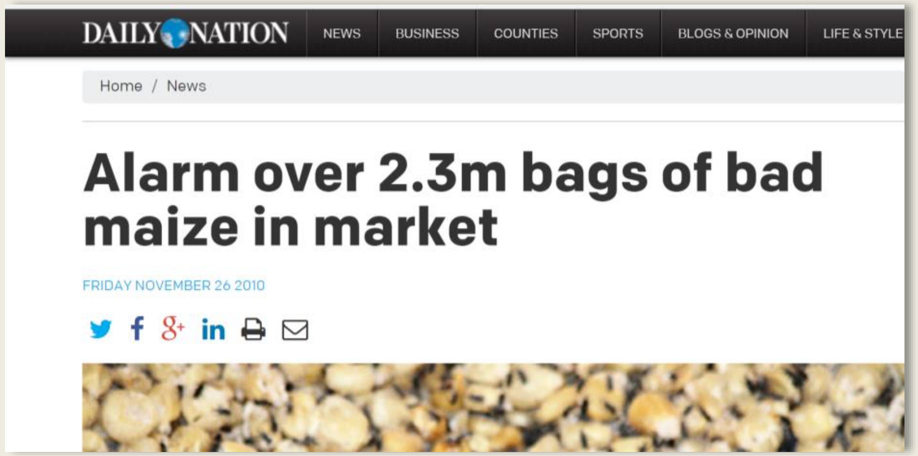
A Multipronged Approach for Aflatoxin Mitigation in Africa Centered on Biological Control

Ranajit Bandyopadhyay
International Institute of Tropical Agriculture (IITA)
Ibadan, Nigeria



DAILY NATION | NEWS | BUSINESS | COUNTIES | SPORTS | BLOGS & OPINION | LIFE & STYLE

Home / News

Alarm over 2.3m bags of bad maize in market

FRIDAY NOVEMBER 26 2010

BBC NEWS

Watch One-Minute World News

Last Updated: Monday, 7 June, 2004, 21:14 GMT 22:14 UK

E-mail this to a friend | Printable version

News Front Page
Africa
Americas
Asia-Pacific
Europe
Middle East
South Asia
UK
Business
Health
Science & Environment
Technology
Entertainment
Also in the news
Video and Audio
Programmes
Have Your Say
In Pictures
Country Profiles
Special Reports

Mouldy maize 'kills 80 Kenyans'

About 80 people have now died of food poisoning in eastern Kenya after eating contaminated maize, officials say.

The military has been sent in to distribute 10,000 bags of maize to the drought-prone Makueni, Kitui, Mbeere and Thika districts.

According to Health Minister Charity Ngilu, 80% of locally available maize stocks are affected.

"We are now withdrawing everything that is in the stores in those areas," the minister said.

Mrs Ngilu, who chairs the National Disaster Management committee, told the press about these decisions on Sunday.

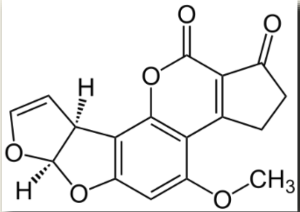
Liver failure

Maize, a staple food in Kenya, is milled into flour to make a porridge known as ugali.

