

AFLATOXINS IN NIGERIAN FOODS: AN UPDATE

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Introduction

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- ❖ **Mycotoxins are fungal secondary metabolites produced on crops under favourable conditions in farm, transit or store . The crops can be raw or processed**
- ❖ **Aflatoxins(*Aspergillus*), Ochratoxin-OTA(*Aspergillus westerdijkiae*), Patulin(*Aspergillus and Penicillium*) and DON, ZEA , Fumonisin(*Fusarium*)**
- ❖ ***Regulated and non regulated***
- ❖ **Based on their effect---carcinogenic(Afl,OTA, Fum,) neurotoxic(Fum)nephrotoxic(OTA), dermatotoxic(Tricho eg DON), Immunosuppressive(Afl,OTA, DON)
Embryotoxic, teratogenic(Afl,ZEA)**

Aflatoxins

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- ❖ Aflatoxins are a group of secondary metabolites produced by some species of fungal genus *Aspergillus*, in farm, during transit or in store. There are many species but the most studied are
- ❖ *Aspergillus flavus* , *A. parasiticus* (differentiation possible through PCR)
- ❖ *Aspergillus flavus* regularly produces B while
- ❖ *Aspergillus parasiticus* readily produces B and G
- ❖ M1 and M2===derivatives of B1 and B2 in the milk.
- ❖ $B1 > G2 > G1 > B2$ (dietary aflatoxins) in decreasing order of toxicity



Targets of Contamination

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TARGETS OF CONTAMINATION

- ❖ Include cassava, maize, millet, groundnut, rice, sorghum, melon, wheat, soybean, beans milk and a variety of spices and vended foods intended for human consumption(Kayode *et al* 2013,Rubert *et al* 2013).
- ❖ 25% world food supply affected (FAO 2000)



History in Nigeria

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- ❖ In 1961, scientists in Nigerian Stored Products Research Institute and Institute of Agricultural Research(IAR), Zaria with the assistance of the Tropical Products Research Institute, London established that groundnuts in the North were susceptible to aflatoxin contamination(McDonald and Harkness,1963; 1964).
- ❖ Institutes CRIN and NCRI as well as export oriented institutions e. g NEPC, NAQS, and Abuja Security and Commodities Exchange Commission got involved.
- ❖ Researchers in Nigerian Universities are interested in detection and management
- ❖ The mandate of the SON and NAFDAC also include aflatoxin regulations and monitoring in food items

Risk Factors

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- ❖ **Moisture content above 15% for maize and other cereals; above 8% for groundnut**
- ❖ **Poor rains , flooding**
- ❖ **Temperature higher than 25° C**
- ❖ **High level of broken grains**
- ❖ **Length of time stored**
- ❖ **Damage by insects and mites**
- ❖ **Degree of invasion before purchase**
- ❖ **Inadequate harvesting, drying and storage practices**

Risk Factors

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In the livestock industry, risk factors include:

- ❖ **susceptible crops,**
- ❖ **physical damage,**
- ❖ **temperature and humidity regime,**
contamination of mixers and conveyors,
- ❖ **unhygienic post pelleting environment.**

