FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Assessment and Mitigation of Aflatoxins and Fumonisins in Animal Feeds in Rwanda

Kizito Nishimwe[1,2], Erin Bowers[1], Jean de Dieu Ayabagabo[2], Richard Habimana[2], Samuel Mutiga[3] and Dirk Maier[1]

[1]Iowa State University, USA

[2]University of Rwanda, Rwanda

[3]BecA-ILRI, Kenya

4th Annual Innovation Platform Meeting

April 2, 2019
Kigali, Rwanda

USAID FROM THE AMERICAN PEOPLE | IOWA STATE UNIVERSITY | UNIVERSITY OF RWANDA | biosciences eastern and central africa | ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE | CGIAR | UF IFAS UNIVERSITY of FLORIDA

Dr. Dirk Maier, PI

Mr. Kizito Nishimwe, Co-PI

Dr. Erin Bowers, Co-PI

Mr. Richard Habimana,
UR, Collaborator

Dr. Samuel Mutiga,
BecA-ILRI, Collaborator

Mr. Jean de Dieu Ayabagabo
UR, Collaborator

Dr. Dirk Maier, Lab technicians, and Enumerators

MYCOTOXINS OF CONCERN

Aflatoxins…

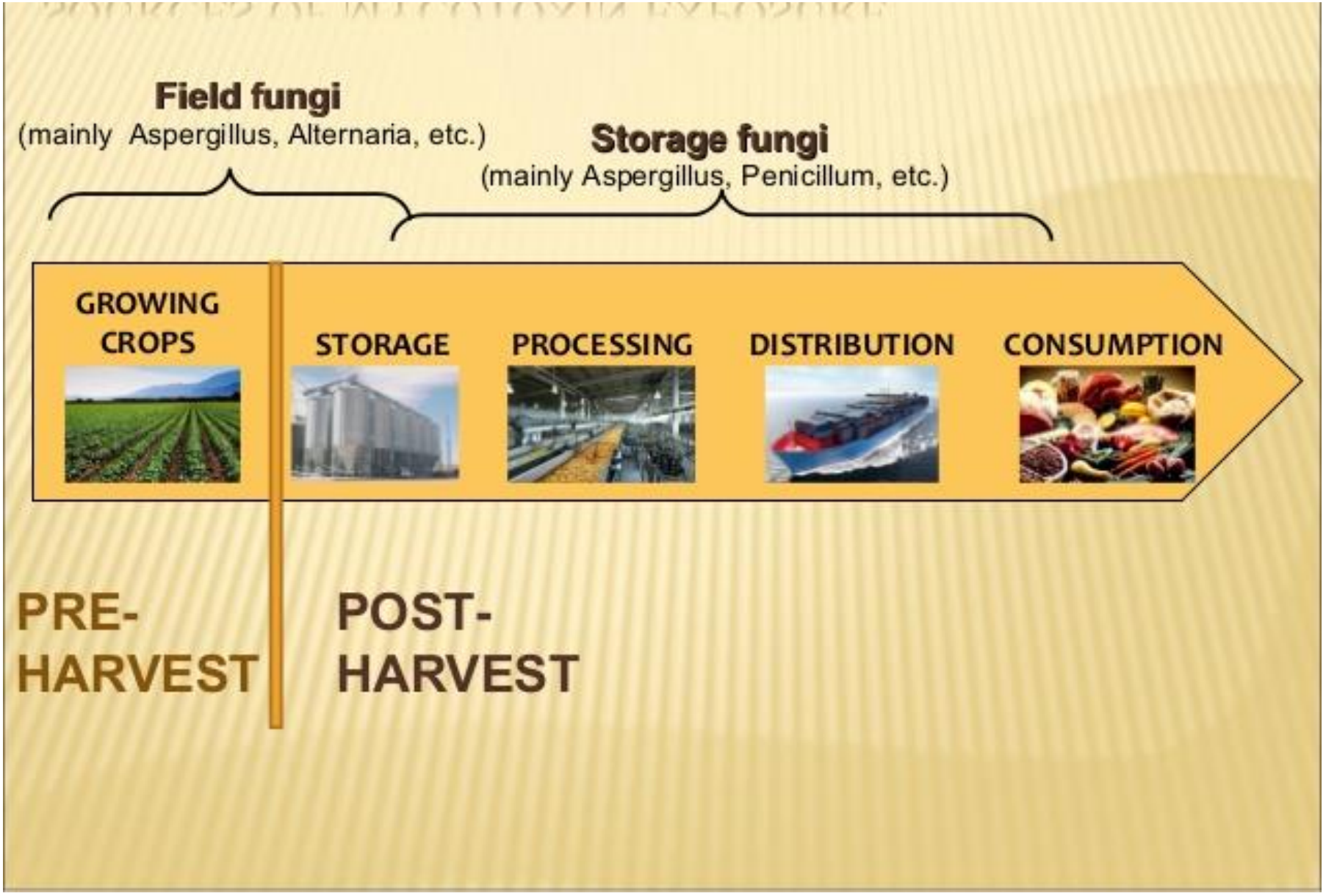
- Toxic metabolites produced by a variety of molds (*A. flavus, A. parasiticus)*
- Among the most carcinogenic substances known