Importance of aflatoxins

Aspergillus

Aflatoxin B1

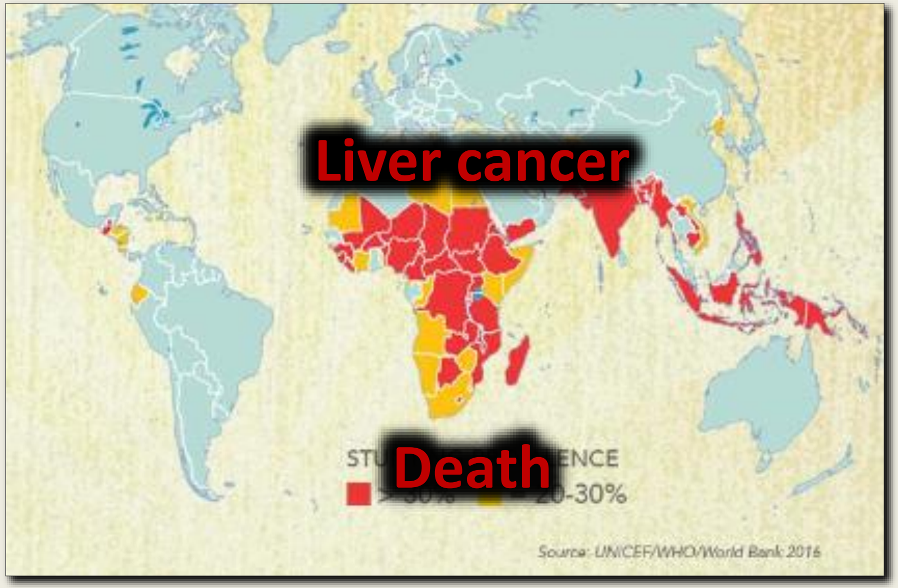


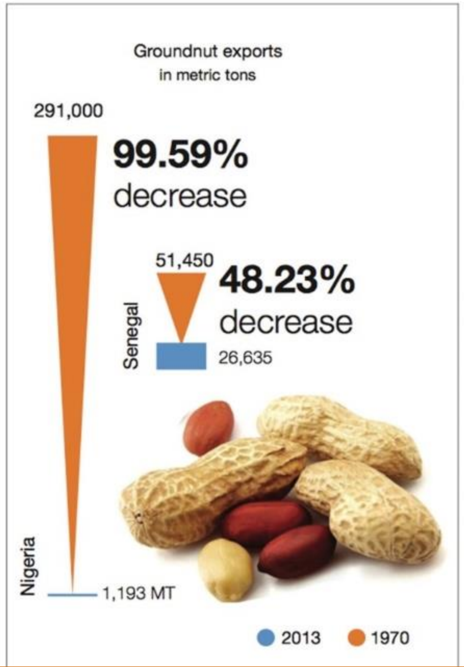
Occurrence

40% of commodities in local markets exceed ML

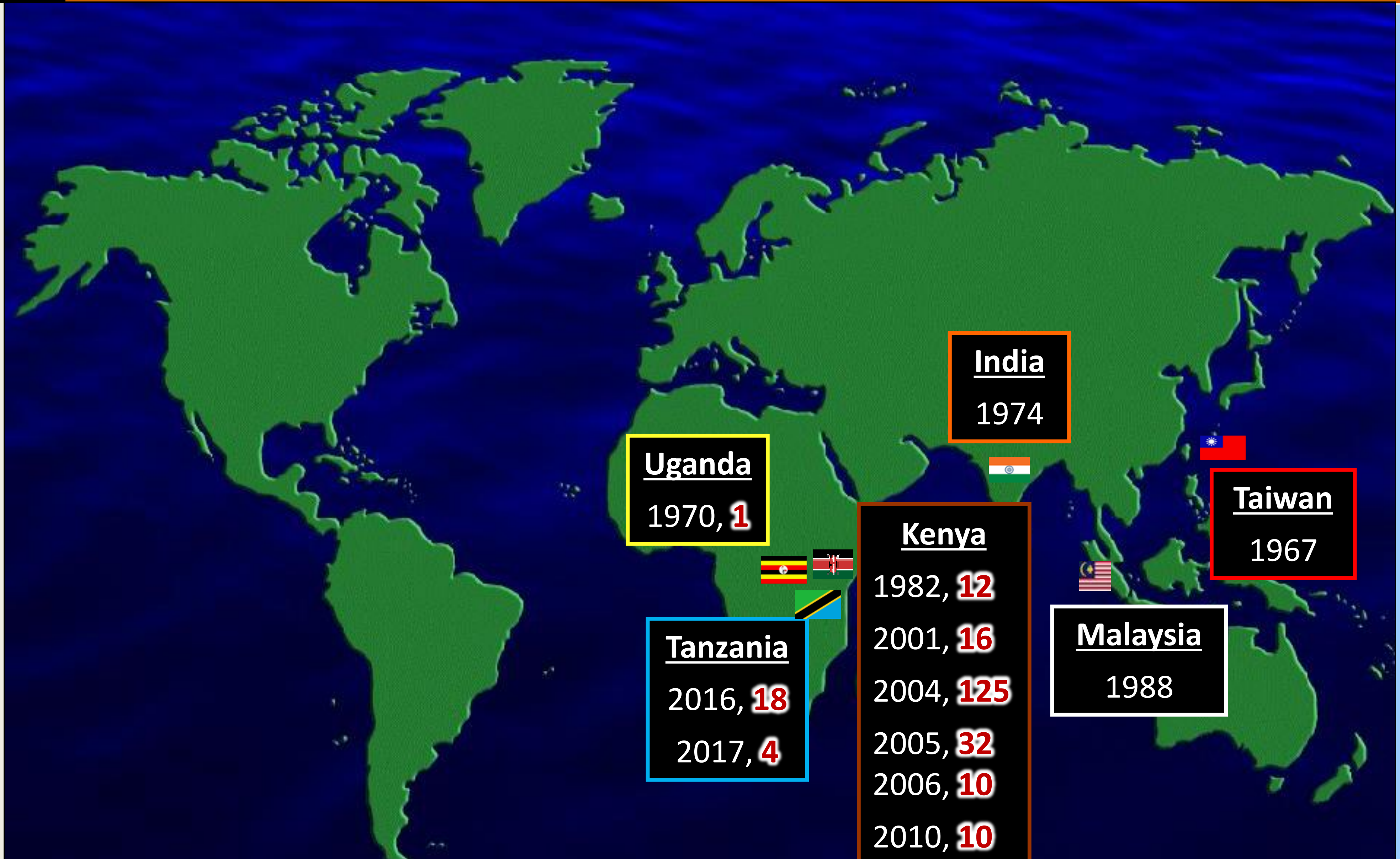
Susceptible crops

Maize, groundnuts, sorghum, cottonseed, chili, millet, figs, melon seed, ginger, sesame, cassava, almond, pistachio…





History of aflatoxicosis outbreaks



Slide prepared by C. Probst and modified by A. Ortega

Health impacts of aflatoxins in Africa

aflatoxinpartnership.org

Countries	Subject	Sample	Aflatoxin levels: Incidence (Mean)	Reference
Benin Benin/Togo	Children (n=480) Children (n=200)	Blood Blood	**99% (33 pg/mg)** **98 – 100% (37 – 87 pg/mg)**	Gong et al. 2003 Gong et al. 2004
Tanzania	Children (n=166) Children (n=166)	Blood Blood	**84% (13 pg/mg)** **99% (24 pg/mg)**	Shirima et al. 2015

Countries	Findings (association)	Reference
Ghana/The Gambia	**Exposure and immune suppression**	Williams et al. (2004)
Ghana	**Exposure and low-weight, still birth and pre-term babies**	Shuaib et al. (2010b)
Tanzania	**Exposure and reduced weight and height among breast fed infants under 6 months**	Magoha et al. (2014)
Benin/ Togo	**High aflatoxin levels and lower growth rates**	Gong et al. (2004)

Country	HCC cases/year	Disability Adjusted Life Years (DALYs) lost	Cost in Million USD
Nigeria	7,761	100,900	**380 – 3,174**
Tanzania	3,333	96,600	**25**

Economic impact of aflatoxin control in Senegal

Courtesy: World Bank

Compliance has economic incentives

$4.1 million capital investment +
15% recurring cost for aflatoxin control

$281 million added value annually to export for the capital investment

30% price differential to oil cake

Export **increase from 25K tons to 210K tons**

IITA Transforming African Agriculture 50 1967 - 2017

Key message

There are moral and economic reasons to address aflatoxins in Africa due to health, trade and food/nutritional security considerations