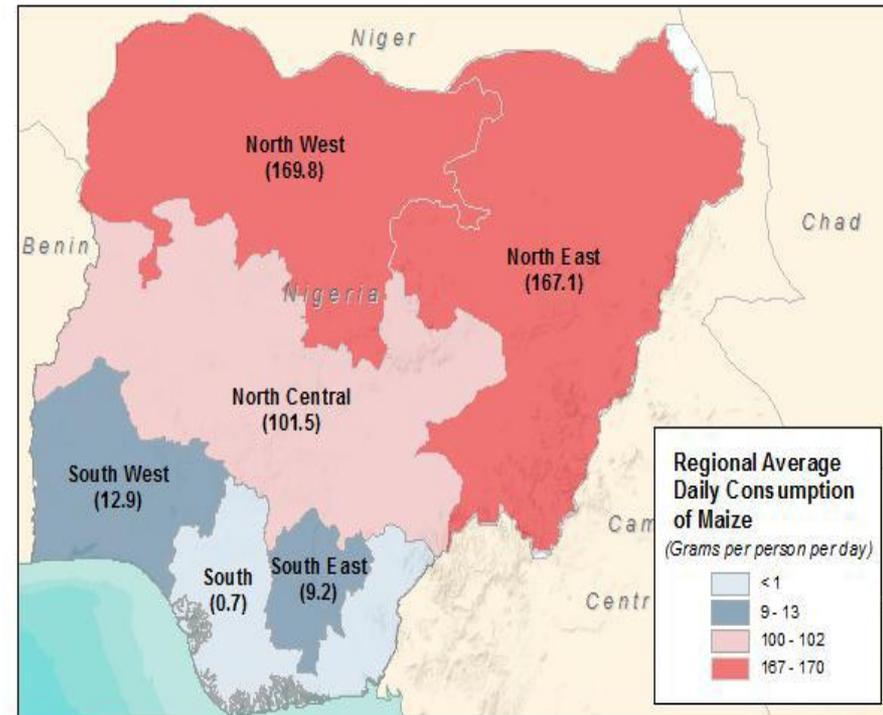
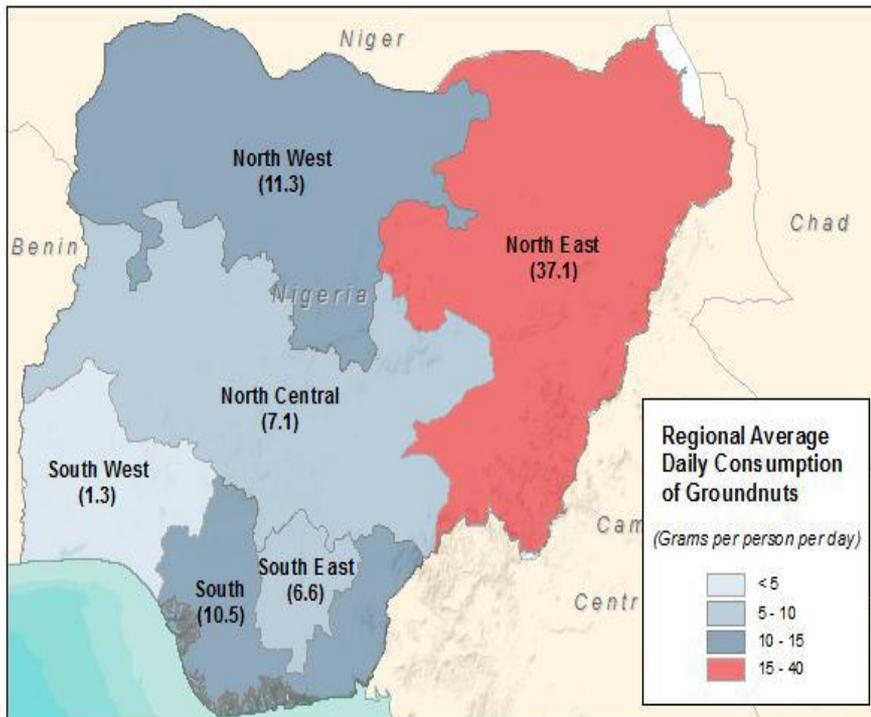
Geographical Distribution

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- ❖ **Although common between 40°N and 40°S of the equator international trade has made it a global threat.**
- ❖ **Conditions are now very favourable for the growth of *Aspergillus* in southern areas of the European mainland due to climate change. This means that “Europe will have more homemade aflatoxin cases in its crops in the future.” Krska,2013**

Daily Consumption of crops

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Source- Meridian/Abt assoc Countrywide Assessment Report 2013

Detection

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- ❖ They are quantitated in parts per million (ppm=mg/kg or 1 minute in 2 years)
- ❖ and parts per billion (ppb=microgram/kg or 1 second in 2 years!!) and detected using
- ❖ -UV light at 365 nm
- ❖ -TLC, RidaScan, HPTLC, ELISA, LC-MS/MS and HPLC, laser sorter (Detox, Toxyn)