Fumonisins…

- Toxic metabolites produced by *Fusarium spp.*
  - Neural tube defects
  - involved in equine leukoencephalomalacia (ELEM; moldy maize poisoning); a devastating neurologic disease of horses caused by eating feed or hay contaminated with fumonisin mycotoxins

➔ Humans and animals are exposed to mycotoxins by consumption of food and feeds contaminated by mycotoxins (especially maize)

Sources of Aflatoxin Exposure



https://paepard.blogspot.com/2018/04/increasing-awareness-of-and-concerted.html

AFLATOXIN IS
POISONOUS

Aflatoxin, a byproduct of naturally-occurring fungi that infect many crops, is a Class 1 Human Carcinogen and leads to:

IN ADULTS
- Liver Cancer
- Immunosupression

10%
OF ADULT DEATHS IN SOUTHEAST ASIA AND SUB-SAHARAN AFRICA ARE CAUSED BY LIVER CANCER

IN CHILDREN
- Stunting
- Mental Impairment
- Acute Poisoning

UP TO 35%
OF CHILD STUNTING IS ASSOCIATED WITH AFLATOXIN

IN LIVESTOCK
- Contaminated Meat & Milk
- Passed to Human Consumers

AFLATOXIN IS HARMFUL TO
ECONOMIES

Higher medical costs, market losses and toxic effects in livestock can devastate economic systems and livelihoods.

