Beneficial Fungi for Aflatoxin Control

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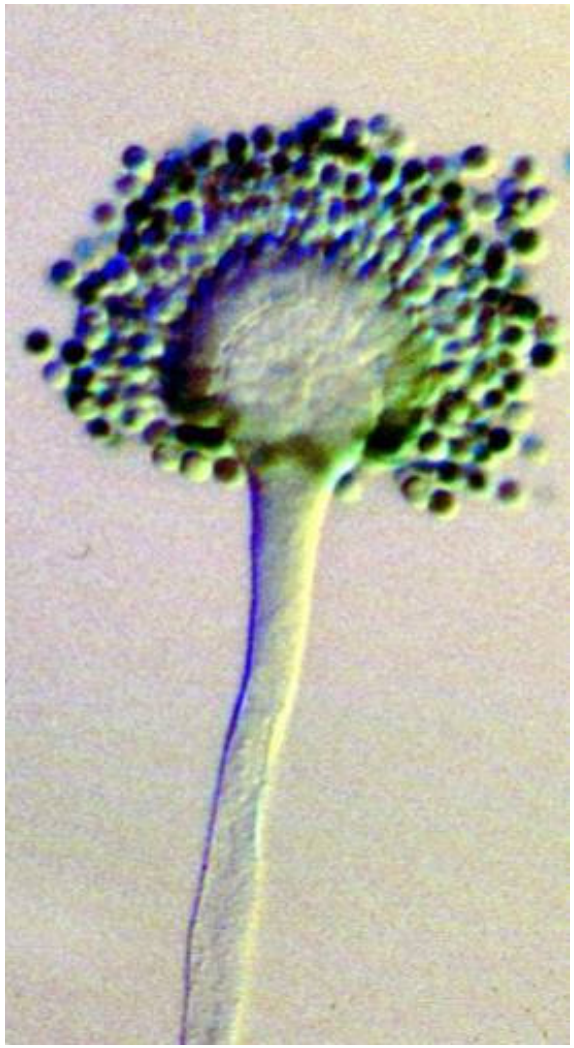
Aflatoxin: What is it?

- Highly toxic metabolite produced by the ubiquitous *Aspergillus flavus* fungus
- The fungus infects crops and produces the toxin in the field and in stores
- Fungus carried from field to store
- Contamination possible without visible signs of the fungus
- Some predisposing factors:
  - pre-harvest high temperature & drought stress
  - wet conditions at harvest and post-harvest periods
  - insect damage



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Farm Press

Drought can deliver a double whammy to dryland corn farmers in parts of Texas.

Aflasafe

BIOCONTROL WORKS
IT WORKS
IN AFRICA
TOO!
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Field trials offer hope of conquering food toxin

Semiu Babalola
26 June 2009 | EN

[LAGOS] The elimination of deadly aflatoxin, which contaminates food crops in Sub-Saharan Africa, is a step closer now scientists have shown that a control method works well in large-scale field trials.


Maize growing in Nigeria
Flickr/MikeBlyth

Aflatoxin is a poison produced by the fungus *Aspergillus flavus*. It contaminates crops such as maize, ground nuts, cassava and yam, either in the field during times of stress — such as drought or insect infestation — or as a result of poor storage conditions.