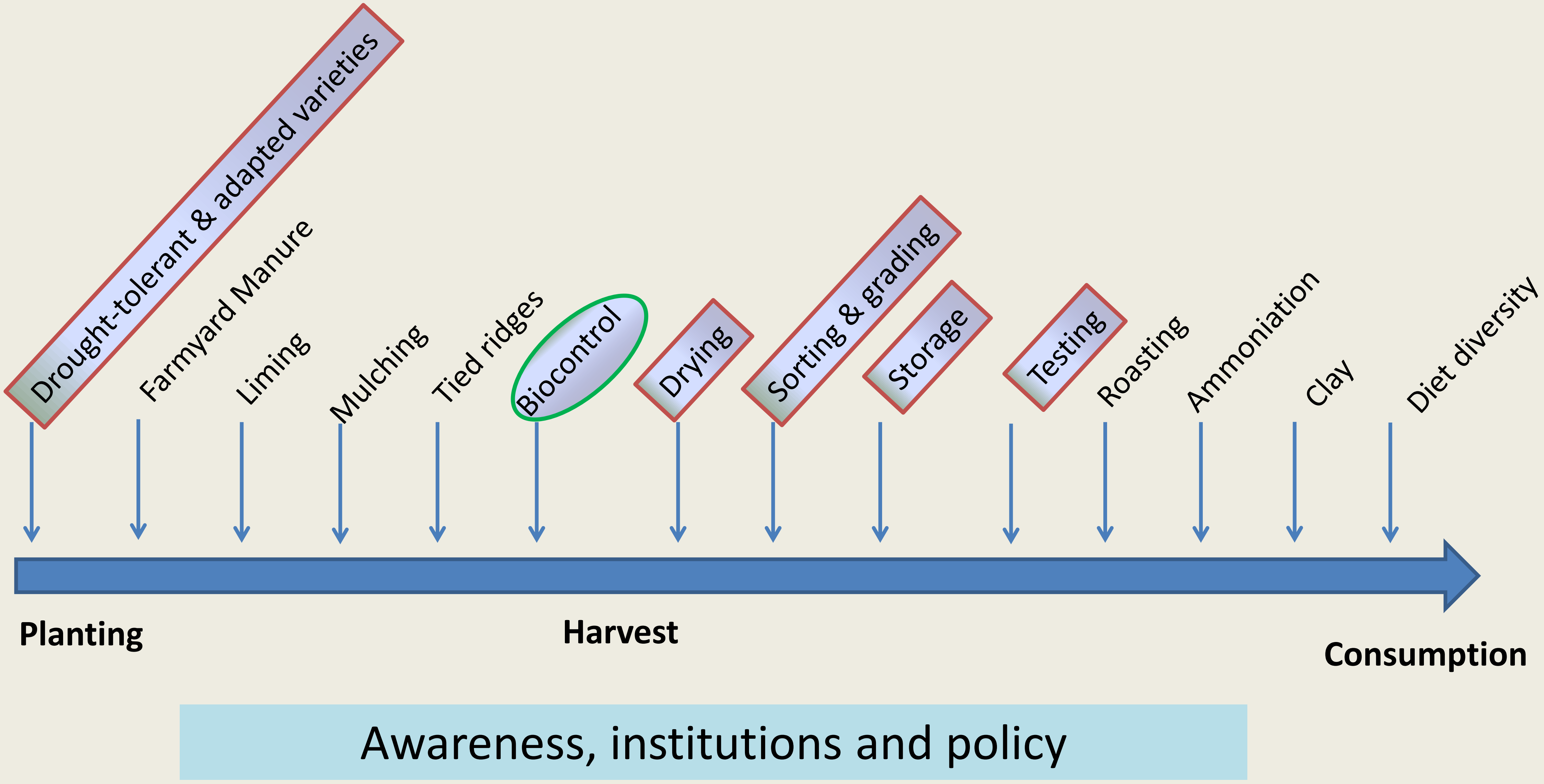
Problem starts in the field

Aflatoxin in Groundnut and Maize at Harvest, 2012, Nigeria

Aflatoxin (ppb)	Peanut (n = 188)	Maize (n = 241)
Distribution (% samples)		
> 4	54	70
> 10	41	52
> 20	29	24
Descriptive statistics (ppb)		
Minimum	< LOD	< LOD
Maximum	3,487	838
Mean	111	33

And……… increases in store

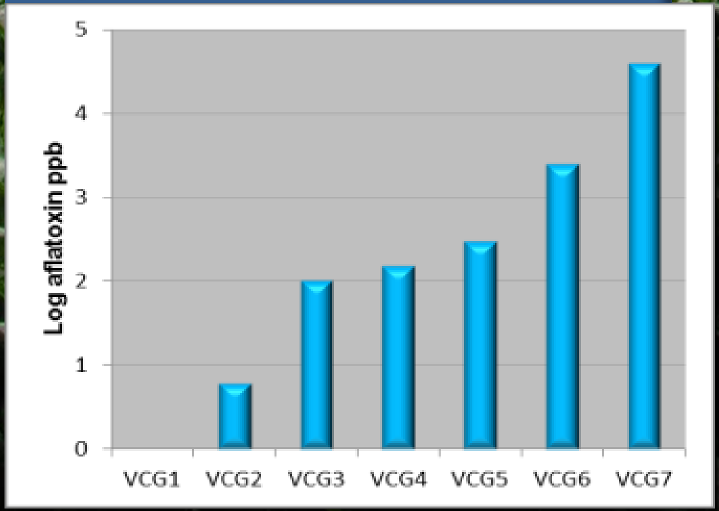
Multiple practices to manage aflatoxins



Aspergillus, crops and biocontrol

Crops will always become associated with *Aspergillus* fungi

Thousands of genotypes
Vegetative Compatibility Groups (VCGs)



Propagules / g

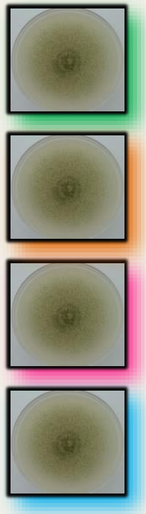
1 – >1,000,000

Aflatoxin content range (ppb)