IN 2001, AFRICA LOST OVER
$600 MILLION
IN TRADE WITH THE E.U. DUE TO AFLATOXIN CONTAMINATION

$1 BILLION USD PER YEAR
ESTIMATED COST OF AFLATOXIN MANAGEMENT IN THE PHILIPPINES, THAILAND AND INDONESIA

25%
OF THE WORLD'S CROPS ARE SUSCEPTIBLE TO AFLATOXIN

MAIZE · MILLET · GROUND NUTS · SORGHUM · SPICES · RICE · CASSAVA

https://**agrilinks**.org/aflatoxins

Carry-Over of Aflatoxin B1 to Aflatoxin M1

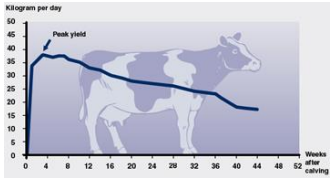
Contaminated milk with AFM1

AFB1 ---> AFM1

Aflatoxin contamination

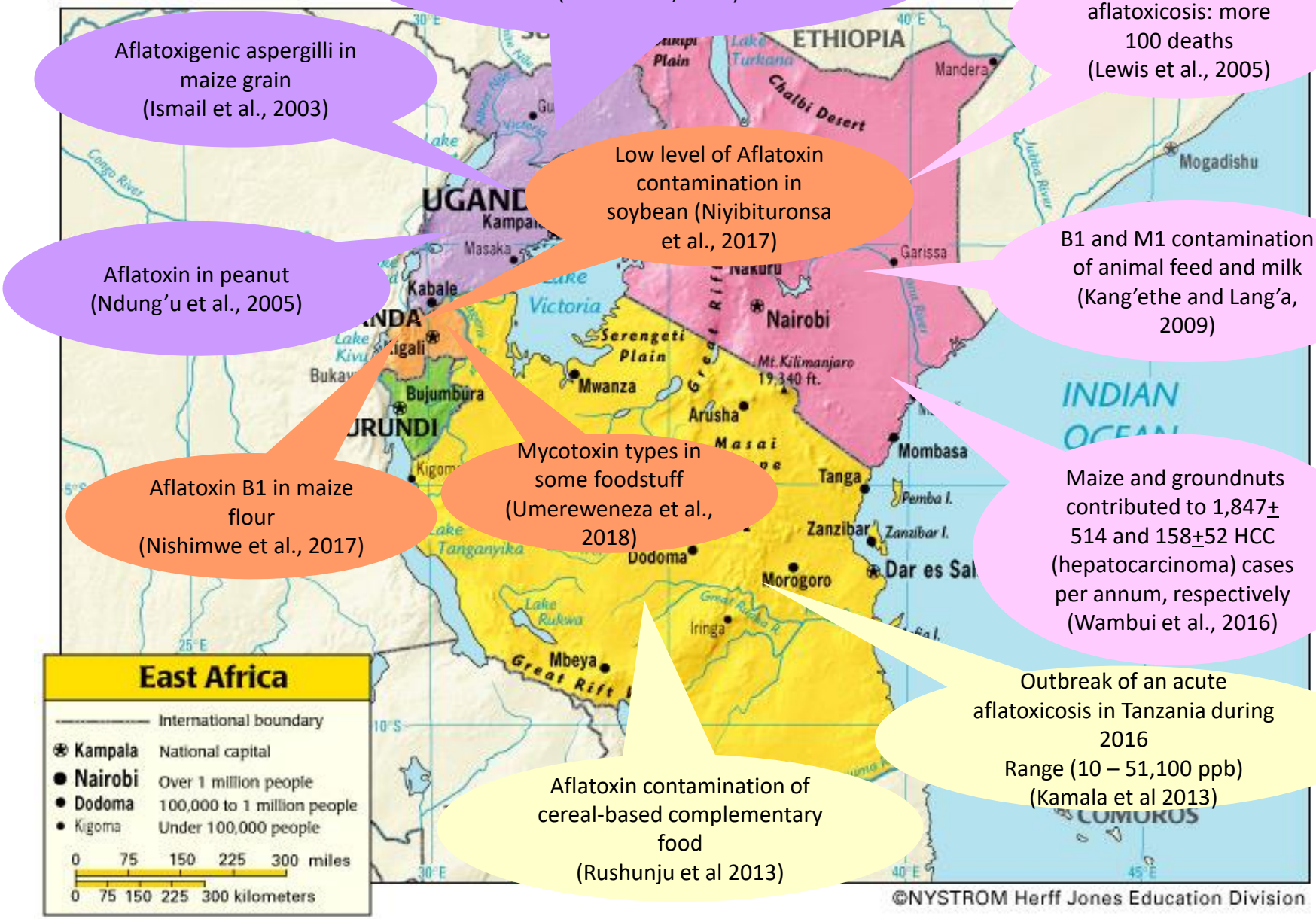
Consequences

Consumers' exposure



Low milk production

EAST A… …NTEXT



Association between maternal aflatoxin exposure during pregnancy and adverse birth outcomes (Laura et al., 2018)

Outbreak of acute aflatoxicosis: more 100 deaths (Lewis et al., 2005)

Aflatoxigenic aspergilli in maize grain (Ismail et al., 2003)

Low level of Aflatoxin contamination in soybean (Niyibituronsa et al., 2017)

Aflatoxin in peanut (Ndung'u et al., 2005)