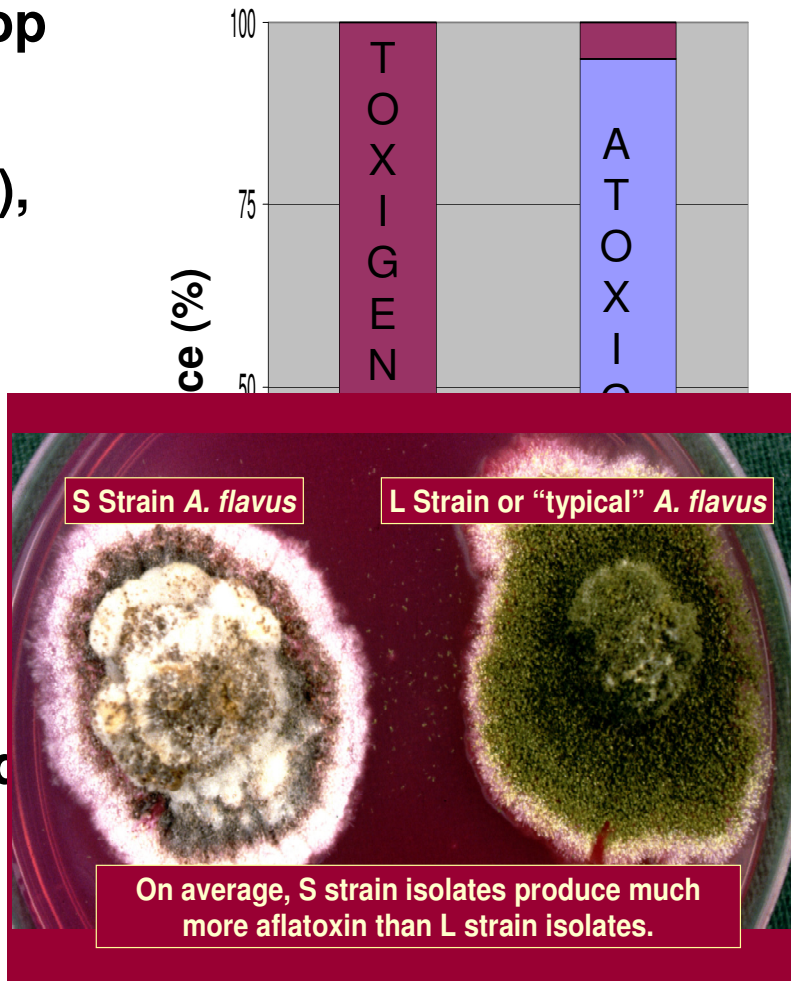
More than 4.5 billion people in developing countries may be chronically exposed to aflatoxin in their food, putting them at risk of diseases such as cancer. Africa also loses about US$450 million in lost revenue from contaminated export grain.

Scientists from the Nigeria-based International Institute of Tropical Agriculture (IITA), the United States Department of Agriculture and the African Agricultural Technology Foundation in Kenya have been working together to develop a biological control method to reduce the amount of aflatoxin contamination in

www.iita.org

Principles of Aflatoxin Biological Control

- Fungal communities differ in aflatoxin-producing ability & this influences crop vulnerability to contamination.
- Some strains produce a lot (toxigenic), and others no aflatoxin (atoxigenic)
- Competitive exclusion (one strain competing to exclude another) is the biocontrol principle practiced
- Shift strain profile from toxigenic to atoxigenic
- Thus, aflatoxin contamination reduced
- We identify and promote only native beneficial strains



Aflatoxin Biocontrol Facts

Crops are infected by complex communities of diverse fungi

Fungal communities differ in aflatoxin-producing ability & this influences crop vulnerability to contamination. Atoxigenic strains can be used to reduce aflatoxin-producing ability.

There are many atoxigenics

Select safe strains best adapted to cropping systems, ecosystems, & climates

Atoxigenics are Already Present on the Crop

Just increase the frequency of endemic strains & natural interference with contamination

Treatments May have Long-Term Influence & Cumulative Benefits

More than One Crop May Benefit From the Applied Strain

Atoxigenic Strains can be Applied Without Increasing Infection

and without increasing the overall quantity of *A. flavus* on the crop & throughout the environment

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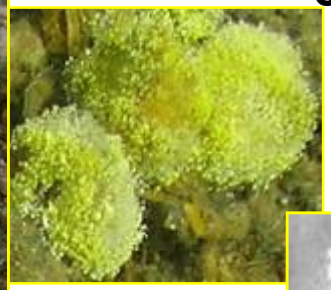
How does Biocontrol Work?