Source-www.bestsorting.com



Regulations

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- ❖ **For most Nigerian food items**
- ❖ **Codex standards until recently. As at 2013, EU standards adopted eg 4ppb for total aflatoxins; 2 ppb Afb1 = This is done since most Nigerian export products go to EU**
- ❖ **South Africa 10ppb(total) 5ppb(Afb1)**
- ❖ **New Zealand 15ppb**

EU Standards

Foodstuffs		Maximum Levels (μ/kg)	
No.	Aflatoxins	B1	Sum of B1, B2, G1 and G2
1.	Groundnuts to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	8.0	15.0
2	Nuts to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	5.0	10.0
3	Groundnuts and nuts and processed products thereof, intended for direct human consumption or use as an ingredient in foodstuffs	2.0	4.0
4	Dried fruit and processed products thereof, intended for direct human consumption or use as an ingredient in foodstuffs	2.0	4.0
5	Maize to be subjected to sorting or other physical treatment before human consumption or use as an ingredient in foodstuffs	5.0	10.0
6	Following species of spices: Capsicum spp. (dried fruits including ginger, chillies,) Piper spp. (fruits thereof, including white and black pepper)	5.0	10.0

The Health Impacts

- ❖ **Dvorachova et al (1972), Slovakia, reported finding aflatoxin B. in liver specimens of two infants, who died with liver damage and encephalopathy**
- ❖ **Rosenberg (1972) , Germany, described the case of a 45-yearold man had eaten mouldy nuts, developed yellow atrophy of the liver, later died.**
- ❖ **In October 1974, some Indians ate the contaminated grain , had liver injury (Krishnamachari, et al, 1975). One hundred and six of 397 patients died**
- ❖ **Reye's syndrome and aflatoxin exposure. Chaves-Carballo et al., (1976)**

Health Impacts contd.

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- ❖ **4.5 billion people in developing countries chronically exposed(WHO,2004).**
- ❖ **Posthumous autopsy of children suffering from kwarshiokor revealed a significant level of aflatoxin in their brains, --due to consumption of contaminated maize –based gruel fed infants in Nigeria (Oyelami *et al* 1996)**



Health impacts contd.

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- ❖ **Child stunting, child mortality, immune suppression and child neurological impairment .**
- ❖ **The IARC in 1987 officially placed aflatoxin B1 on the list of Group 1 carcinogens(definitely carcinogenic to humans). Additional data analysed in 2002 further confirmed the categorization(Schmidt 2012)**
- ❖ **Globocan 2008, the IARC), liver cancer in sub-Saharan Africa accounted for 43,345 deaths, which is about 10.3% of the total mortality attributable to cancer. *Not a few of this may be traceable to aflatoxin consumption***
- ❖ **DALY=(Disability Adjusted Life Years) burden of aflatoxin-induced disease high among poor people.**

Monetized Health impacts of aflatoxin in Nigeria

REGION	MAIZE (consumption in g/day)	GROUNDNUT (consumption in g/day)	POPULATION IN 2010 (in thousands)	HCC CASES (cancers/ year)	DALY	VSL (in millions)
North Central	102	7	25,571	3,698	48,161	\$1,513
North East	167	37	21,066	3,075	39,987	\$1,258
North West	170	11	39,854	221	2,864	\$90
South East	9	7	18,235	258	3,375	\$105
South South	1	11	23,352	163	2,115	\$67
South West	13	1	30,763	346	4,462	\$142
National	84	12	155,842	7,761	100,965	\$3,174

Adapted from Meridian/Abt assoc CAR 2013

SOF
ARCN- NIFST 2013

Health Impacts contd

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- ❖ **About 37% of infertile men in Nigeria had high aflatoxin levels in their blood and semen far above the permissible limits(Uriah *et al* 2001)**
- ❖ **High levels detected in sera (Denning *et al*,1988)and urine (Bean *et al*, 1989)of Nigerian men**
- ❖ **Sperm abnormalities expressed in albino rats**
- ❖ **There is now a link between viral load and aflatoxin exposure in HIV positive cases(Jolly *et al* 2013)**