B1 and M1 contamination of animal feed and milk (Kang'ethe and Lang'a, 2009)

Aflatoxin B1 in maize flour (Nishimwe et al., 2017)

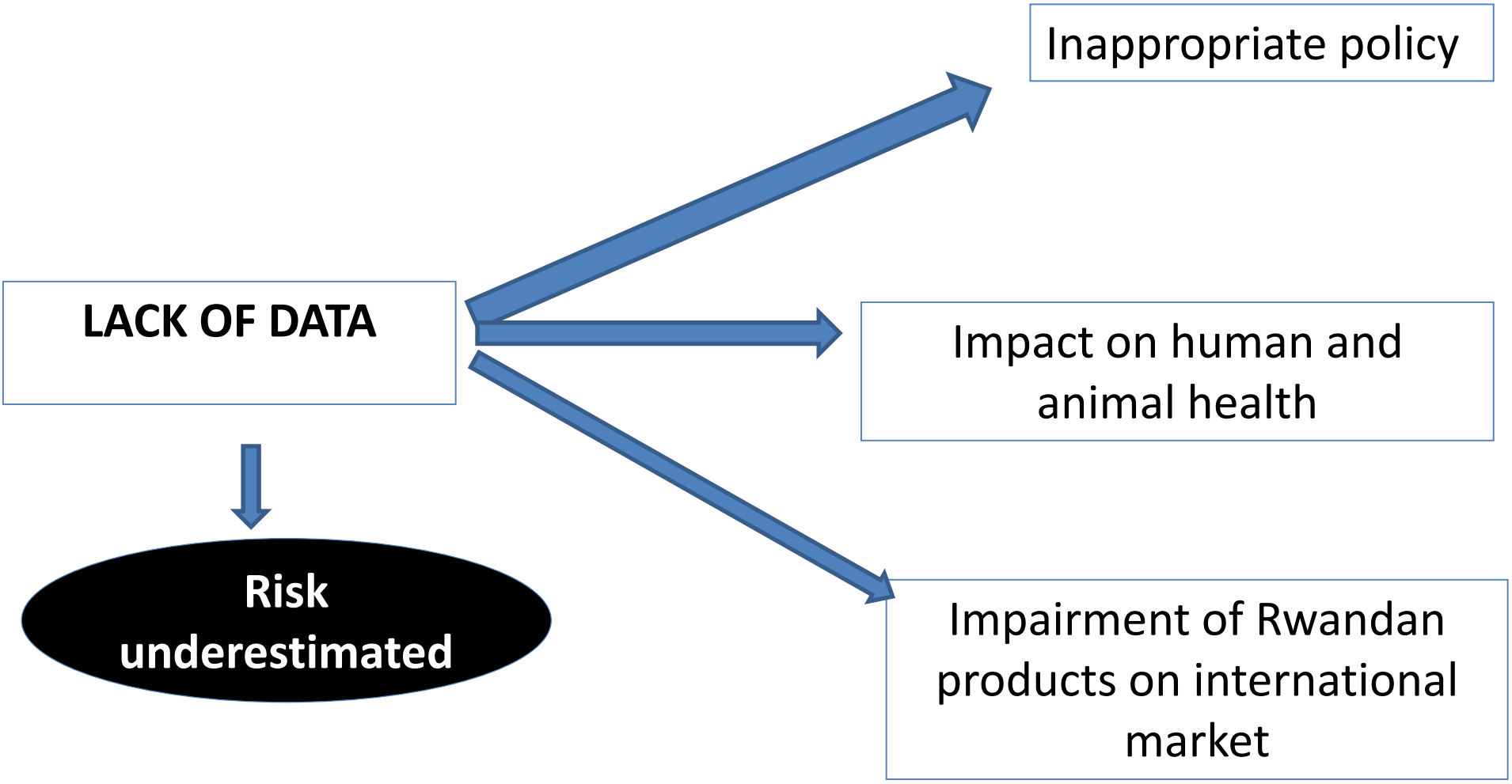
Mycotoxin types in some foodstuff (Umereweneza et al., 2018)

