency under Part II of the Environmental Protection Agency Act, 1994 (Act 490) and that accordingly, the product may be sold and marketed in Ghana as authorised by the Agency.

Provisional clearance of the product with the Agency also denotes that the permit holder (including his agents and employees) is responsible for ensuring full compliance with the laws of the Republic of Ghana regarding the importation, manufacture, storage, distribution, sale, advertisement, use and disposal of the product.

<b>Permit Number:</b>	PCL/18217/1073G
<b>Trade Name:</b>	Aflasafe GH02
<b>Type:</b>	Fungicide
<b>Active Ingredients:</b>	Four atoxigenic <i>Aspergillus flavus</i> strains (0.0005%)
<b>Formulation:</b>	Granule
<b>Manufacturer:</b>	IITA Business Incubation Platform, Ibadan, Nigeria
<b>Local Representative:</b>	International Institute of Tropical Agriculture (IITA), Accra, Ghana
<b>Pest(s):</b>	Aflatoxins
<b>Crop(s):</b>	Maize, groundnuts and sorghum
<b>Application Rate:</b>	10kg/ha

**CONDITIONS OF PROVISIONAL PERMIT**

- The provisional clearance is limited to the formulation presented and for the recommended uses only. All other formulations of the same active ingredient will have to be appraised for efficacy and risks.
- Only the approved label shall be used and the pesticide shall be packed in a package of the type approved as per the label.
- The chemical shall conform to the specifications in the label.
- The Registrar shall be notified of any change in the formulation of the product.
- The quantities of the product shall be limited to the quantities specified in the label.
- Clearance permit shall be valid for one year from the date of issue.

Summary of >4 years of research

Size	% Reduction
3	100
2	100
38	100
22	100
01	98

**SAFETY INSTRUCTIONS:**

Avoid contact with eyes, skin or clothing. Prolonged or frequently repeated skin contact may cause allergic reaction in some individuals.

Apply **aflasafe GH02** only when the possibility for drift to potential sensitive areas (e.g. residential areas, water bodies, known habitat for threatened or endangered species) is minimal. Do not apply directly to water, or to areas where surface water is present. Do not contaminate water when disposing of equipment wash water or rinsate.

**DO NOT CONTAMINATE WATER, FOOD, OR FEED BY STORAGE AND DISPOSAL**

**SEE ADDITIONAL PRECAUTIONARY STATEMENTS ON THE BACK OF THE PACKAGE**

**WARNING:** May be harmful if inhaled. Avoid breathing dust. May cause moderate eye irritation.

Wash hands thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet.

**ANTIDOTE:** If contact with eyes occurs, rinse eyes thoroughly with clean running water for 15 minutes and report to your doctor with the product package. If inhaled, report to your doctor with the product package.

aflasafe GH02

**Active ingredient:**  
Four atoxigenic *Aspergillus flavus* strains\* ... 0.0005%

**Other ingredients:**  
Sorghum grains (sterilized) ..... 99.8495%  
Food colorant ..... 0.2000%  
Polymer sticker ..... 0.1500%  
Total ..... 100.0000%

**Formulation: Granule**  
\*Contains a mixture of four *Aspergillus flavus* strains from Ghana that cannot produce aflatoxin: GH511-3, GHM109-4, GHM002-5, and GHM287-10. A minimum of 3,000 Colony Forming Units of each of the four strains are present in each gram of **aflasafe GH02**.

BIOPESTICIDE

**aflasafe GH02** is a biopesticide for application in maize, groundnut, and sorghum fields to displace aflatoxin-producing strains of *Aspergillus* fungi. **aflasafe GH02** contains living fungi coated on sterile sorghum grain, which serves as both carrier and nutrient source. A polymer binder helps the spores stick to grains, and does not rub off or stick to the hands of applicators. A blue food-grade dye is also coated on grains to distinguish it from food/feed grain. After application, and once grains are exposed to sufficient moisture, **aflasafe GH02** strains will grow out. These growing fungi will first appear as white fuzz and with green spores, and later appear as green fuzz containing spores. The green spores will eventually spread to the crop by wind and insects in the same manner that aflatoxin-producing fungi are spread.

**EPA Registration Number:** PCL/18217/1073G  
**Batch Number:** MGR/RAK/2018  
**Manufacturing Date:** 18 May 2018  
**Expiration Date:** 18 May 2020  
**Manufacturer:** International Institute of Tropical Agriculture Business Incubation Platform, PMB 5320 Oyo Road, Ibadan, Nigeria  
**Local Agent:** International Institute of Tropical Agriculture, Accra, Ghana

**DIRECTIONS FOR USE**

- Prior to **aflasafe GH02** application, the fields should be weeded, fertilizer applied, and all other cultural practices carried out in the field to avoid trampling of the **aflasafe GH02** grains after application.
- Do not carry out any operation that will bury **aflasafe GH02** under the soil after application. Ensure that **aflasafe GH02** stays on the soil surface.
- For maize, groundnut, and sorghum, broadcast **aflasafe GH02** by hand 2 to 3 weeks before flowering at the rate of 10 kg/ha.
- As far as possible, apply **aflasafe GH02** after rains, when rains are forecasted, or when the soil is wet. When there is adequate moisture in the soil, the atoxigenic strains grow rapidly on the sorghum grain carrier which serves as their food.
- Five to seven days after **aflasafe GH02** application, visit the field and observe the colour of the carrier grains. A greenish growth should be visible on some or all sorghum carrier grains if soil moisture is adequate. If the greenish growth is not evident, return to the field after 3 to 5 days to repeat the observation.
- Follow good harvest and post-harvest practices. Do not mix with fertilisers, or pesticides before application.