Economic Impacts

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- ❖ **DALY=YLL(Years lost while living with aflatoxin)+YLD(years lost due to premature death). Formula designed by Harvard for World bank in 1990 , adopted by WHO 1996). An epidemiological term**
- ❖ **VSL=Value of Statistical Life (An estimated attempt to put monetary value to human life)**
- ❖ **North East and North Central are flashpoints according to CAR**

Economic impacts

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For livestock, there is reduced sale arising from compromised weight and productivity

- ❖ **Reduced feed intake, nervousness, abortions, kidney and liver damage, high mortality and increased**
- ❖ **carcass condemnation**
- ❖ **Reduced export value to producers from the developing countries.**



The UN in 1999, likened the consumption of aflatoxin-contaminated food to malnutrition which in itself is an index of poverty

Economic impacts contd.

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- ❖ **A 2005 World Bank study revealed that the European Union regulations on aflatoxins cost Africa 750 million dollars each year in export of cereals, dried fruits and nuts through reduced export value, rejects and trade bans.**
- ❖ **EU has put in place the “RASFF” and harsh measures to punish repeat offenders**
- ❖ **Melon (59), ogbono (13), and durum beans (9), collectively accounted for 81 of 102 EU trade alerts issued on Nigerian crop exports over the previous 5 years (EU, 2012)**

CONTACT/SOURCES/EXPORTERS OF MELON SEEDS REJECTED IN EU COUNTRIES

S/N	CONTACT	PRODUCT	CONTAMINANTS	COUNTRY
1.	████████████████████ Onitiri Street, Surulere, Lagos	Melon Seeds	Aflatoxins	Spain
2.	████████████████████ Road, Ikeja, Lagos	Melon Seeds	Aflatoxins	Italy
3.	████████████████████,Of Upper Erhumunse, Benin	Melon Seeds	Faecal Coliforms	Italy
4.	████████████████████ Badewa Street, Ikorodu, Lagos	Melon Seeds	Aflatoxins	United Kingdom
5.	████████████████████ ██████████, Gemade Est, By Gowon Est, Ipaja	Melon Seeds	Insects	United Kingdom
6.	████████████████████ ████████████████████ Est, By Gowon Est, Ipaja	Melon Seeds	Aflatoxins	United Kingdom
7.	████████████████████ Way, Ajao Estate, Lagos	Ground Melon Seeds	Aflatoxins	United Kingdom
8.	████████████████████ ██████████ Complex, NAHCO Nigeria	Melon Seeds	Aflatoxins	United Kingdom

Intervention strategies

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- ❖ **Physical separation,**
- ❖ **Microbial inactivation and fermentation**
- ❖ **Chemical methods like ammoniation,**
- ❖ **Inactivation of toxicity by dietary binders**
- ❖ **Herbs**
- ❖ **Resistance breeding,**
- ❖ **Regulatory control,**
- ❖ **Good agricultural , processing and manufacturing practices(GAP, GPP and GMP)**

Summary of GAPs and GMPs for aflatoxin control (Codex, 2002)

STAGE	COMMODITY	HAZARD	CONTROL MEASURE
Preharvest	Cereal grains, oil seeds, nuts	Mold infestation with subsequent aflatoxin formation	<ul style="list-style-type: none"> Use resistant crop varieties - Use native beneficials - Insect control - Adequate irrigation - Proper agronomic practices
Harvesting	Cereal grains, oil seeds, nuts	Increase in aflatoxin formation	<ul style="list-style-type: none"> -Harvest at appropriate time - Rapidly dry to safe moisture level
Postharvest storage	Cereal grains, oil seeds, nuts	Increase and/or occurrence of mycotoxin	<ul style="list-style-type: none"> -Protect stored product from moisture, insects -Store product on dry, clean surface.
Postharvest, processing and manufacturing	Cereal grains, oil seeds, nuts	Aflatoxin carryover or contamination	<ul style="list-style-type: none"> -Test all ingredients added -monitor processing/manufacturing -Follow good manufacturing practices
Animal feeding	Dairy, meat and poultry products	Transfer of mycotoxin to livestock products	<ul style="list-style-type: none"> -Use good quality feed ingredients -Test products for aflatoxin