Maize and groundnuts contributed to 1,847± 514 and 158±52 HCC (hepatocarcinoma) cases per annum, respectively (Wambui et al., 2016)

Outbreak of an acute aflatoxicosis in Tanzania during 2016
Range (10 – 51,100 ppb)
(Kamala et al 2013)

Aflatoxin contamination of cereal-based complementary food (Rushunju et al 2013)

CONSEQUENCES OF MYCOTOXIN CONTAMINATION



RESEARCH OBJECTIVES

Assessment and Mitigation of Aflatoxin and Fumonisin in Feeds in Rwanda

1. Asses prevalence of aflatoxins and fumonisins in feeds
2. Establish mycotoxin lab and staff capacity at University of Rwanda
3. Raise awareness of mycotoxin contamination and prevention
4. Provide input to regulatory framework regarding mycotoxin policy

+ Assess presence of aflatoxin M1 in farm milk samples

METHODS

- **Targeted Population**
  - Dairy farmers
    - ***Criteria:*** Use of supplements to feed animal additional to forage
    - At least 2 cows
  - Poultry farmers
  - Feed processors
  - Feed vendors
  - Grain (maize) mills

Questionnaire

- **Area of study**
  - All 30 districts of Rwanda
- **Rounds**
  - Samples collected in 6 rounds
- **Period**
  - March – October 2017

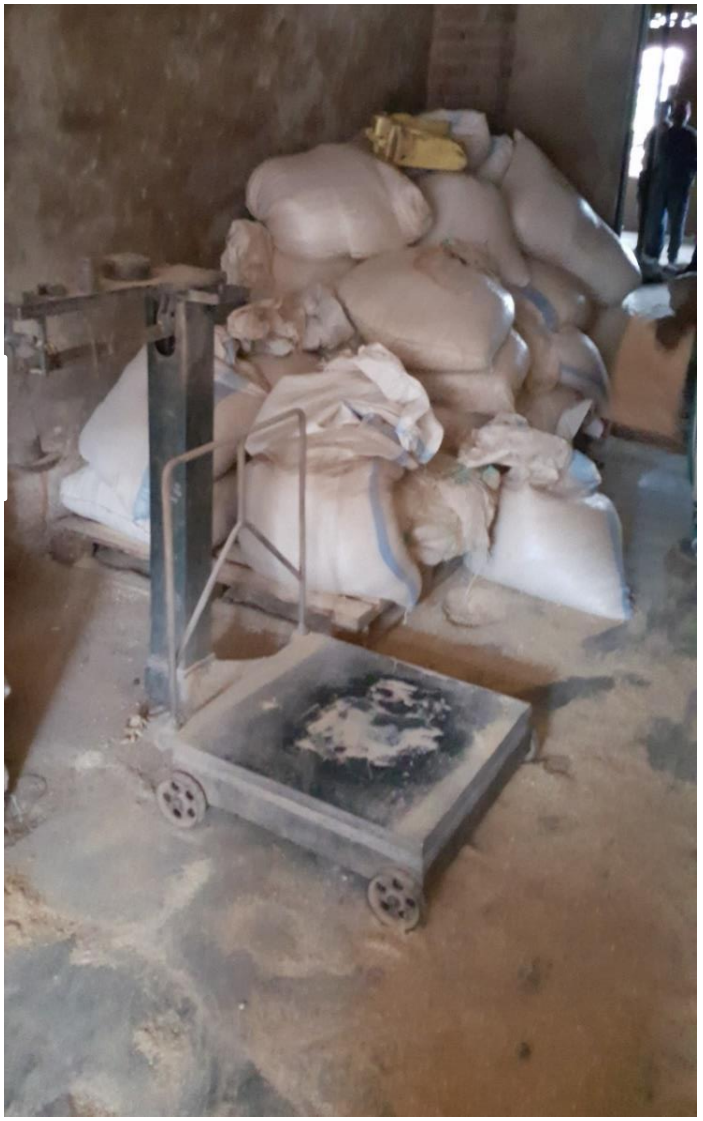
- **Methods of analysis**
  - Feed samples: ELISA (HELICA, USA)
  - Milk samples: Fluorometry (VICAM, USA)

