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

Aflatoxin Impacts on child growth

Ahmed Kablan, PharmD, PhD.

International Nutrition and Public Health Adviser

Office of Agricultural Research and Policy
Bureau for Food Security (BFS/ARP);
USDA/ARS/Office of International Research Program
DC MSNS-Nutrition GLEE
akablan@usaid.gov

Presentation overview

1) Overview of the current state of the scientific evidence linking Aflatoxin to child growth

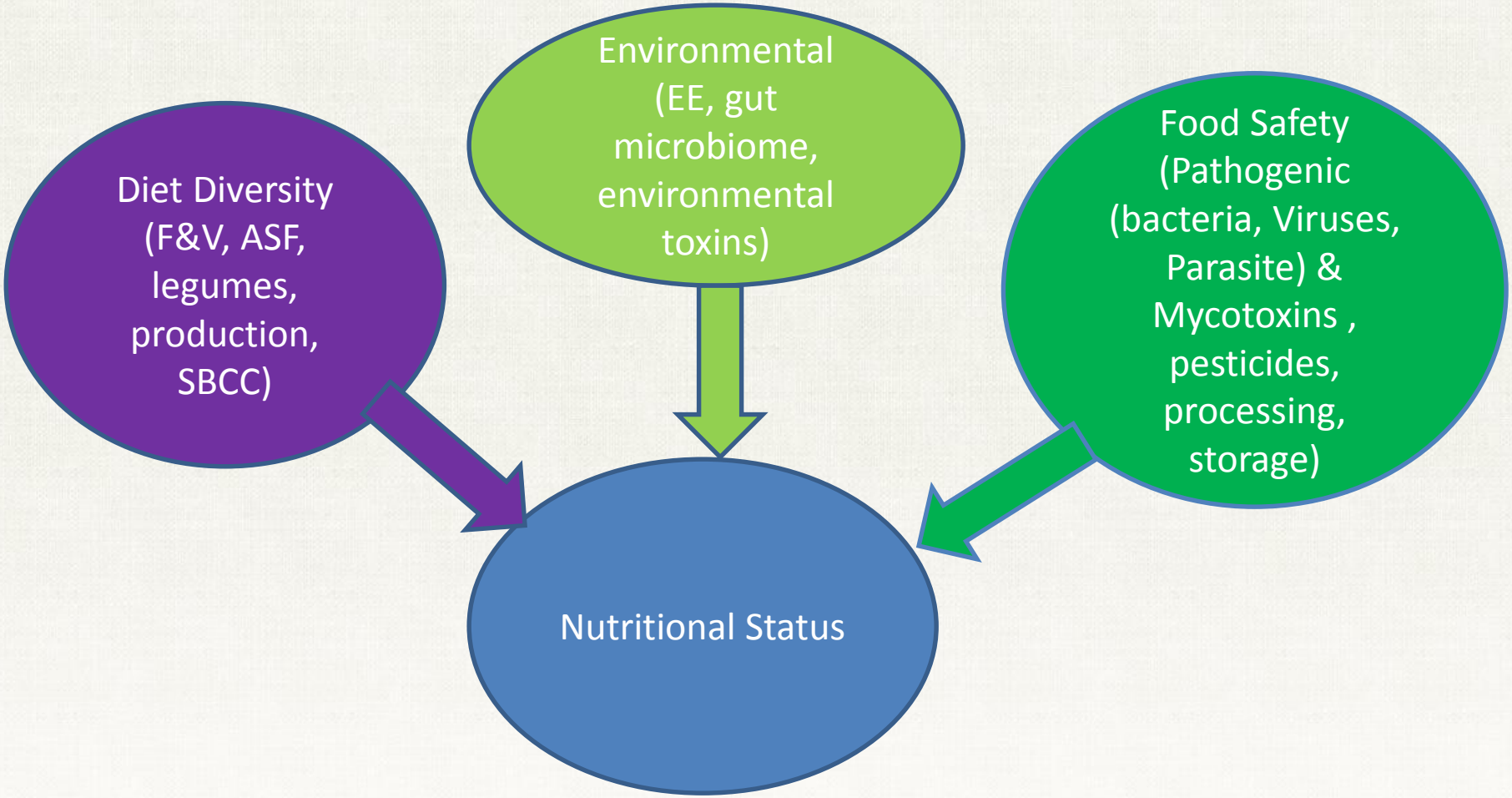
2) What are the criteria needed to decide that aflatoxin cause stunting

3) What are the possible solutions?

4) Conclusion

Lancet 2013

- 10 targeted interventions implemented at 90% coverage cuts stunting by 20%, mortality by 15%.
- But…"coverage rates for [many] interventions are either poor or non-existent."
- Cost: US$9.6 billion per annum.
- Even at 90% coverage, 80% of stunting remains!!!