**CULTURAL PRACTICES:**  
Follow standard agronomic practices in your area to grow the crop.

WHO Class U. Non-hazardous, green colour band.

# Status of the Aflasafe Initiative



Completed | Being Implemented

**National Food Security Investment Plans of the Governments of Tanzania, Nigeria, Malawi, Senegal, The Gambia, and Uganda recommend the use of Aflasafe products**

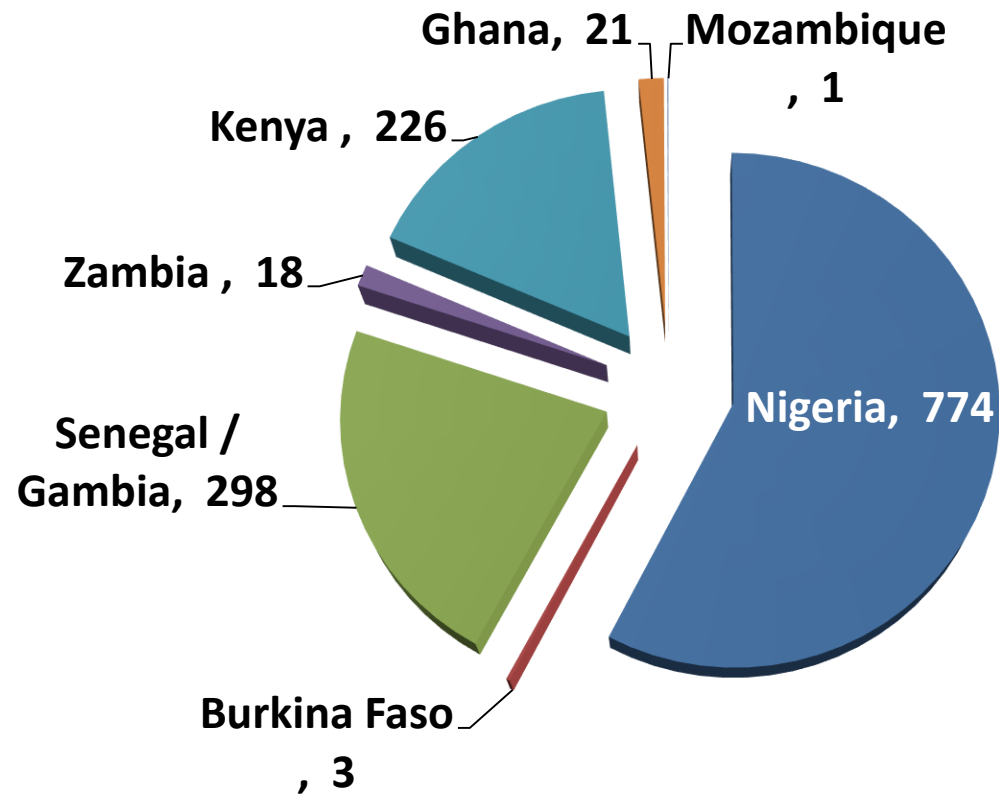


**This Manufacturing Facility in IITA-Ibadan can supply aflasafe to treat 2 million ha