- **Methods validation**
  - External validation: BecA-ILRI
  - Internal validation: Use of Reference Materials (Romer Labs, Austria)

Dairy Producer

Poultry Layer Producer

Local Feed Manufacturer



Commercial Feed Manufacturer

Feed Vendors

Feed Vendors

Maize Miller

OBJECTIVE 2: ESTABLISH MYCOTOXIN LAB & STAFF CAPACITY

Romer Mill Grinder

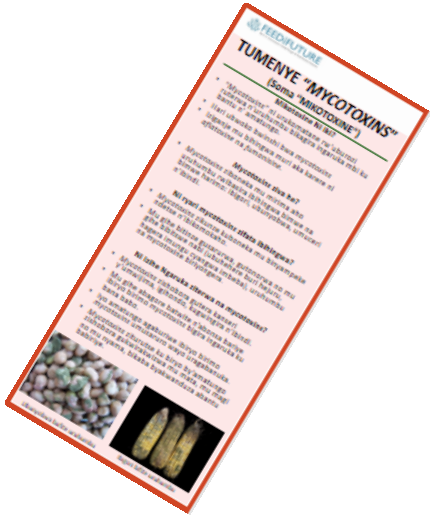
Microplate reader for ELISA analysis

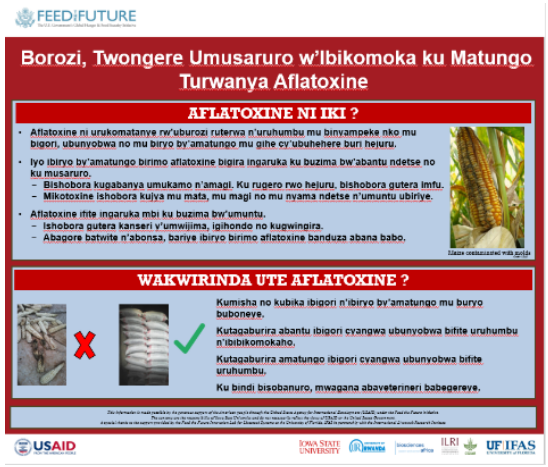
AflaTest Basic Equipment

Sample cost: $15 - $25 vs >$150 HPLC Sample Cost

Established mycotoxin lab with rapid mycotoxin tests at U of Rwanda Department of Food Science & Technology for research and extension and trained staff to operate it

OBJECTIVE 3: RAISE AWARENESS OF MYCOTOXIN CONTAMINATION AND PREVENTION





- Teaching materials (in Kinyarwanda) developed to raise awareness among farmers during the last (6th) round
- Poster (in Kinyarwanda) displayed at sector/district level raising mycotoxin awareness in general public
- Seminars and trainings organized at University of Rwanda

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

TUMENYE "*MYCOTOXINS*"
(Soma "MIKOTOXINE")

Mycotoxins Ni Iki?

- *"Mycotoxins"* ni urukomatanye rw'uburozi ruterwa n'uruhumbu bikagira ingaruka mbi ku bantu n' amatungo.
- Hari ubwoko bwinshi bwa *mycotoxins*
- Iziganje mu bihingwa muri aka karere ni *aflatoxine* na *fumonisine*.

Mycotoxins ziva he?

- *Mycotoxins* ziboneka mu mirima aho uruhumbu rwibasira ibihingwa bimwe na bimwe harimo: ibigori, ubunyobwa, umuceri n'ibindi.

Ni ryari *mycotoxins* zifata ibihingwa?

- *Mycotoxins* zikunze kuboneka mu binyampeke ndetse n'ibikomokaho.
- Mu gihe bitinze gusarurwa, gutonorwa no mu gihe bibitswe nabi (ubuhehere buri hejuru, hagera imungu cyangwa imbeba), uruhumbu na mycotoxine biriyongera.