0.0 – 20

21 – >48,000

Aflasafe composition

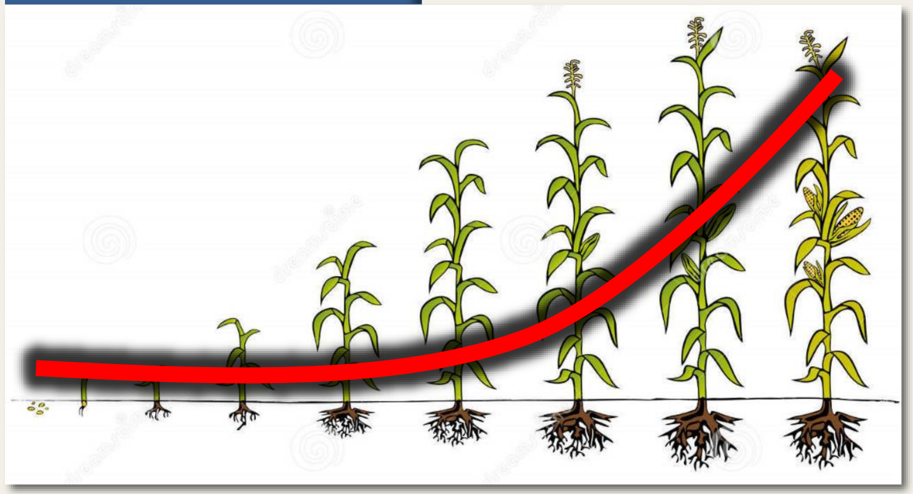


Aflasafe ingredients

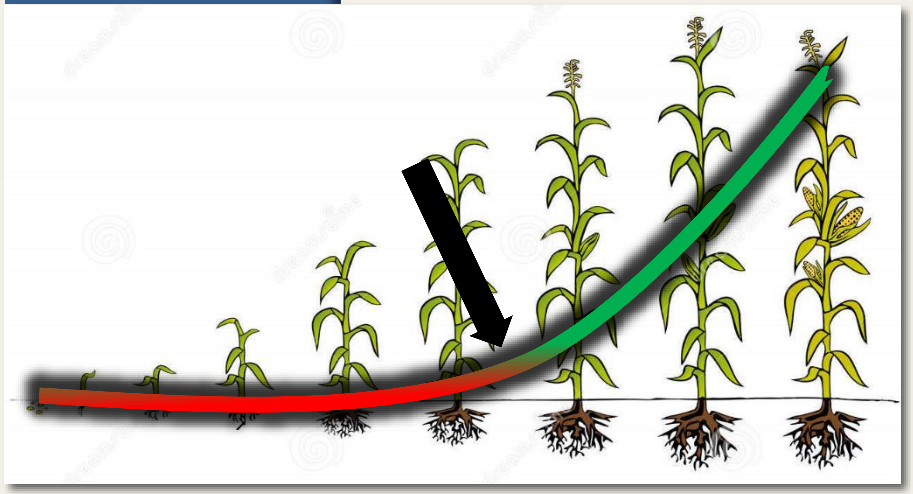
Product

Product in the field

Non-treated field



Treated field



Aflatoxin reductions

More than 1,500 farmers' field trials in 4 countries

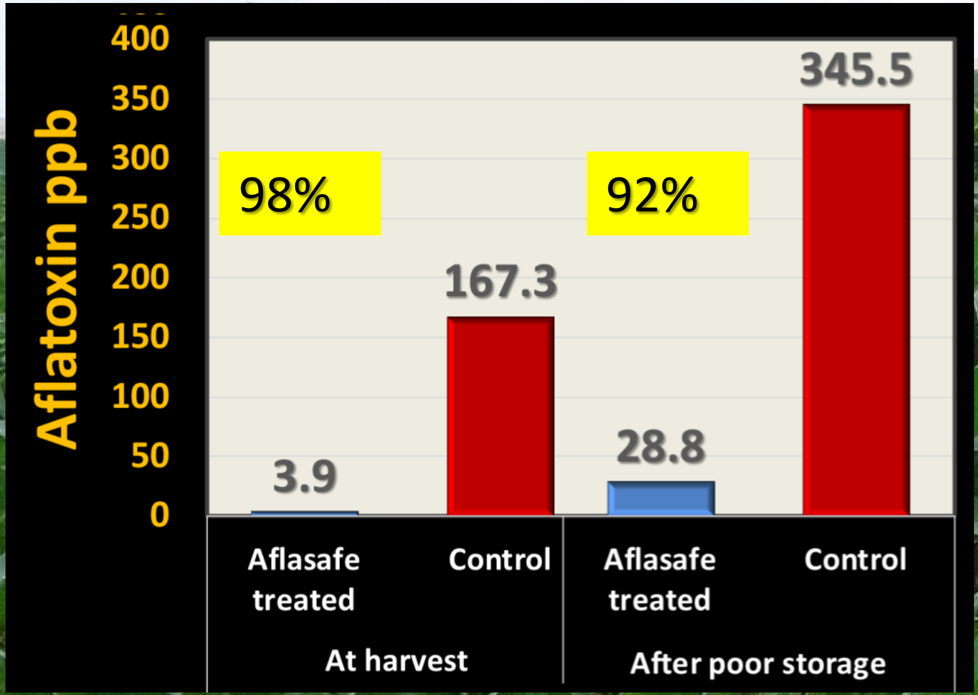
Treated vs non-treated

95%: **<4 ppb**

5%: **5 – 20 ppb**

vs

>20, >100, >1,000 ppb



In 2017, over 105,000 ha were protected with Aflasafe products

Biocontrol is a simple field intervention that effectively reduces aflatoxin contamination from farms until consumption

Aflasafe

- One application per season
- Multi-crop & multi-season effect
- 10 kg/ha
- $12-19/ha
- Willingness to pay: $11-19/ha