annually**

**Large-scale: capacity 5 tons/hour**  
**Product cost: \$12 to \$18.75/ha**

# Aflasafe production in Ibadan

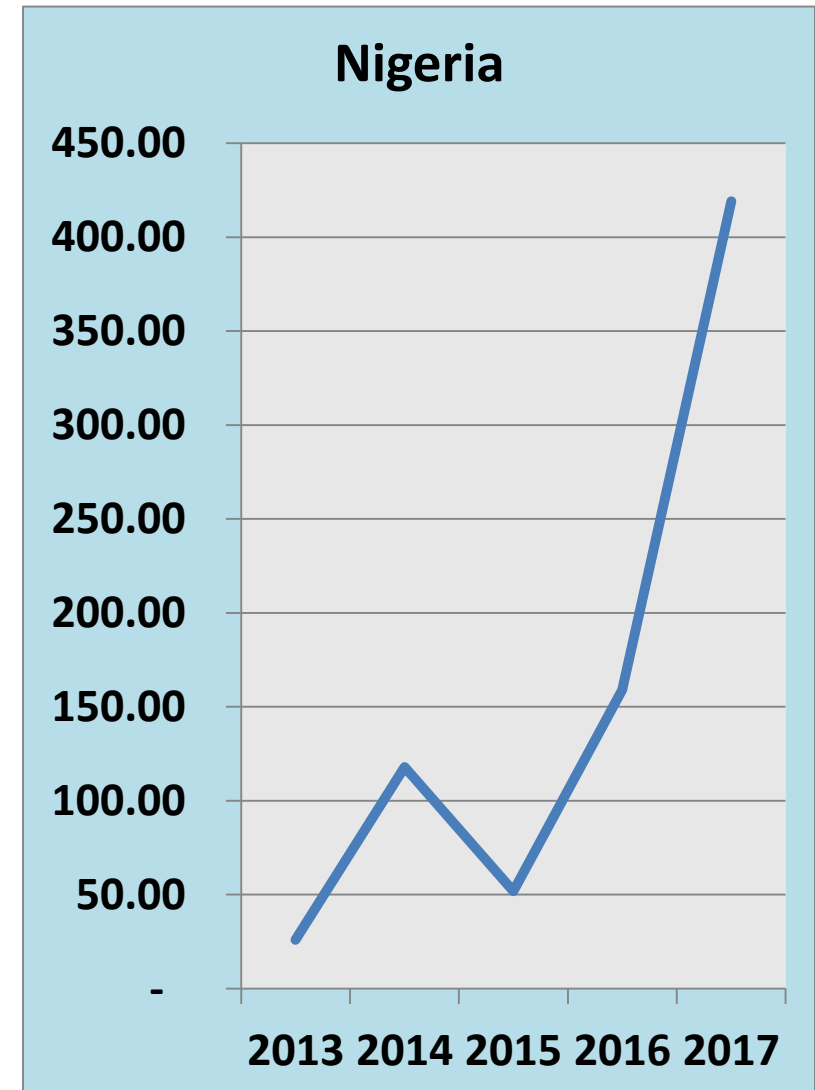
## Total production (tons): Countries



**Total production: 1,342 tons**

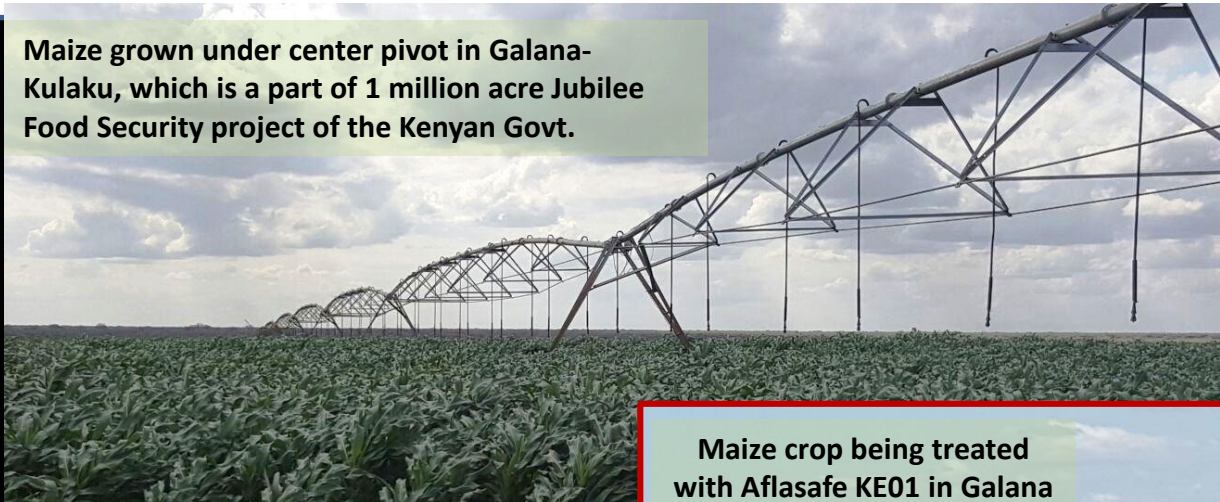
**Treatable area: 340,000 acres**

## Growth in production (tons)



# Kenya food security project

Maize grown under center pivot in Galana-Kulaku, which is a part of 1 million acre Jubilee Food Security project of the Kenyan Govt.