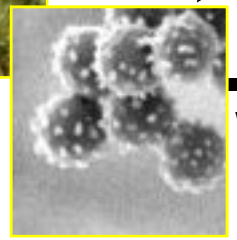
Sporulation on moist soil



Soil colonization

Insects

3-20 days



Spores

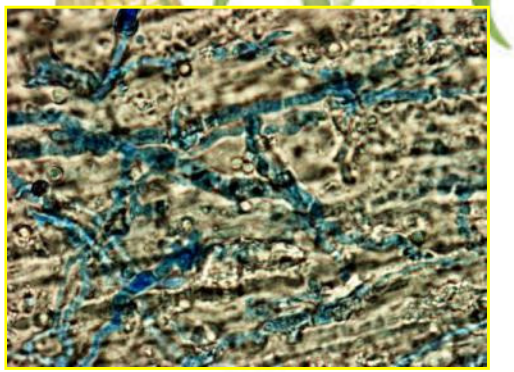
Wind

30-33 grains m^{-2}

Broadcast @ 10 kg/ha 2-3 weeks before flowering

Inoculum on sorghum grain carrier

Hyphal network in seed pericarp



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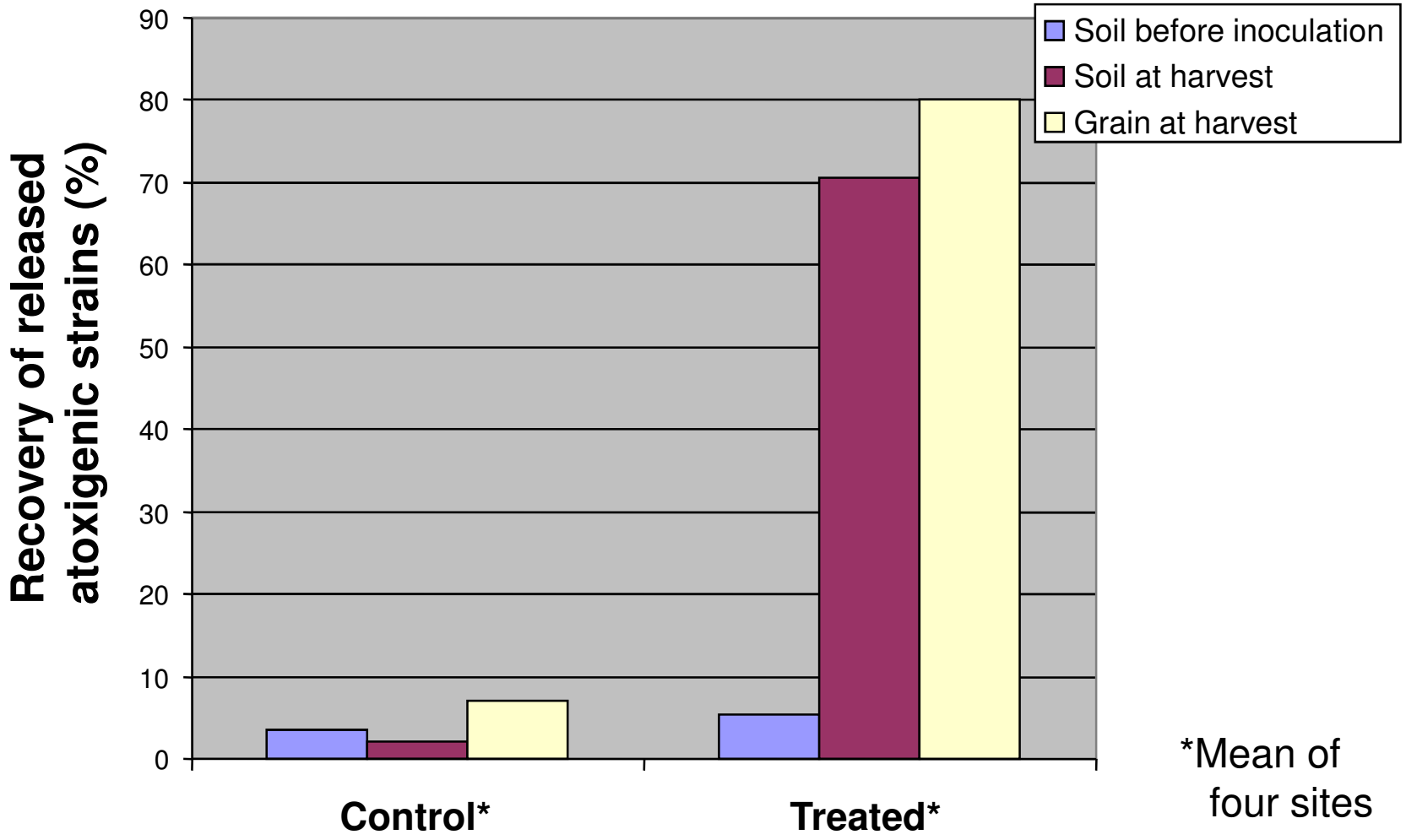
B-aflatoxin in stored maize grains from untreated and atoxigenic treated plots