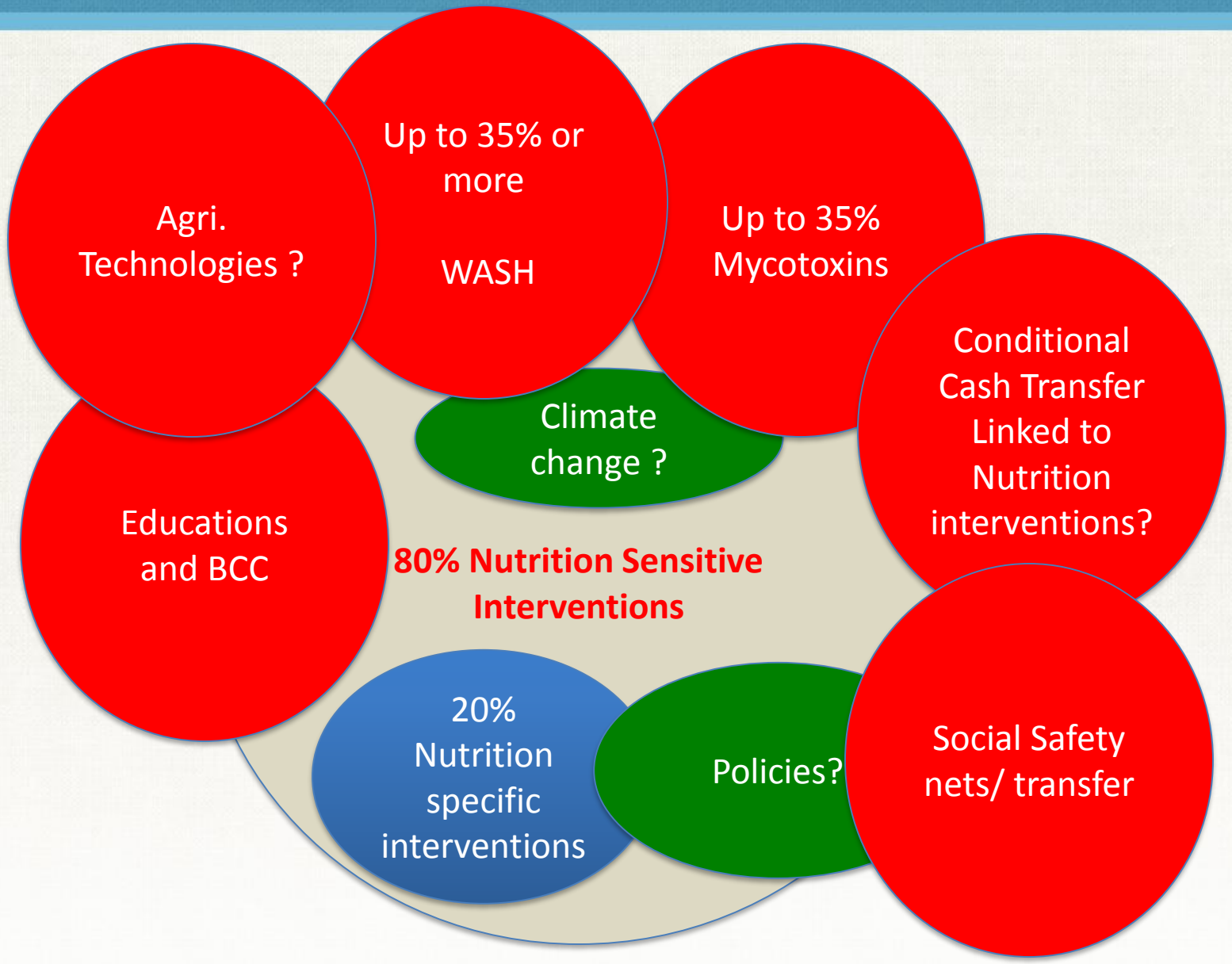


key factors affecting Nutritional Status

Working together (i.e. Not one approach can do it all) ?

Could we achieve the 100%??

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



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

Our Goal!

Improve
Diet
Diversity

Better Nutritio

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

The problem-----Chronic Malnutrition

- 165 million <5 are stunted
- Growth retardation in young children associated with:

Several Research efforts are focusing on identifying presently unknown causes of growth retardation!!!!