Maize crop being treated with Aflasafe KE01 in Galana



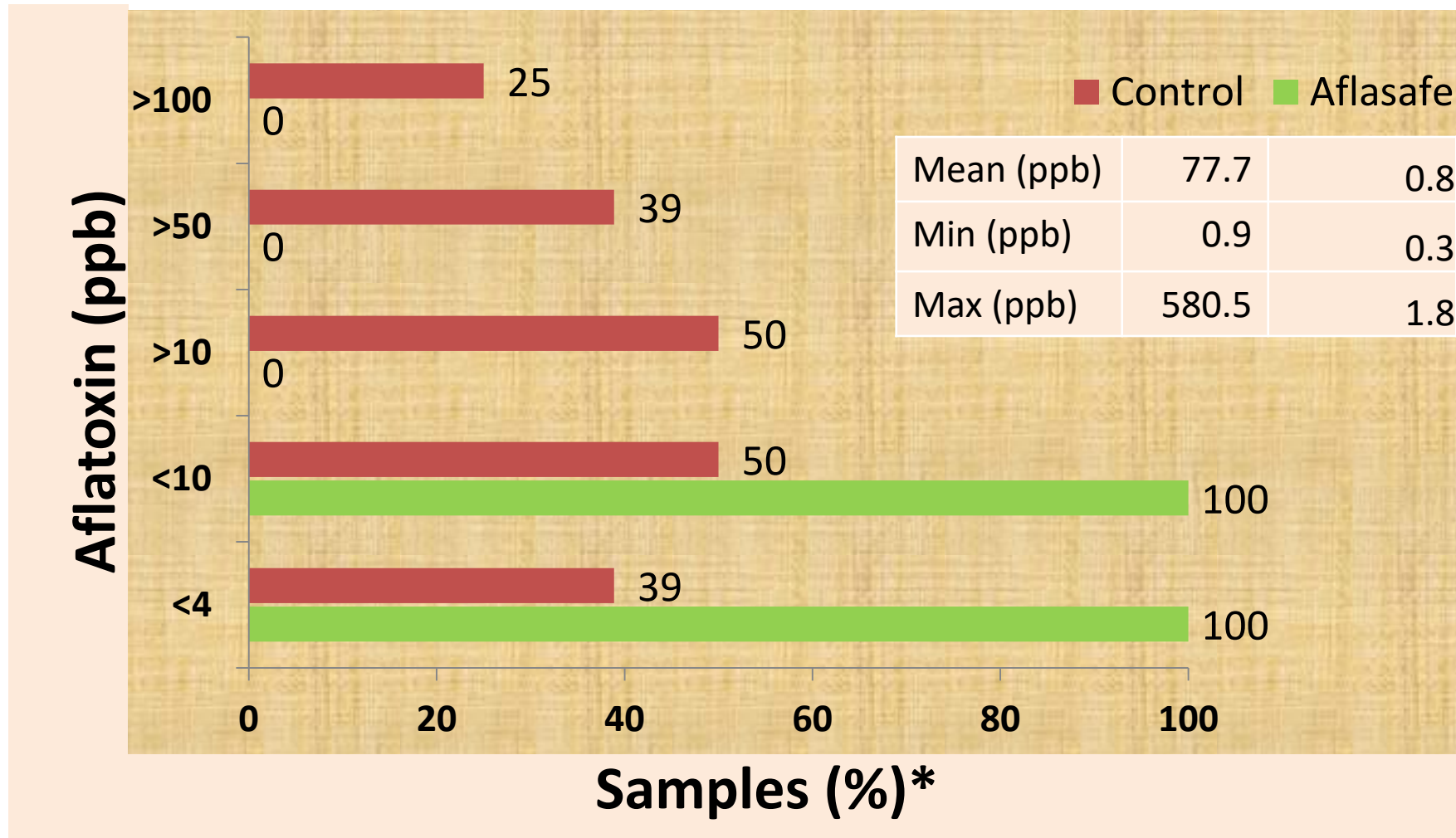
- The entire crop of 3,500 acres treated with aflasafe
- 99% grain lots had <4 ppb aflatoxins
- **Sufficient maize harvested to feed 492,000 people for 1 month in drought-stricken counties**

- Managed by the National Irrigation Board (NIB)
- Highly productive area but aflatoxin-prone
- Maize frequently rejected as >50% strains in soil are highly toxic



Aflasafe KE01 in the Aflasafe factory in IITA-Nigeria ready for shipment to Kenya





\*Number of samples: 36 for control and 18 for aflasafe treated

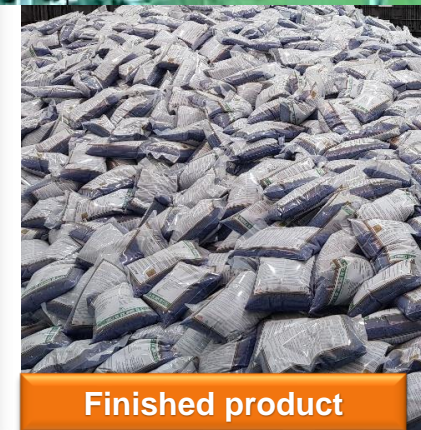
# Aflasafe Modular Manufacturing Plant at KALRO-Katumani, Kenya



Quality Control Lab



Production April 2018



Finished product

**National News**  
**Daily Nation**  
**5 June 2018**

## Researchers bet on plant in aflatoxins war

**BY STEPHEN MUTHINI**

A plant that manufactures Aflasafe, which reduces aflatoxin levels in maize, is now operational.

The Aflasafe plant at the Kenya Agricultural and Livestock Research Organisation (Kalro) in Katumani, Machakos County, will help combat food insecurity in the country.