Aflasafe Manufacturing Plant, IITA, Nigeria

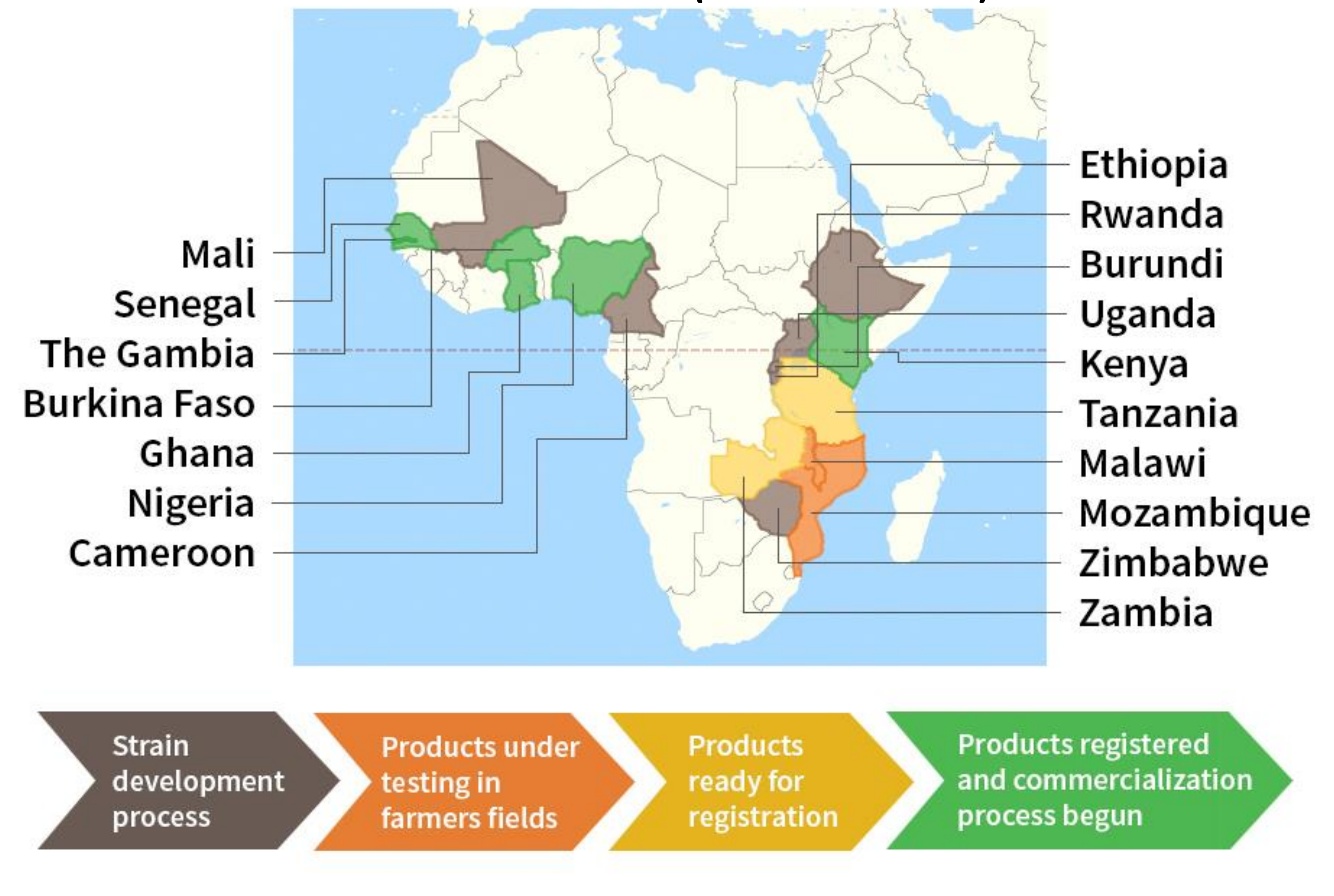
Large-scale: capacity 5 tons/hour

Product cost: $12 to $18.75/ha

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

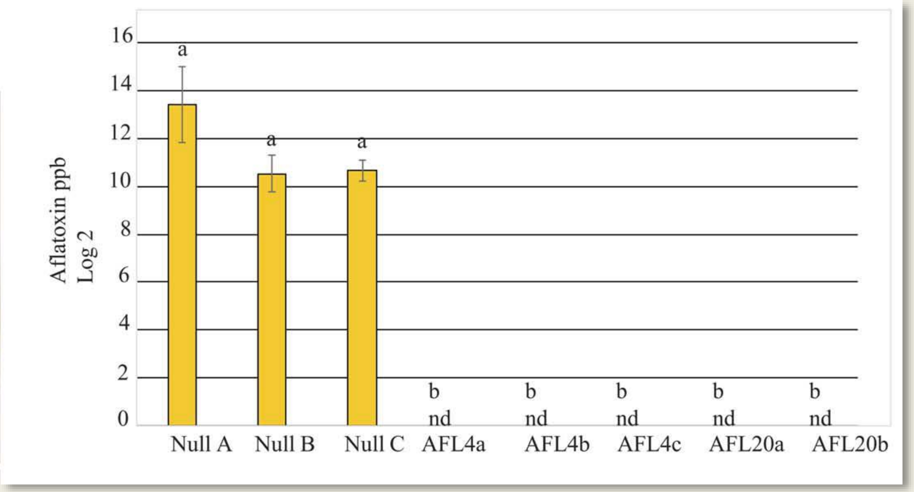
Status of Aflasafe development in Africa

(June 2018)



Host-mediated control

- Resistance is the most preferred solution
- Major efforts to breed for resistance since the last 40 years
- Excellent progress made in identifying sources of resistance
- Proteomics, transcriptomics, marker research underway
- RNAi and transgenics provide extremely high resistance
- No farmer-acceptable resistant cultivar available, search continues
- Drought-tolerant adapted cultivars best bet



Thakare et al. 2017

Combining resistance and biocontrol

Aflatoxin (ppb) at harvest in Low-Aflatoxin Maize Lines With and Without Biocontrol Treatment

Experimental variety	Aflatoxin (ppb)	
	No biocontrol	Biocontrol
RSYN2-Y	19.6	1.7
RSYN3-W	6.9	1.8
SYN3-Y	18.4	1.7
TZB-SR (susc.)	**57.5**	4.7

66-88% AF reduction over Susc. by resistance alone

97% AF reduction over Susc. by resistance and biocontrol combined

74-92% AF reduction over corresponding variety by biocontrol alone

Combining resistance and biocontrol

Aflatoxin (ppb) after poor storage in Low-Aflatoxin Maize Lines With and Without Biocontrol Treatment

Experimental variety	Aflatoxin (ppb)	
	No biocontrol	Biocontrol
RSYN2-Y	462	44
RSYN3-W	627	38
SYN3-Y	387	19
TZB-SR (susc.)	**1,152**	163

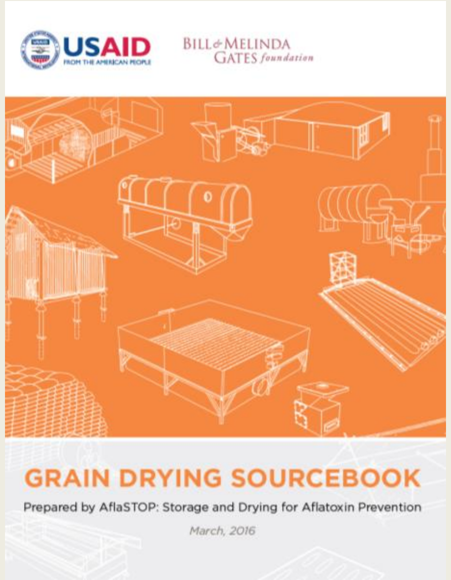
46-66% AF reduction over Susc. by resistance alone