Ni Izihe Ngaruka ziterwa na *mycotoxins*?

- *Mycotoxins* zishobora gutera kanseri y'umwijima, igihondo, kugwingira n'ibindi.
- Mu gihe abagore batwite n'abonsa bariye ibiryo birimo *mycotoxins* bigira ingaruka ku bana babo.
- Iyo amatungo agaburiwe ibiryo birimo *mycotoxins* umusaruro wayo uragabanuka.
- *Mycotoxins* ziturutse ku biryo by'amatungo zishobora gukwirakwizwa mu mata, mu magi no mu nyama, bikaba byakwanduza abantu babiriye.

Ubunyobwa bufite uruhumbu

Ibigori bifite uruhumbu

Ni Gute Wakwirinda *Mycotoxins*?

1. **Sarura ku gihe.**
2. **Tonora ibigori ukimara kubisarura.**
3. **Umisha ibigori ukimara kubisarura ku rugero rw'ubuherere rungana na 13%.**
4. **Hunika ibigori byumishijwe neza ahantu hasukuye, mu mifuka n'ibigega byabugenewe.**

Ibyo witaho mu gusarura

- Sarura ikigori gifite ubuhehere buri hagati ya 20-25%.
- Wibyumishiriza mu murima bitemwe.
- Tandukanya ibirwaye n'ibizima.
- Bishishure kugira ngo byume vuba.
- Vungura ibigori ukoresheje uburyo butangiza impeke. (Impeke zangiritse zibasirwa byoroshye n'uruhumbu ndetse na *mycotoxins*).

Ni gute warinda *mycotoxins* mu biryo by'amatungo?

- Irinde kugura, kugurisha cyangwa kugabura ibiryo birimo uruhumbu.
- Pimisha ibiryo by'amatungo muri laboratoire kuri *mycotoxins*.
- Irinde kubika ibiryo by'amatungo igihe kirekire.
- Tereka ibiryo by'amatungo ku mbaho, ahantu humutse neza.
- Genzura niba bifite ibara n'impumuro y'umwimerere.

Ukeneye ibindi bisobanuro wahamagara kuri izi numero: 0787247248, 0782555390, 0787869675

This information is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the Feed the Future initiative.
The contents are the responsibility of Iowa Sate University and do not necessarily reflect the views of USAID or the United States Government.
A special thanks to the support provided by the Feed the Future Innovation Lab for Livestock Systems at the University of Florida, IFAS in partnership with the International Livestock Research Institute

USAID FROM THE AMERICAN PEOPLE | IOWA STATE UNIVERSITY | UNIVERSITY OF RWANDA | biosciences eastern and central africa | ILRI | UF IFAS UNIVERSITY of FLORIDA

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Borozi, Twongere Umusaruro w'Ibikomoka ku Matungo Turwanya Aflatoxine

AFLATOXINE NI IKI ?

- Aflatoxine ni urukomatanye rw'uburozi ruterwa n'uruhumbu mu binyampeke nko mu bigori, ubunyobwa no mu biryo by'amatungo mu gihe cy'ubuhehere buri hejuru.
- Iyo ibiryo by'amatungo birimo aflatoxine bigira ingaruka ku buzima bw'abantu ndetse no ku musaruro.
  - Bishobora kugabanya umukamo n'amagi. Ku rugero rwo hejuru, bishobora gutera imfu.
  - Mikotoxine ishobora kujya mu mata, mu magi no mu nyama ndetse n'umuntu ubiriye.
- Aflatoxine ifite ingaruka mbi ku buzima bw'umuntu.
  - Ishobora gutera kanseri y'umwijima, igihondo no kugwingira.
  - Abagore batwite n'abonsa, bariye ibiryo birimo aflatoxine banduza abana babo.

Maize contaminated with molds
Credit: USAID

WAKWIRINDA UTE AFLATOXINE ?

Kumisha no kubika ibigori n'ibiryo by'amatungo mu buryo buboneye.