Speaking when he toured the plant yesterday, Agriculture Cabinet Secretary Mwangi Kiunjuri said it could to produce 10 tonnes of Aflasafe a day, which could be increased to 40 tonnes daily.

Mr Kiunjuri said his ministry will come up with a policy to ensure that all farmers, especially in regions prone to aflatoxin infection, use Aflasafe.

"We are coming up with a policy, which I will push through the Cabinet to ensure that every farmer uses Aflasafe," Mr Kiunjuri said, adding that this will cushion farmers against crop losses and ensure food security, one of the pillars of the government's "Big Four" agenda.

Other measures the government is taking to ensure food sufficiency include introducing farmers to irrigation so that they don't depend solely on rain, developing new maize seed varieties which mature in 120 days, and greater use of technology in fighting crop diseases.



"We are coming up with a policy, which I will push through the Cabinet to ensure that every farmer uses Aflasafe," Mr Kiunjuri said, adding that this will cushion farmers against crop losses and ensure food security, one of the pillars of the government's "Big Four" agenda.

Visit of Agriculture Cabinet Secretary and Permanent Secretary on 4 June 2018

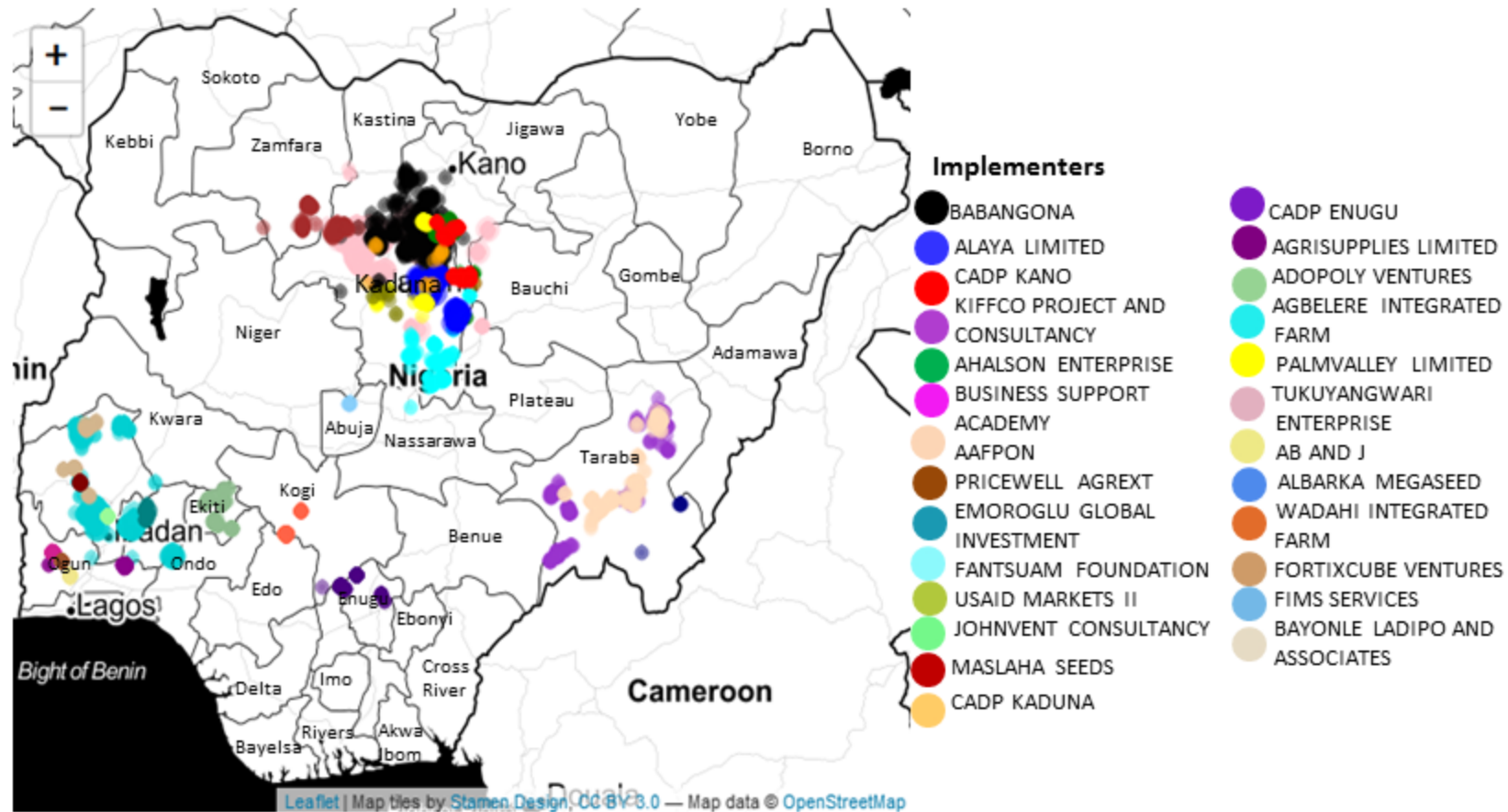


AgResults is a USD \$118 million multilateral initiative using *pull mechanisms* to incentivize and reward high-impact agricultural innovations that promote global food security, health, and nutrition and benefit smallholder farmers.