96-98% AF reduction over Susc. by resistance and biocontrol combined

86-95% AF reduction over corresponding variety by biocontrol alone

Grain drying devices

Interesting developments in grain drying, but no devices scaled up



Grain storage devices

PICS bags

GrainPro Super bag

Traditional

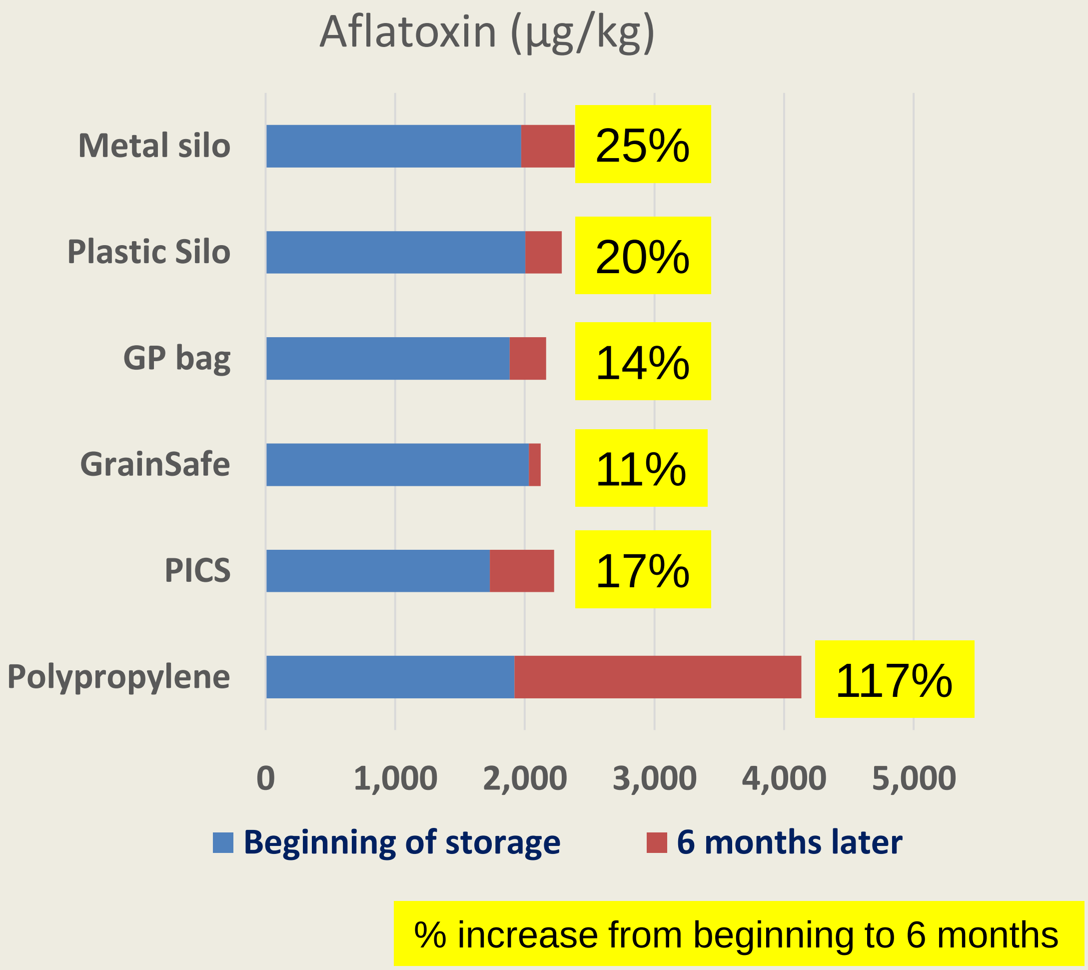
Plastic silo (Kentainers)

Metal silo

Comparison of storage devices

- All devices similarly well to suppress aflatoxin increase
- All devices have pros and cons
- Metal silos are durable, rat-proof, but high initial cost
- PICS bags most preferred. Low cost, locally produced and effective

Walker et al., 2018
AflaSTOP project



Impact of maize postharvest practices

Randomized Control Trial, Tanzania

Source: Kamala et al., 2018, WMJ

Postharvest practices evaluated

- Drying on mat/raised platform
- Hand sorting
- Moisture content testing
- Insecticides use
- De-hulling before milling

Good postharvest practices reduce aflatoxins and fumonisins and improve health

IITA 50 Transforming African Agriculture 1967 - 2017

Major postharvest loss prevention projects

USAID FROM THE AMERICAN PEOPLE

BILL & MELINDA GATES foundation

AflaSTOP:

Drying and Storage for Aflatoxin Prevention

(Formerly the Post-Harvest Drying and Storage for Aflatoxin Prevention Project)

Key message

- Several effective pre- and postharvest technologies are available
- More work required on drying

Institutions

Different scale, type…….

- National Food Safety Committees
- Standard setting, implementation and control boards
- International agencies, e.g., CGIAR, FAO, WFP, GAFSP, STDF
- Regional Economic Communities
- National governments and research institutions
- NGOs, e.g., AGRA, GAIN
- Private sector including financing
- **Partnership for Aflatoxin Control in Africa (PACA)**

Health institutions less involved

IITA 50 Transforming African Agriculture 1967 - 2017

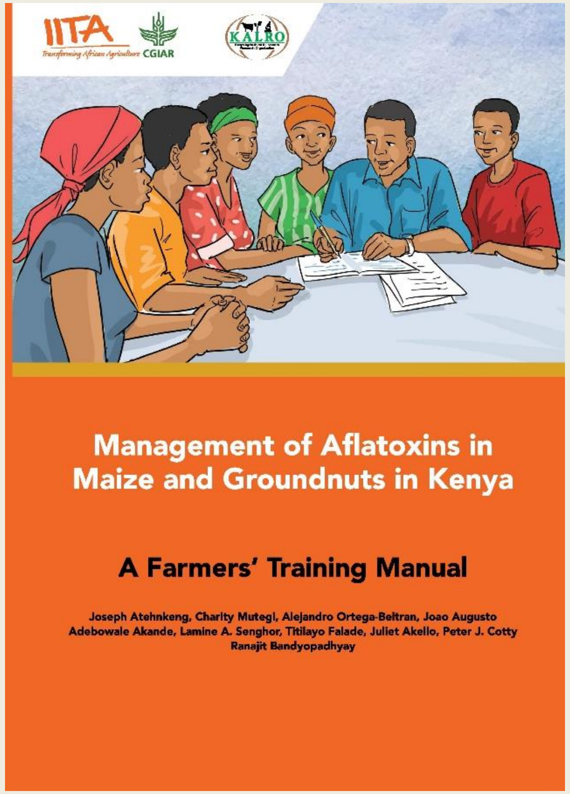
Policies

In policy-makers agenda:

- Aflatoxin standards: MRLs and CODEX
- FAO codes of practices
- Food safety laws
- Policy briefs by East African Community (EAC)
- Aflatoxin Control Plan for ECOWAS, COMESA and EAC member states
- Mainstreaming aflatoxin mitigation in NAFSIPs