Kutagaburira abantu ibigori cyangwa ubunyobwa bifite uruhumbu n'ibibikomokaho.

Kutagaburira amatungo ibigori cyangwa ubunyobwa bifite uruhumbu.

Ku bindi bisobanuro, mwagana abaveterineri babegereye.

This information is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the Feed the Future initiative.
The contents are the responsibility of Iowa Sate University and do not necessarily reflect the views of USAID or the United States Government.
A special thanks to the support provided by the Feed the Future Innovation Lab for Livestock Systems at the University of Florida, IFAS in partnership with the International Livestock Research Institute.

USAID FROM THE AMERICAN PEOPLE
IOWA STATE UNIVERSITY
UNIVERSITY OF RWANDA
biosciences africa
ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE
CGIAR
UF IFAS UNIVERSITY of FLORIDA

Enumerators teaching farmers about mycotoxins using teaching materials

Training on mycotoxin analysis (Aug 2017)

Seminar at University of Rwanda (Jan 2017)

OBJECTIVE 4: PROVIDE INPUT TO REGULATORY FRAMEWORK ON MYCOTOXIN POLICY

- Rwanda Standards Board (RSB) develops and maintains official standards

- Found one RSB standard regarding mycotoxin regulation
  - Cattle feed supplements — Specification: RS 100: 2017

6 Mycotoxin and anti-nutritional factors limits

Cattle feed supplements shall comply with maximum limits for aflatoxin and free gossypol as specified in Table 3.

Table 3 — Aflatoxin and gossypol permissible limits

S/N	Aflatoxin	Maximum limit (µg/kg)		Test method
1	Total aflatoxin (µg/kg)	calves	100	ISO 16050
		other cattle	300	
2	AFB1 (µg/kg)	dairy cattle	5	ISO 14718
		calves	10	
		others	50	
3	Free gossypol, mg/kg	500		ISO 6866

7 Other contaminants

RECOMMENDATIONS AND SCALING PLANS

- **Feed formulation**
  - Explore potential of mycotoxin binders in feed rations
  - Blending with clean grain or other ingredients
  - Considering different species sensitivity and age

- **Awareness / Education**
  - Develop & implement training for dairy/poultry farmers, feed processors/vendors, maize millers including ingredient quality & management, feed ration formulation, mycotoxin mitigation
  - Deliver awareness reminders via communication channels (radio, TV, social media, phone…)
  - Dry and store feeds properly

RECOMMENDATIONS AND SCALING PLANS (2)

- **Mycotoxin Testing Service**
  - Mycotoxin lab to receive & analyze feed/ feed ingredient samples
  - Promote availability of mycotoxin testing service

    ➔Cost effectiveness

- **Intervention / Mitigation**
  - A year-round surveillance and early detection system in the Rwanda feed value chain
  - Risk-based policies and standards for different species and mycotoxins in feed ingredients and mixed feeds
  - Initiate collaboration among the different stakeholders (Public, Academia and Private sectors)

TAKE-HOME MESSAGE

- Commercial feeds are highly contaminated with aflatoxins. More research needed on forages like grass and hay.
- Maize bran is the major feed ingredient used and primary cause of aflatoxin presence in feeds
- Low level of aflatoxin awareness among producers
- Lack of comprehensive mycotoxin standards for grains, ingredients and feeds
- Mycotoxin lab using ELISA (grains, ingredients, feeds) and Fluorometry (milk) can be used for low cost analysis and quick results

ACKNOWLEDGMENTS

- LSIL – University of Florida

- Partner Institutions
  - University of Rwanda, Rwanda
  - Iowa State University (ISU), USA
  - BecA-ILRI, Kenya

- Participants

- Borlaug Higher Education for Agricultural Research and Development (BHEARD) Program

- Enumerators

FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

www.feedthefuture.gov

USAID FROM THE AMERICAN PEOPLE

IOWA STATE UNIVERSITY

UNIVERSITY OF RWANDA

biosciences eastern and central africa

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

CGIAR

UF IFAS UNIVERSITY of FLORIDA