Mycotoxins (e.g. Aflatoxin is one of those UNKs)

- opportunity to prevent stunting
  - Scaling up of 10 proved nutrition-specific interventions to cover 90% of stunted will reduce stunting by 20% ONLY?? (Lancet 2013)

The problem-----Chronic Malnutrition

- 165 million <5 are stunted

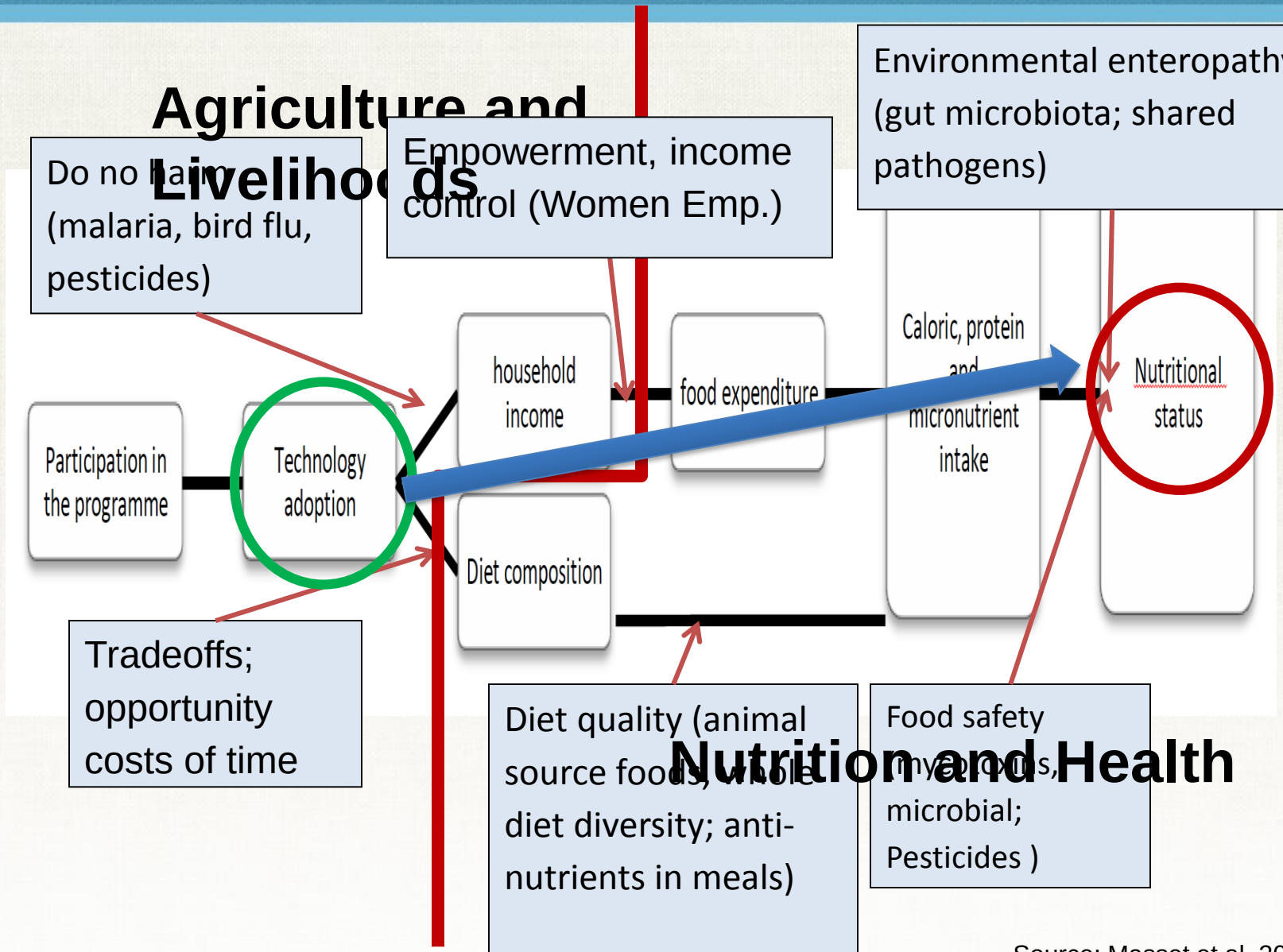
- Growth retardation in young children associated with:

  - delays in cognitive development,
  - lower school achievement,
  - lower earnings and a higher probability of non-communicable chronic diseases at adulthood.

- Current evidence on most effective way to reduce stunting:

  - Scale-up interventions to *prevent* (rather than *treat* or *reverse*) stunting
  - First 1,000 days (i.e. from conception to 24 months of age), “window of opportunity to prevent stunting”
  - Scaling up of 10 proved nutrition-specific interventions to cover 90% of stunted will reduce stunting by 20% ONLY?? (Lancet 2013)

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



Thanks for Dr. Webb for sharing this slide

Source: Masset et al. 2011

What are Aflatoxins

- Aflatoxins are toxins produced by *Aspergillus* fungi which infect maize, groundnuts, wheat, and many other staple foods.
- Drought stresses crops, Pest infestation also increase infection rates
- Control of toxin happen pre-harvest (e.g. Aflasafe) or post-harvest good agronomy practices (e.g. good drying practices and proper storage minimizing moisture.