With intentions to implement

Training and communication material



Integrated Management

Cost-effective technologies require enablers for adoption and scale-up

Push elements:

- Pre-harvest and post-harvest technologies including testing
- Training – farmers, transporters, traders, regulators, consumers
- Awareness – entire range of value chain participants
- Advocacy – regional, national, global
- Policies – standards, harmonization, trade, regulations
- Institutions – regulators, markets, quality assurance, agribusiness

Pull elements / incentives:

- Premium market – food/feed processors, poultry/fish industry, export
- Public health – home consumption; urban and rural markets; government procurement, Home-grown school feeding
- Pay for performance

National Innovation System for Adoption

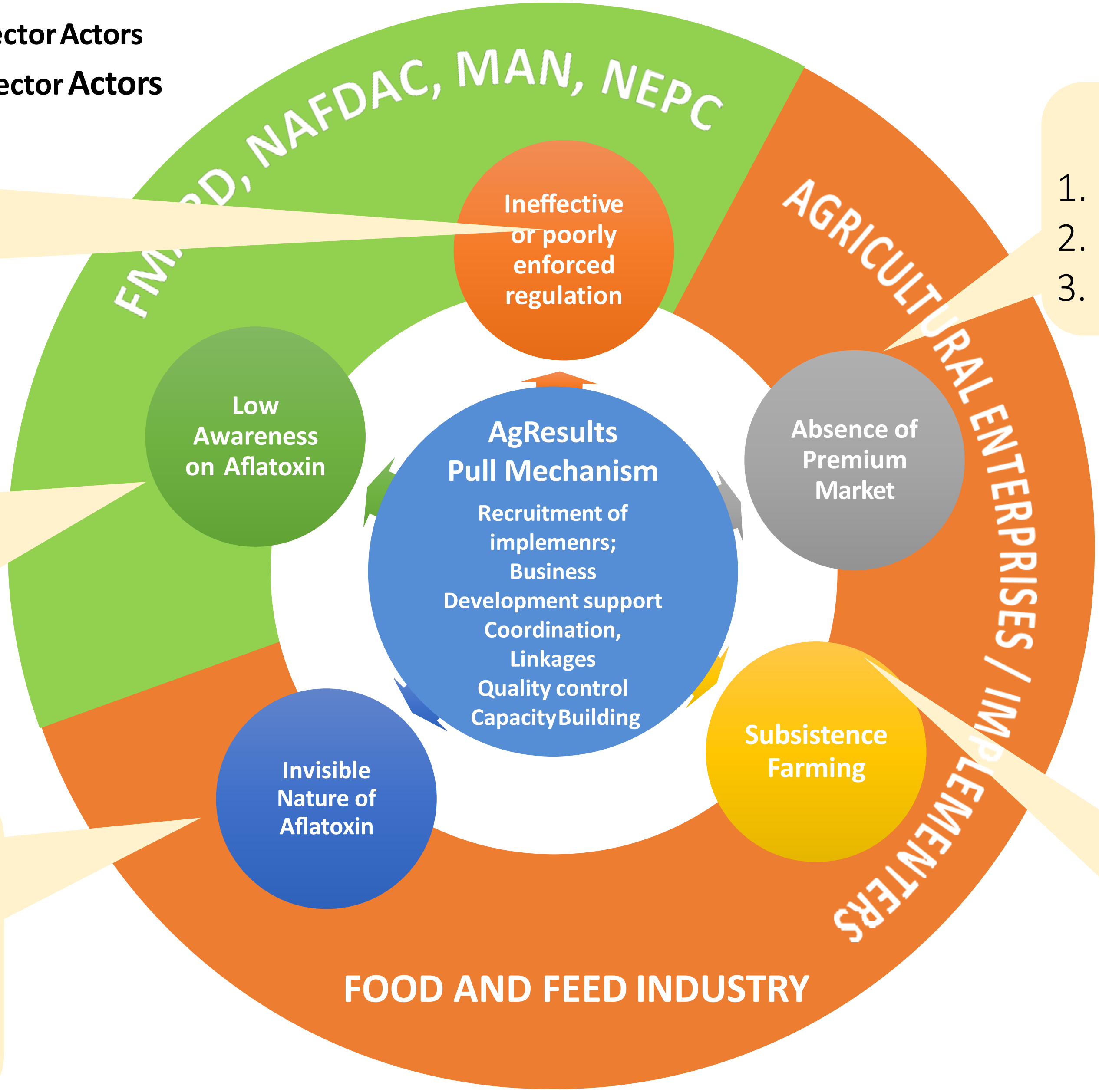
Public Sector Actors

Private Sector Actors

Solutions
1. Policy & Advocacy
2. Laboratory for Certification
3. Inter-governmental Panel on Aflatoxin

Solutions
1. National awareness programs:
2. Community awareness programs
3. Capacity building

Solutions
1. Testing
2. Training on aflatoxin management
3. Aflatoxin management manual



Solutions
1. Demonstrate product value
2. Innovation platform
3. Market linkage

Solutions
1. Agribusiness group farmers
2. Aggregation for quality control / market access
3. Access to finance, credit and quality inputs
4. Training for Improved productivity and agribusiness
5. Support in GAP for Production

Integrated Aflatoxin Management System

- Public
- Private
- Public-private

- Aflasafe
- Training for aflatoxin management
- Training to improve productivity
- Inputs and services
- Farmer groups/ value chain/Finance
- Implementers
- Awareness and sensitizations
- Policy and advocacy
- Market linkages
- Aflatoxin testing
- Post-harvest management
- Aggregation

Impacts (2013-2017)

- 32 agribusinesses
- 49,500 farmers
- Farm size: 1.34 ha/farmer
- 63,000 ha maize grown
- 600 tons Aflasafe purchased

Productivity: 3.1 tons/ha compared to 1.5 tons/ha national average

Grain lots (n = 2,362) with aflatoxin concentration	%
<4 ppb	90%
<10 ppb	94%
<20 ppb	96%

Meets international standards

More trade

More income

194,310 tons of grains harvested

- 57% aggregated for sale
- 27% consumed at home
- 16% sold in local market

Better health

- 10.7% premium in the market over normal maize
- $1.491 million in net earning from premium