Location	Treatment	Stored		Poorly stored	
		Aflatoxin (ppb)	Reduction (%)	Aflatoxin (ppb)	Reduction (%)
Ibadan	Control	42	73	2408	96
	Treated	11*		105**	
Ikene	Control	54	91	956	93
	Treated	5*		62**	
Zaria	Control	73	85	7561	95
	Treated	11*		343**	
Mokwa	Control	50	86	2481	94
	Treated	7*		149**	

* $P < 0.05$, ** $P < 0.01$

Recovery of released strains from soil and grain of control and treated plots



*Mean of four sites

Ex-Ante Impact Assessment of Aflatoxin Biocontrol in Nigeria

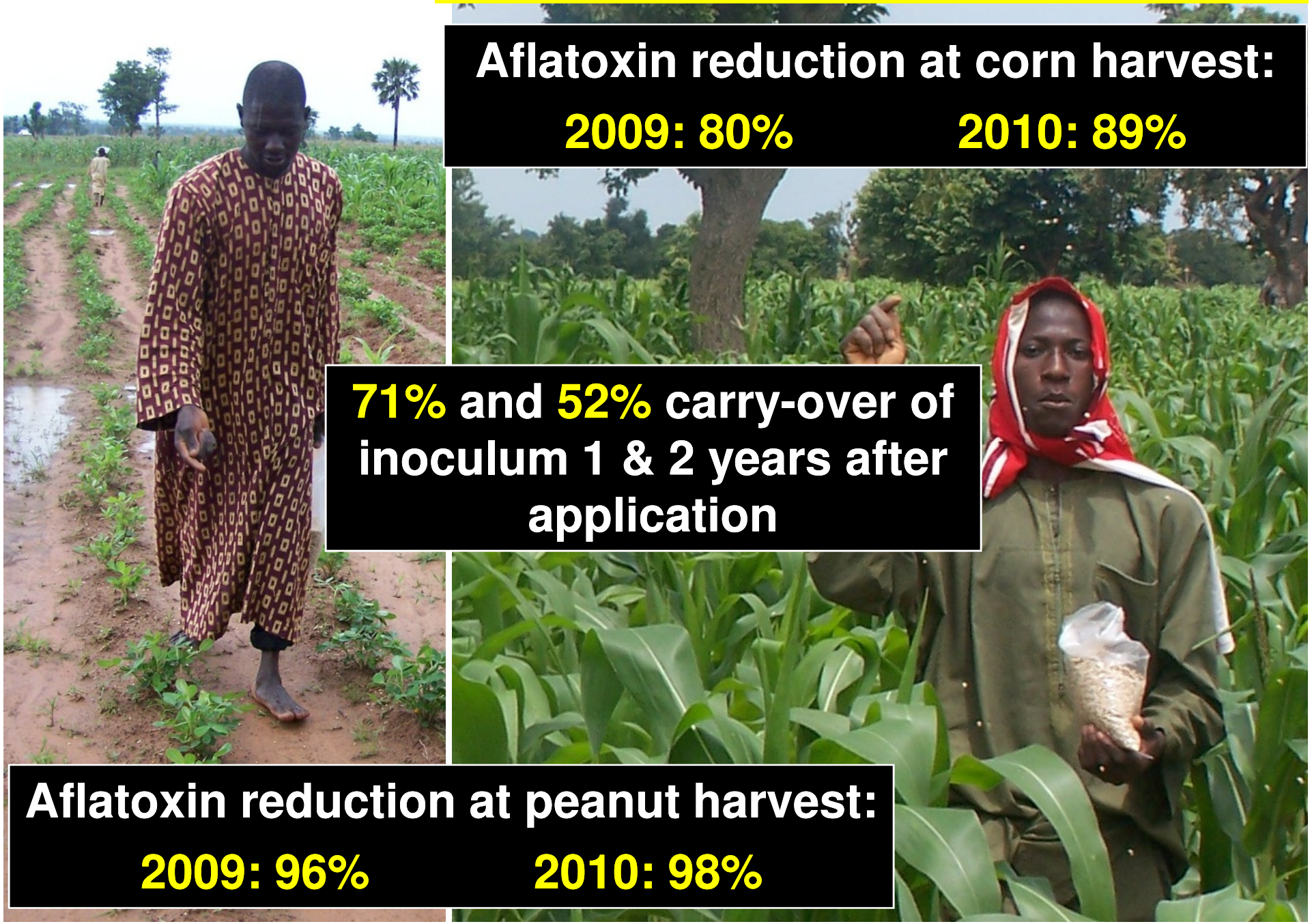
- DALYs saved: 103,000 to 184,000
- Cost-effectiveness ratio: 5.1 – 24.8
- Benefits are likely to be higher if all health impacts from aflatoxin exposure are considered.