Aflatoxin risk: a complex set of drivers

Aflatoxin risk determined by:

Host: crop species and variety/type

- Fungal population
- Crop management in field
- Environmental conditions
- Postharvest practices

What do we know about Aflatoxins toxicity?

- Acute Exposure

  If large doses are eaten, it will cause rapid death (e.g. Aflatoxicosis; Kenya 2004, 317 cases of reported death)

- Chronic exposure
- Chronic exposure to low doses Cause of liver cancer

- May Cause child stunting and low birth weights in animals and **humans**!!!!

Suggested by:

- Evidence from human and animal studies
- Current knowledge of the biological mechanisms of action of aflatoxin

How do we get exposed to Aflatoxins:

- Aflatoxin present in dried foods; human breast milk; cow milk, poultry, eggs, and meat if animals given feed with aflatoxins.
- Child exposure risk increases after weaning
- Dependence on single commodity with little diet diversity increase the risk of exposure significantly

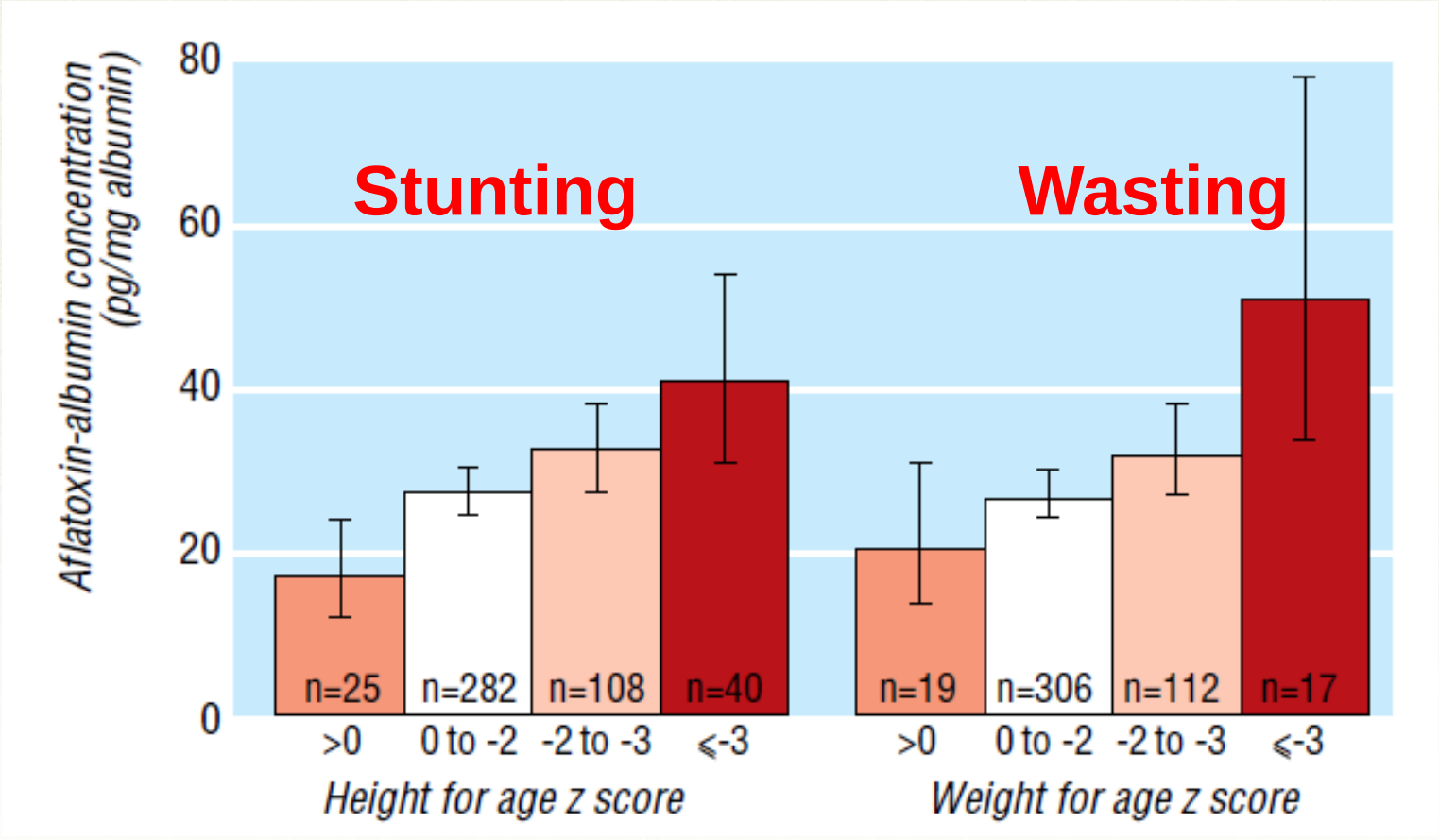
Studies linking aflatoxin to growth impairment in children-Just an example of the evidence!!