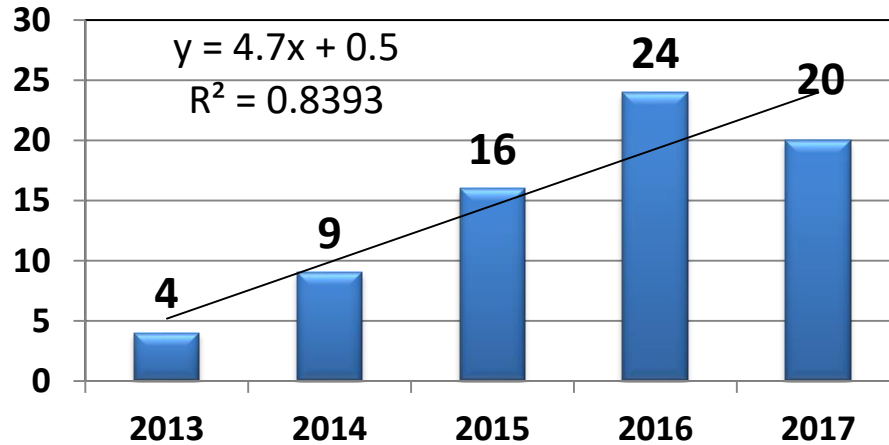


The Nigeria Aflasafe™ Pilot focuses on incentivizing the adoption of Aflasafe™, by smallholder maize farmers.

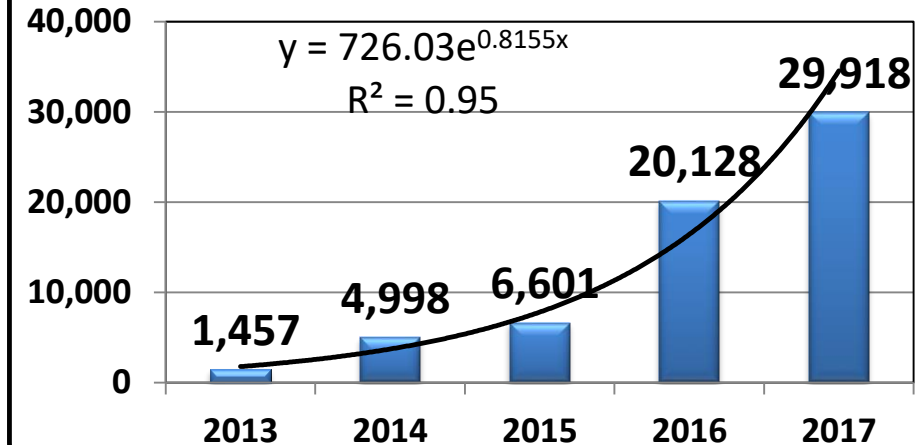
# Map Showing all Yr.1 –Yr.3 AgResults Implementers Location in Nigeria