Wu & Khlangwiset (2010) Food Additives & Contaminants


10-kg boxes of AflaSafe
ready for deployment

Explaining aflatoxin and biological control to farmers in their fields

Farmers treating maize and groundnut fields with AflaSafe



Aflatoxin reduction at corn harvest:

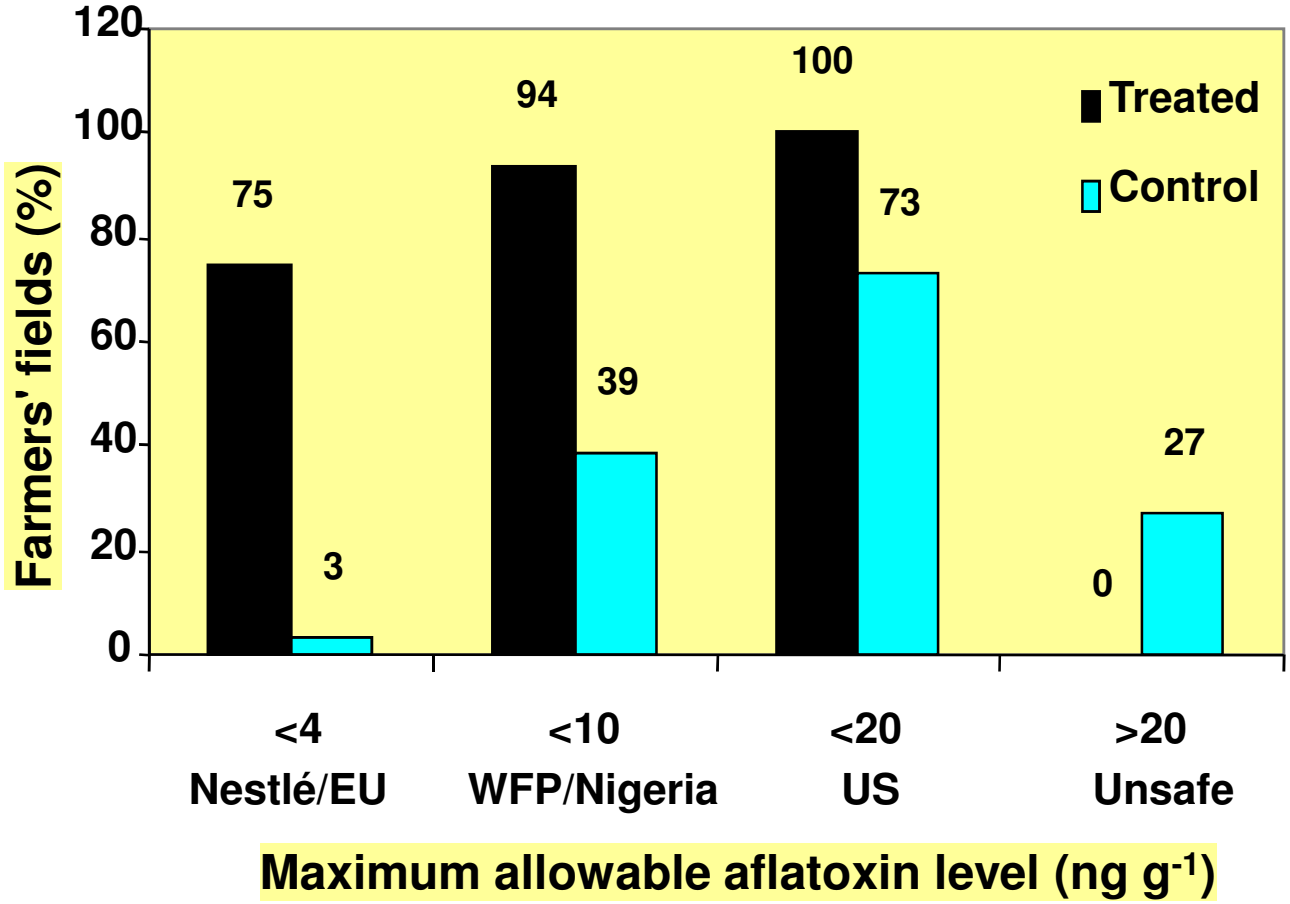
2009: 80% **2010: 89%**

71% and 52% carry-over of inoculum 1 & 2 years after application

Aflatoxin reduction at peanut harvest:

2009: 96% **2010: 98%**

Different Levels of aflatoxin in AflaSafe™ treated and untreated fields at harvest



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Senegal

Aflatoxin Reduction: 87% at harvest

Farmers harvesting and threshing groundnut

Farmers treating groundnut fields with AflaSafe

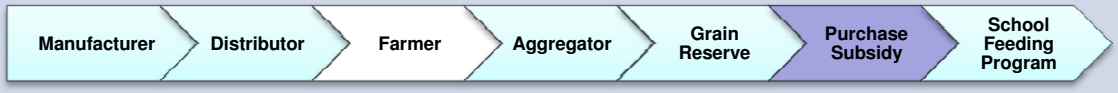
Focus Countries and Stages of Development

Country	Strain identification	Partnerships	Commercialization	Capacity development
Nigeria				
Senegal				
Burkina Faso				
Ghana				
Cote d'Ivoire				
Kenya				
Malawi				
Mozambique				
Tanzania				
Zambia				
Mali				

Completed Partially started Yet to start

How do we Generate Demand in the Medium-Term

- Enable development of native beneficials in key countries
- **Develop manufacturing capacity**
- Create awareness about aflatoxin
- Demonstrate efficacy of Aflasafe
- Incentivize use of Aflasafe by the poor
- Train farmers in aflatoxin management
- Enable aflatoxin testing of products
- Link Aflasafe users to food and feed market

Structure of Pull Mechanism	Pros	Cons
1. Buy Aflasafe directly, give to smallholder farmers for free OR highly subsidize and bundle with other inputs such as fertilizer 	• Easiest way to clearly incentivize manufacturing	• Distribution difficult to do and verify • No monetary incentive for farmer (fully reliant on health education effort) • Creates precedent of giving Aflasafe away for free, distorting market
2. Pay for performance: survey maize fields and reward contractor (& farmer?) for prevalence of Aflasafe strains OR reduction in overall aflatoxin contamination in an area 	• Ensures money is provided for successful adoption by farmers, aligning subsidy with ultimate objective.	• Need for costly surveys, both baseline and results, with results potentially questioned • As above precedent of Aflasafe given free/below cost is established • No clear partner to take on contracting role
3. Buy Aflatoxin-free ag products (like maize), creating a 'premium' value-chain 	• Establishes precedent for farmers buying Aflasafe • Creates new commodity category of aflatoxin free maize with price premium • Introduces aflatoxin testing at many points of the value chain	• Requires careful coordination among a number of additional players • More difficult to explain to manufacturer when trying to incentivize investment • Involves all the tricky aspects of a maize purchasing subsidy

Summary

- Aflatoxins in food and feed pervasive in Africa
- Biological control in conjunction with other management practices can dramatically reduce aflatoxin contamination
- Large scale manufacturing and commercialization of biocontrol agents a prerequisite for adoption.
- Aflatoxin mitigation plan developed
- Linkage being developed with other organizations for downstream dissemination activities for biocontrol
- Support and partnership needed from national governments, donors/investors, private food sector, farmer groups, and regulators

Africa-wide Initiative
on Aflatoxin biocontrol can improve health and income of African people