Type of study	Results	Nation & study
Aflatoxin measurements in stored flour, rural homes	Stunting, underweight, & wasting associated with higher AF levels in flour	*Kenya* (Okoth & Ohingo 2004)
Cross-sectional: AF-alb levels in maternal, cord, child blood	Stunting & underweight associated with higher AF-alb levels in these fluids	*Togo, Benin, United Arab Emirates, The Gambia* (Gong et al. 2002*, Abdulrazzaq et al. 2004, Turner et al. 2007)
Longitudinal: AF-alb levels in children's blood	Reduced height gain in 8 mos associated with AF-alb levels	*Benin* (Gong et al. 2004)
AFM1 in mothers' breastmilk	Lower length at birth & in infancy associated with AFM1	*Iran* (Sadeghi et al. 2009, Mahdavi & Nikhniaz 2010)

*Dose-response relationship between AF-alb & HAZ, WAZ

Khlangwiset P, Shephard GS, Wu F (2011). Aflatoxins and growth impairment: A review. *Critical Reviews in Toxicology* 41:740-755.

- Gong et al (BMJ, 2002) showed that **stunting** and **weight for age** was inversely related to aflatoxin levels in Gambia. Jolly and colleagues (Peanut Innovation Lab) have shown the same in Ghana.



Gong et al, BMJ 2002

How does Aflatoxin cause stunting? Exact Mechanism is still missing; however several has been proposed:

1) Immunomodulation associated with aflatoxin exposure (Bondy and Pestka, 2000; Turner et al., 2003) ---cause recurrent infections in children, which can lead to growth impairment (Gong et al., 2008)

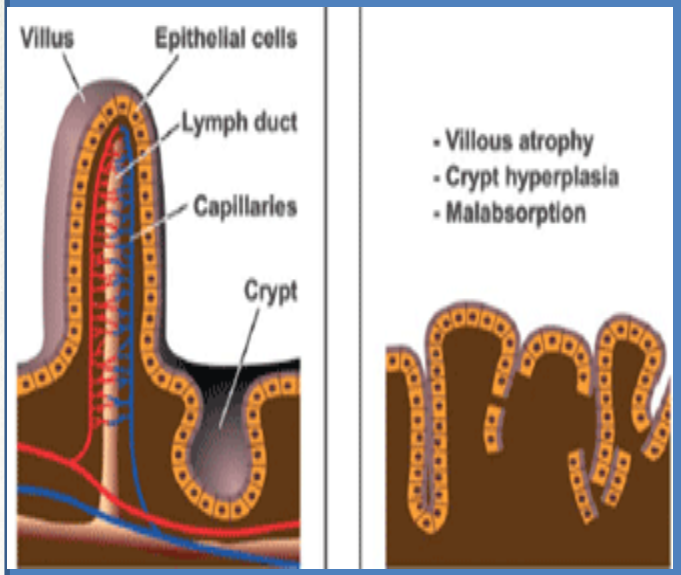
2) Changes in intestinal integrity (possibly in part resulting from immunomodulation) could make hosts more vulnerable to intestinal foreign microbes (Gong et al., 2008)