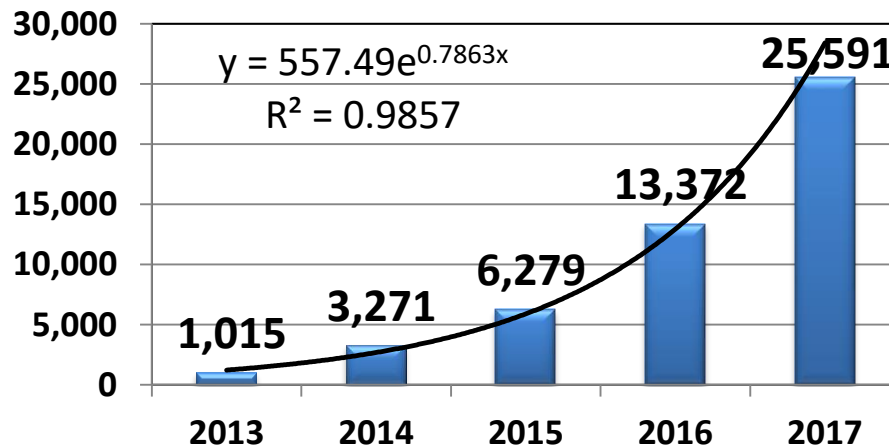
### Number of implementers



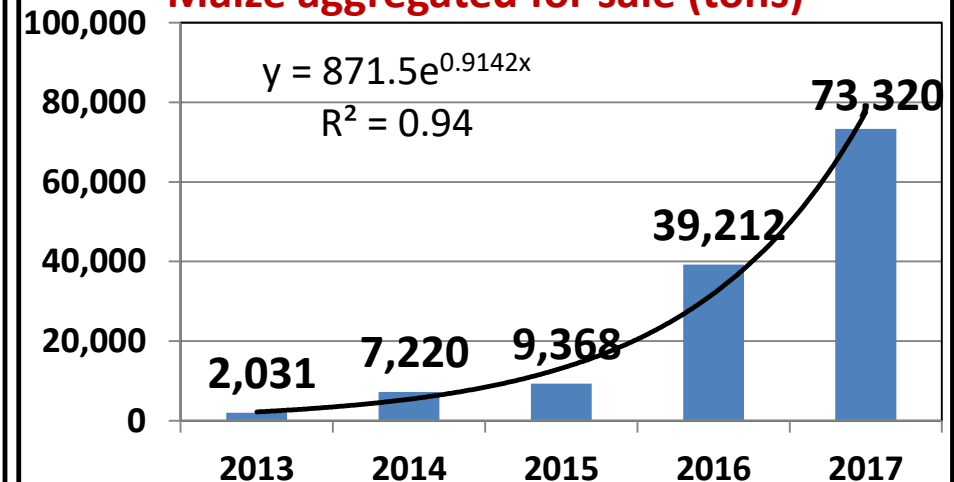
### Treated area (ha)



### Number of farmers

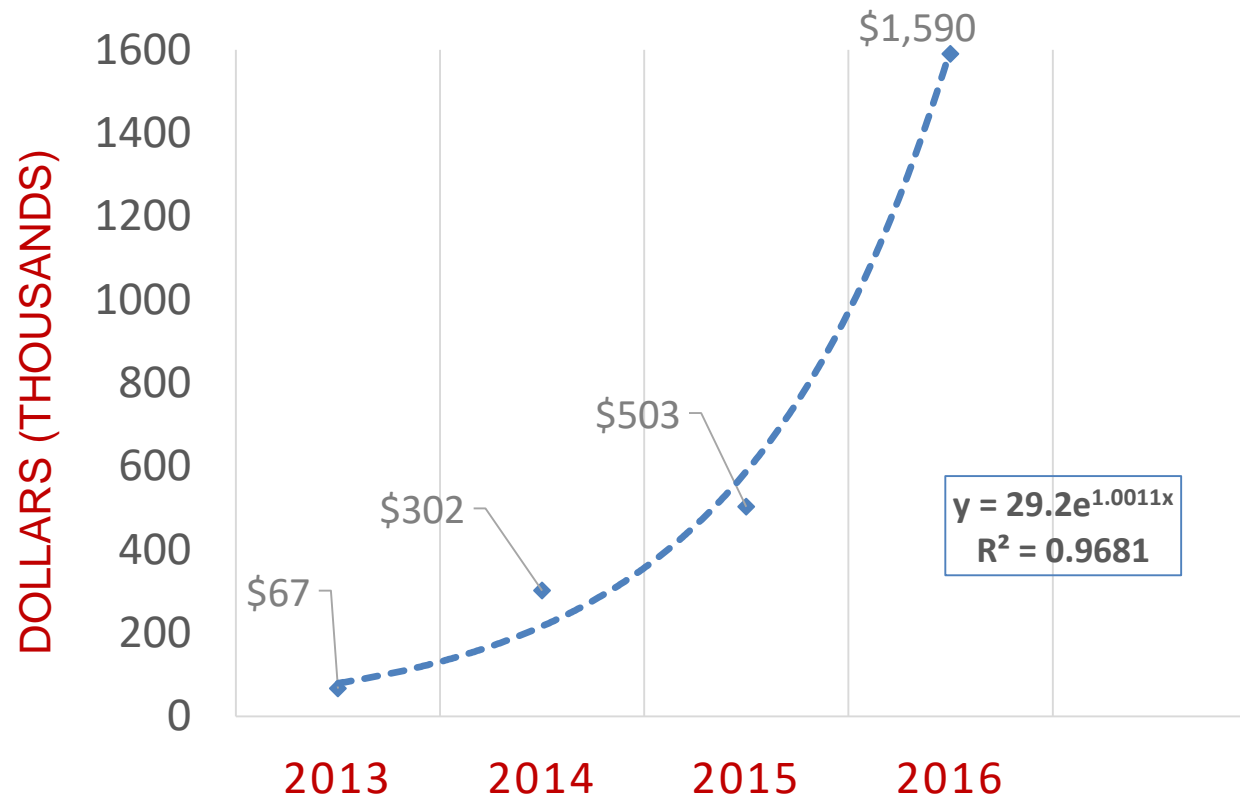


### Maize aggregated for sale (tons)



The economic impact is dramatic for implementers. The market has responded to high quality maize and implementers are paid a premium for their maize

## TOTAL EXTRA EARNINGS



Parameters	2013/14	2014/15	2015/16
<p><b>Grain lots meet international standards</b></p> <p>Samples with &lt;4 ppb AF (%)</p> <p>Samples with &lt;10 ppb AF (%)</p> <p>samples with &lt; 20 ppb AF (%)</p>	<p><b>Farmers earn higher income</b></p> <p>99%</p> <p>99%</p> <p>99%</p>	<p><b>Better health</b></p> <p>93%</p> <p>96%</p> <p>98%</p>	<p>95%</p> <p>98%</p> <p>99%</p>