Pre-Harvest Aflatoxin Management

Factors influencing fungal growth and toxin development

Pre Harvest

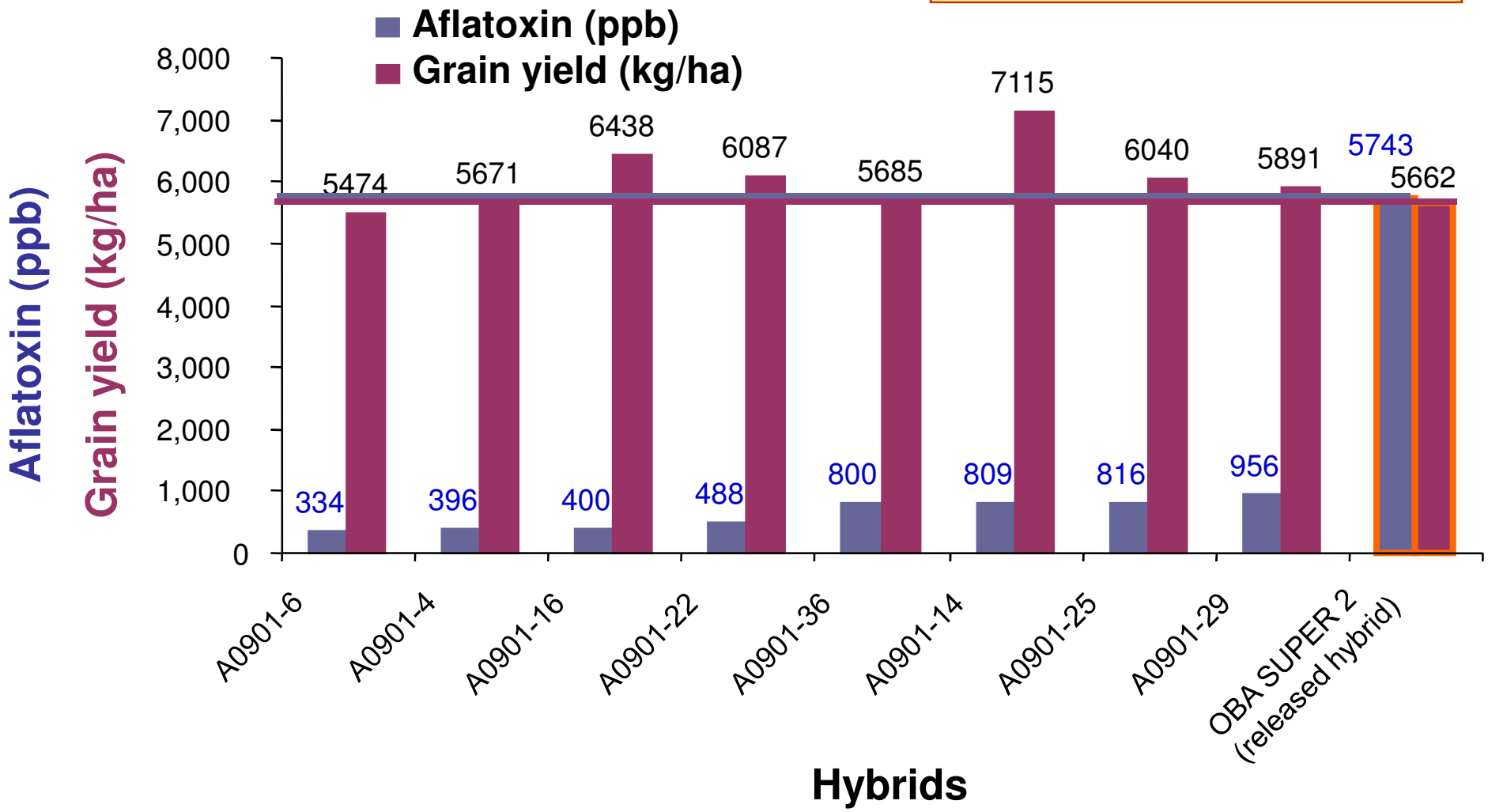
- Growth cracks, mechanical injury and damage by pests to grains leads to infestation by fungi.
- Toxins are produced under high temperatures, drought, high insect activity prior to harvest.
- Wet conditions at harvest leading longer duration for drying in the field after grain maturity

Pre-Harvest Management

- Plant less susceptible varieties, if available
- Biological control
- Adjustments in planting dates
- Reduce plant stress
  - Water management (irrigation, mulching)
  - Lower plant population
  - Use of FYM and gypsum (primarily for groundnut)
  - Foliar disease control (primarily for groundnut)
- Harvesting at 13 to 15% grain moisture
- Insect control and removal of insect damaged cobs and lodged plants at harvest
- No effective fungicides for aflatoxin control

Less Aflatoxin Susceptible, High-Yielding Yellow Maize Hybrids

Less toxin – high yield



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