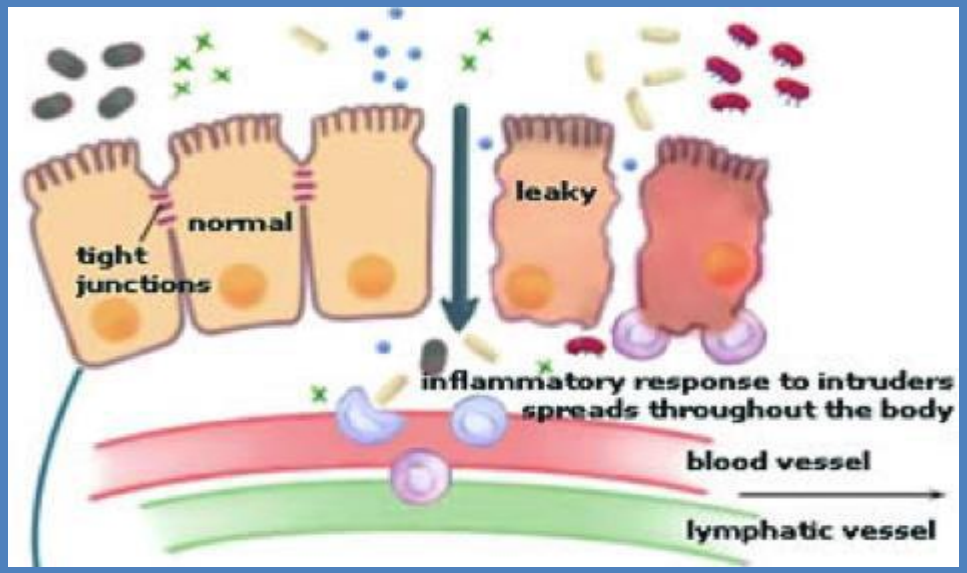
3) Downregulation of genes associated with energy production and fatty acid metabolism (Yarru et al., 2009)
4) Impairment of protein synthesis and the inability to mobilize fat (Kocabas et al., 2003)

5) Changes in hepatic metabolism of vitamins and micronutrients (Schaeffer and Hamilton, 1991).