**Smallholder farmers have safer crops, improved income and better health**





With support from



## New Aflasafe products

- Registration of Aflasafe products for use in additional countries

## Availability and accessibility of Aflasafe

- Develop, validate country-specific commercialization strategies
- Develop partnerships with specific government and private entities interested in manufacturing and distributing Aflasafe
- Develop and execute technology transfer agreements
- Provide technical support, monitor product quality control and usage by farmers

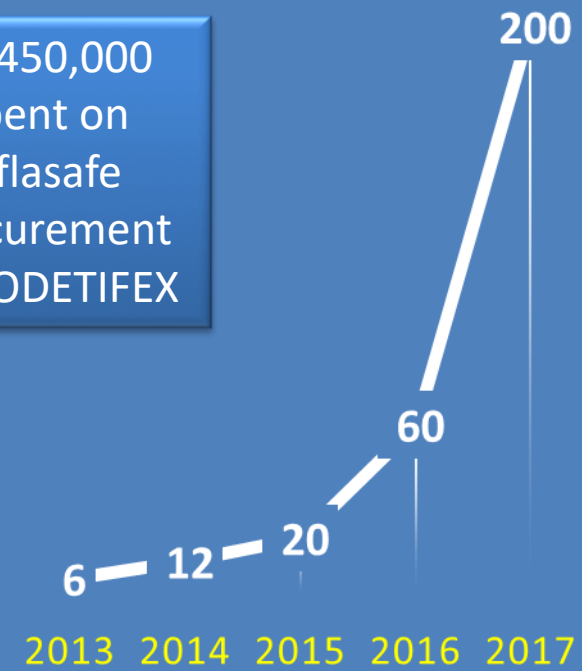
## Markets for aflatoxin-safe products

- Develop demand for aflatoxin-safe products at the end market to stimulate uptake of the Aflasafe technology by farmers



## SENEGAL/GAMBIA (TONS PURCHASED)

> \$450,000  
spent on  
Aflasafe  
procurement  
by SODETIFEX



## Signing of TTLA



- About \$800,000 investment
- Machinery ordered
- Production will start in 2018
- Projected use:
  - 2018 - 20K ha
  - 2022 - >160K ha



## Assigned manufacturing site



## Targets to meet as per Tech Transfer and Licensing Agreement (TTLA)

Years	Sale target (tons)	Crop area (ha)
2018	1,350	135,000
2019	3,660	366,000
2020	5,225	522,500
2021	5,750	575,000
2022	7,185	718,500

- Biological control with other practices can dramatically reduce aflatoxin contamination and improve food safety and security
- **Farmer income and health can improve with adoption of biocontrol-centric aflatoxin management**
- Efforts are underway to scale up sustainable models to transfer and commercialize aflatoxin biocontrol in Africa
- **Biocontrol included in the national investment plans of six countries to promote adoption**



Overall Leadership

DNA Technologies

Product Development and Field Testing

Advocacy

Commercialization

Breeding for Resistance

Manufacturing

Socio-Economics

Policies

Project Management

Graduate Students

And many Key partners...

**USDA** 

**THE UNIVERSITY OF ARIZONA** 

**BMZ**  Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

**USAID**  FROM THE AMERICAN PEOPLE

**BILL & MELINDA GATES foundation** 

**Austrian Development Agency** 

**universität bonn** 

**ZARI**  Zambia Agriculture Research Institute

**DFID**  Department for International Development

**UKaid**  from the Department for International Development

**EUROPEAN UNION** 

**NISIR**  NATIONAL INSTITUTE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH ZAMBIA

**NAERLS** 

**AA-TF** 

**MycoRED** 

**giz**  Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

**ZARI**  Zambia Agriculture Research Institute

**Researching Soils, Crops and Water in Zambia** 

**NAFDAC**  NATIONAL AGENCIES FOR FOOD AND DRUG ADMINISTRATION AND CONTROL

**PACA**  Partnership for Aflatoxin Control in Africa

**Meridian Institute**  Connecting People to Solve Problems

**MycoKey**  Integrated and innovative key actions for mycotoxin management in the food and feed chains

**INERA**  INSTITUTE OF NATURAL RESOURCES RESEARCH AND DEVELOPMENT

**Dalberg** 

**DOREO PARTNERS** 

**Nestlé** 

**KARI** 

**FOREIGN AGRICULTURAL SERVICE** 

**USDA** 

**NB NATIONAL IRRIGATION BOARD** 

**AgResults**  INCENTIVIZING INNOVATION FOR GLOBAL FOOD SECURITY

**CGIAR**  RESEARCH PROGRAM ON Agriculture for Nutrition and Health

**Africa RISING** 

Led by IFPRI