Nestlé Grain Improvement Programme in Ghana *(& Nigeria)*

Why

- Improved quality and safety of raw materials used in our factories (*up to 50% of maize grains rejected at factory gate in 2007*)
- To use 100% of locally-sourced maize grains

Courtesy: Owen Fraser, Nestlé

Holistic approach to mycotoxins management in maize in the supply chain

Identify the risks

- Establish critical control limits
- Sampling & testing
- Reject non-compliant raw materials

Good Agricultural Practices

- Best variety selection
- Farmers training & technical support
- Post-harvest best practices
- Storage & transport best practices

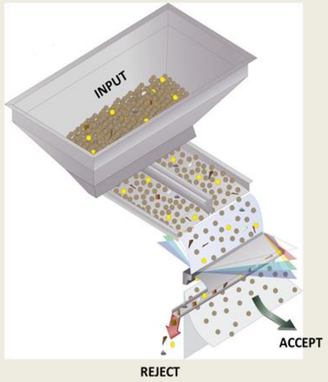
Technology application

- Mycotoxin testing
- Biological control application
- Application mechanical cleaning & sorting

Science-based risk assessment

Establish specifications & critical controls

OPTICAL SORTING

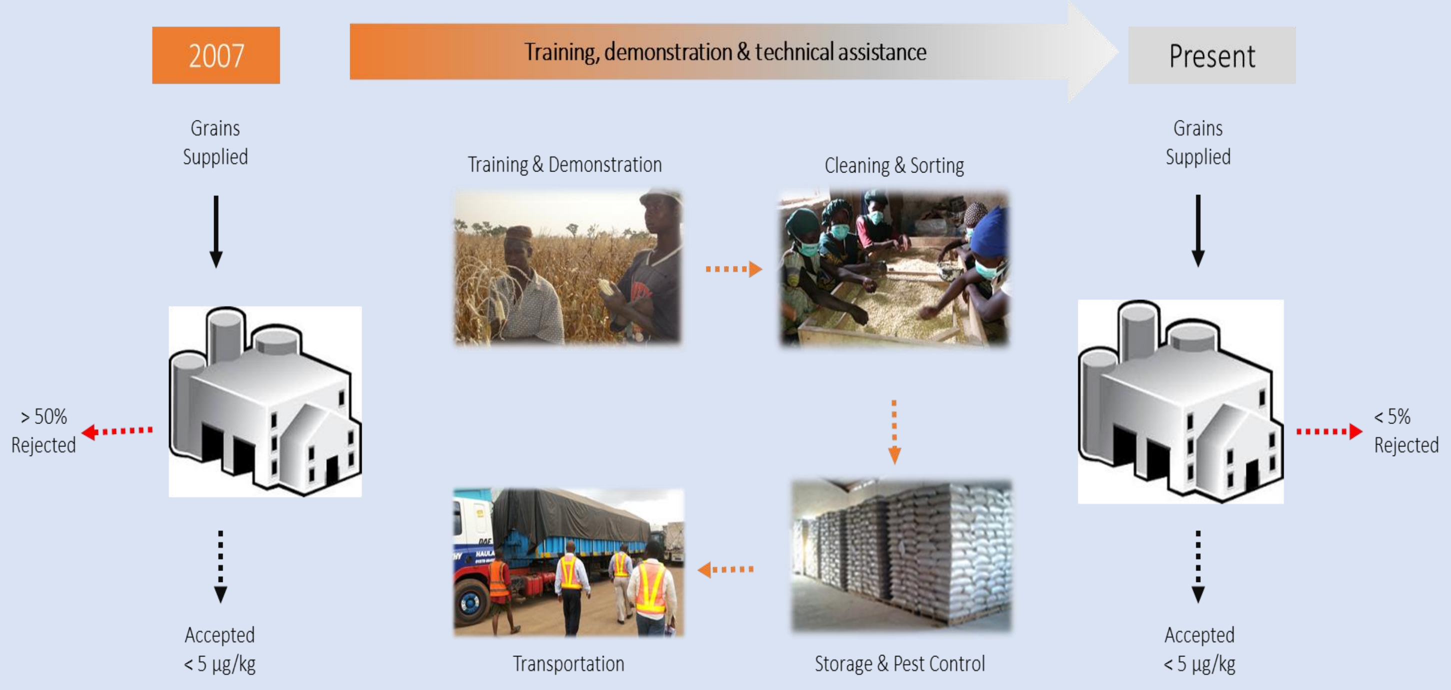


- 98% reduction in total aflatoxins in maize grains
- Large capacity & high throughput
- Variable sensitivity
- Can be used to sort both yellow and white maize grains

Significantly reduce & control the level of aflatoxins in the supply chain

Outcome & Social Benefits

- Significantly improved grain quality – rejection at factory gate reduced to less than 4% by 2013
- Over 80,000 farmers trained in awareness of health risks due to mycotoxin contamination in food
- 150 communities trained in contamination prevention
- About 50% are women
- Reduced loss, increased yields and revenue for farmers
- Improved food safety at home



Needs

- More effort needed to create awareness
- Need to test innovations at scale to determine adoption potential
- Cost-benefit analysis of incremental stacking of technologies to better understand value of integrated management
- Opportunities for decontamination or alternate use of contaminated products required
- Work in value chain settings and partner with the private sector

Summary

- Aflatoxins are pervasive in Africa
- More efforts needed to translate knowledge into actions for benefitting African smallholders
- Biological control with other practices can dramatically reduce aflatoxin contamination and improve food safety and security
- Context-specific Institutional and policy innovations must support technology adoption
- Scale-up of sustainable models to commercialize aflatoxin biocontrol underway in Africa

Joint effort

And many Key partners...

USDA ARS
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
DFID Department for International Development
UKaid from the Department for International Development
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
ZARI Zambia Agriculture Research Institute
Researching Soils, Crops and Water in Zambia
NISIR National Institute for Scientific and Industrial Research Zambia
NAERLS
AATF
MycoRed
MycoKey Integrated and innovative key actions for mycotoxin management in the food and feed chains
INERA
Nestlé
NAFDAC
PACA Partnership for Aflatoxin Control in Afric
Meridian Institute Connecting People to Solve Problems
Dalberg
DOREO PARTNERS
KARI
FOREIGN AGRICULTURAL SERVICE USDA
NATIONAL IRRIGATION BOARD
AgResults INCENTIVIZING INNOVATION FOR GLOBAL FOOD SECURITY
CGIAR RESEARCH PROGRAM ON Agriculture for Nutrition and Health Led by IFPRI
Africa RISING