AF DON FUM

Aflatoxin along with DON and fumonisin, might lead to environmental enteropathy

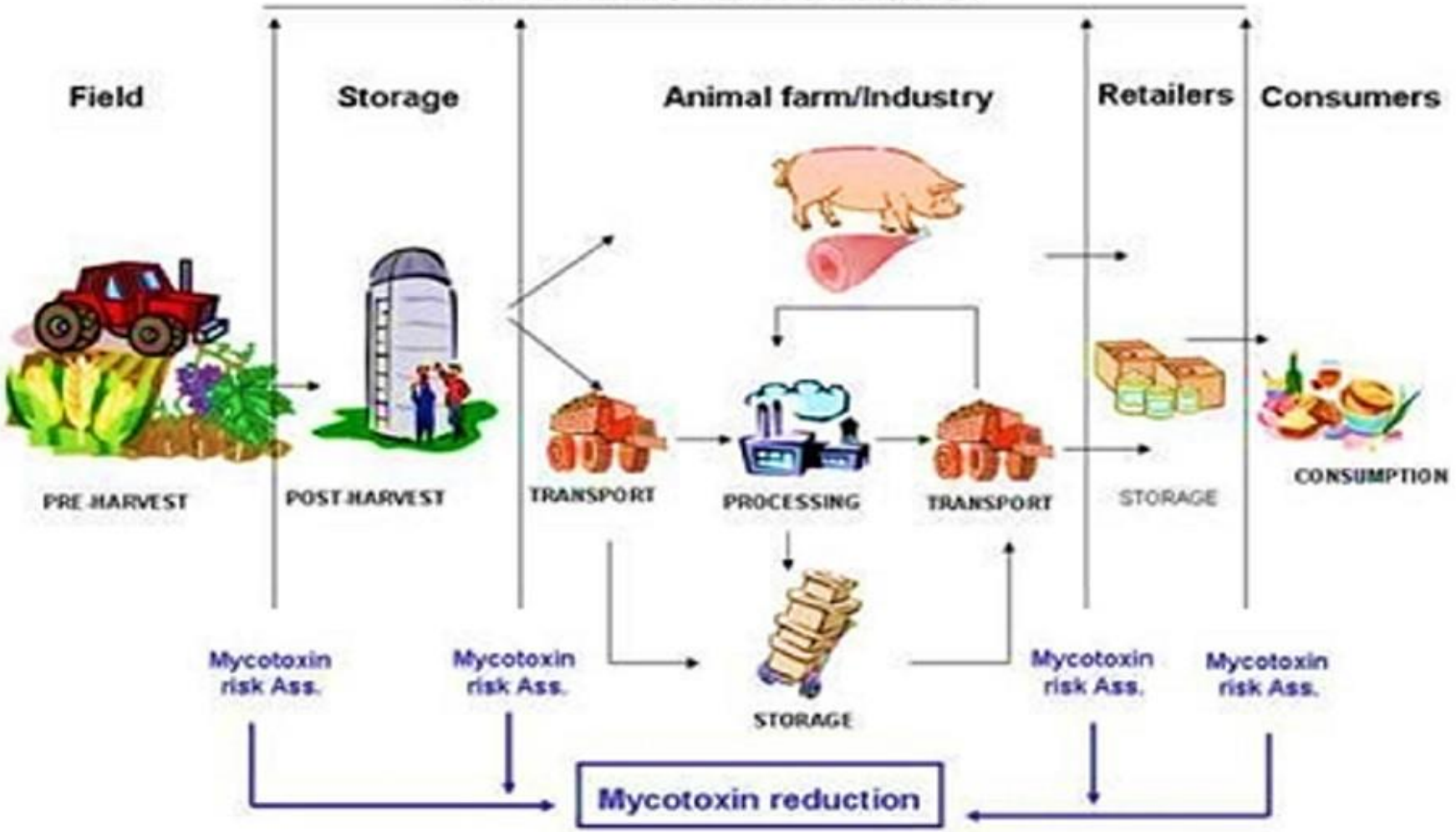




Impaired Growth

Laura E. Smith et al. Adv Nutr 2012;3:526-531

Points of Control of Aflatoxin



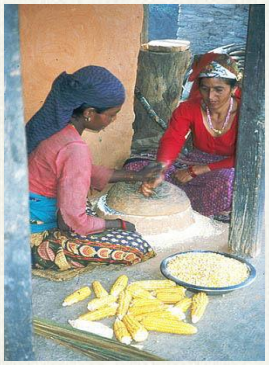
FEED THE FUTURE
The U.S. Government's Global Hunger and Food Security Initiative

Interventions to reduce aflatoxin risk

Reduce Exposure

Preharvest

- Good agricultural practices
- Genetically enhancing plants' resistance
- Biocontrol
- Biotechnology/breeding



Postharvest

- Improved sorting, drying, food storage
- Crops not prone to aflatoxin (e.g. Soybean)

Mitigation

- **Dietary**
  - Improved dietary diversity
  - Dietary enterosorbents
  - Dietary chemoprevention
    - Curcumin
    - Compounds in cruciferous & Allium vegetables
    - Green tea polyphenols

??

- Hepatitis B vaccine:
  - Aflatoxin consumption in HBV+ patients increase risk of Liver cancer

Wu F, Khlangwiset P (2010). "Health economic impacts and cost-effectiveness of aflatoxin reduction strategies in Africa: Case studies in biocontrol and postharvest interventions."*Food Addit. Contam* 27:496-507.

Food additives:

- "Enterosorbents" trap aflatoxins in the gut
- E.g. Calcium montmorillonite clay (marketed as NovaSil)

- Evidence on efficacy:
  - Ghanaian adults given a placebo, either a 1.5- or 3-gram clay capsule; Daily for three months;
  - Net reduction in serum aflatoxin levels of 21% and 24%.

Remaining questions and concerns:

- Effect large enough to reduce negative effects on linear growth?
- To what extent does clay also bind micronutrients and lead to micronutrient deficiencies?

- Important concern for use of both enterosorbents and chemopreventive agents:

  - Should not be interpreted as a substitute for good crop agronomy

  - Should not unintentionally encourage the use of foods not fit for human consumption.

What does this mean?

- Eliminating stunting & malnutrition will require provision of adequate and diverse diets; removing environmental contamination (e.g. Aflatoxin) ; preventing infectious diseases. **Why these?**

- Stunting is strongly related to foodborne **toxins (such as Aflatoxin)**, etc.

Conclusions

- Aflatoxin relation with Stunting? → It is strongly **associated** with it and likely a cause
- What is needed next? → Controlled experimental studies urgently needed.
- Are we doing enough? → NO; This is a Global health and an Agriculture issue that is equally important to both sectors and GH community needs to engage actively to add to the evidence base and find solutions

- Is USAID doing anything to add to the evidence base?

Yes; The next couple of slides shows some examples from Feed the Future

Examples of Feed the Future programs

Key Washington Research Projects

ARP:

- Peanut/Mycotoxin Innovation Lab
- Nutrition Innovation Lab
- NBCRI with USDA/ARS
- Venganza Research Grant
- KSU Post Harvest Innovation Lab
- Purdue Food Processing Innovation Lab

MPI:

- AflaSTOP Post Harvest Storage Structures
- AgResults Nigeria pilot project

Africa Bureau:

- Regional East Africa for Aflasafe

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

Key Field Mission Projects

- EA Regional:

1) Aflatoxin Policy and Program for East African Region (APPEAR)

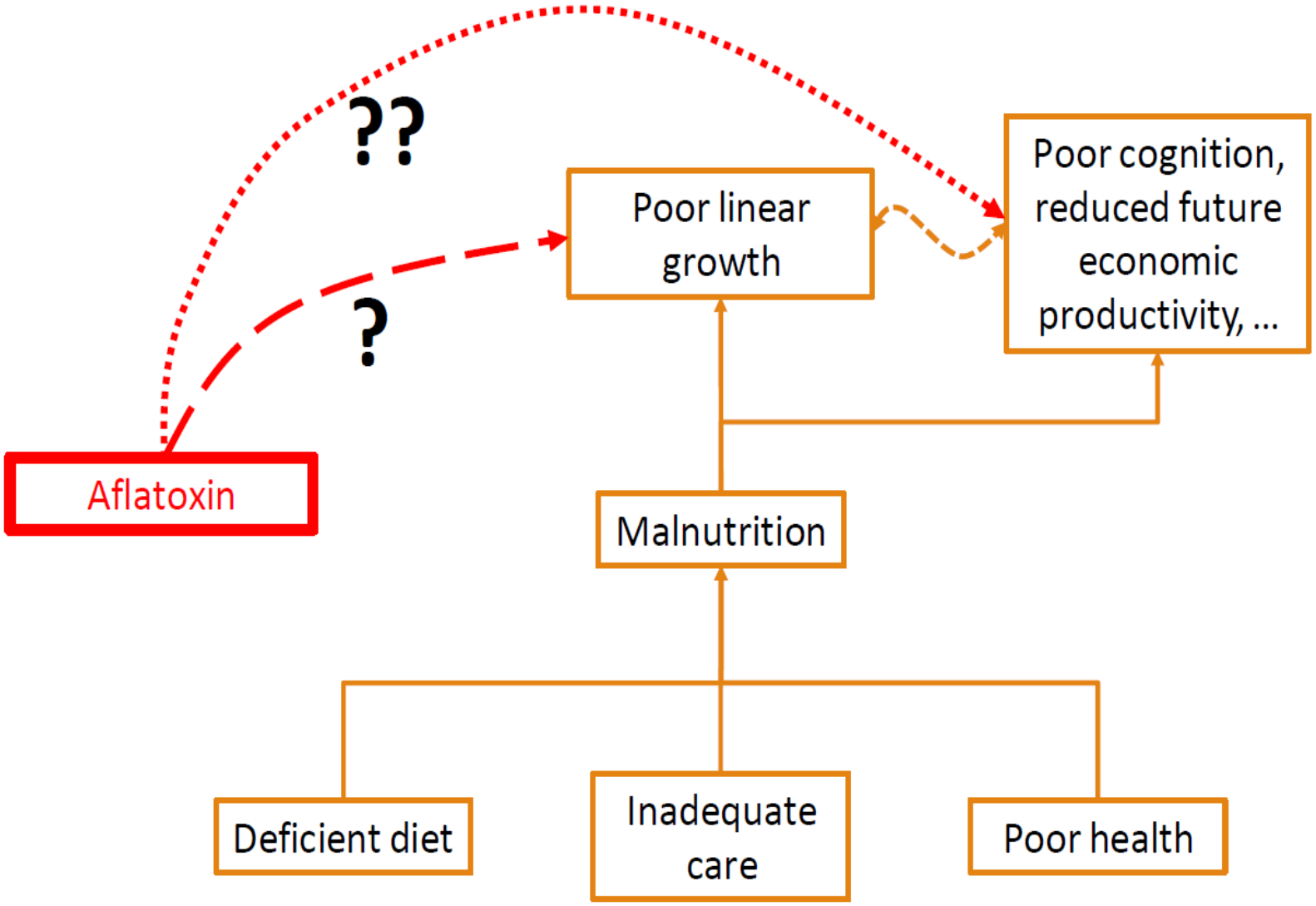
2) Aflasafe Utilization in 11 countries (Kenya, Ghana, Nigeria 1st) with IITA and BMGF;

3) Support for EAC Aflatoxin Policy and Action Plan

- Kenya/Ghana/So. Africa (SPS Capacity Building)
- Zambia (Maize/Groundnuts: Biocontrol)
- Mozambique (Maize/Groundnuts: Biocontrol)
- Rwanda (Maize/Cassava: Biocontrol)
- Malawi (Maize/Groundnuts – Biocontrol)
- Tanzania (Maize – Prevalence/Markets)
- Afghanistan-Mycotoxin Assessment study

- Will Aflatoxin reduction improve the health problems associated with stunting e.g. cognition problems? → We don't know

- Should we wait to take an action for more evidence ? → Absolutely not; we have enough evidence from animal and human studies and we need to take actions urgently.


??
?
Poor linear growth
Poor cognition, reduced future economic productivity, ...
Aflatoxin
Malnutrition
Deficient diet
Inadequate care
Poor health

Leroy J. 2013

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

www.feedthefuture.gov

@feedthefuture

Thank you

Chemopreventive agents:

- Chlorophyllin (a derivate of chlorophyl) and oltipraz (an antischistosomal drug);
- Intervene in the biochemical pathway linking liver cancer to aflatoxin exposure;
- Whether effective in stunting pathway is unknown. Important concern for use of both enterosorbents and chemopreventive agents:

Wu F & Khlangwiset P (2010)