Intervention strategies contd

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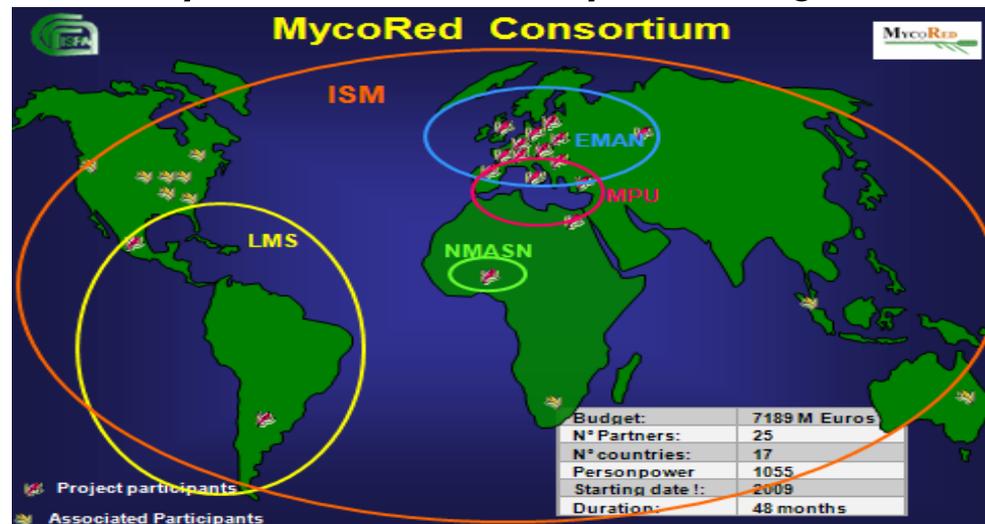
- ❖ **Proper harvesting and drying of grain (NSPRI drier)**

- ❖ Awareness campaigns e.g. Mycotoxson activities

- ❖ **EU initiative = Mycohunt** for DON Europe

 = **MycoRed-Global** integrated approach.

implemented, by International Society for Mycotoxicology ISM, with Nigeria (MSN) as the only African country having an active national body.



Intervention strategies contd

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- ❖ **Bill and Melinda Gates initiative (\$19.6-million) to make Africa “aflatoxin-safe” using both proven and innovative strategies**
- ❖ **Country-wide assessment Nigeria and Tanzania**
- ❖ **The Africa Union- Partnership for the Control of Aflatoxin in Africa (AU-PACA) draws the road map for the management of aflatoxin**

Intervention strategies contd.

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- ❖ **Biocontrol= ‘ *fungus-fight*’ where the predating atoxigenic strain is made to crowd the toxigenic one out of existence. A combined effort at IITA Ibadan has led to the development of a biopesticide, *Aflasafe* which has been field-tried on maize with some success. (Atehnkeng *et al.*, 2008)**

Proposals on interventions

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1. *Based on holistic approach*

- ❖ **A=Enlightenment/Awareness Campaign** (in local languages through jingles, posters, handbills, regular meetings with farmer, exporters and commodity traders.
To be facilitated by **government** and **food and feed -safety activists** e.g. Mycotoxson, African Mycotoxin Network., Safe Food and Feed Foundation
- ❖ **B=Regulations and standards**, including monitoring compliance (assistance to farmers; extension service).
To be facilitated by **government**.
- ❖ **C=Capacity building**. (Involving globally validated procedures for detection/analysis, user-friendly management techniques)
To be facilitated by **Government; international bodies e.g. EU, FDA; food and feed safety activists**.

Proposals on Interventions

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- ❖ **D=Good Practices.** (Involving Agricultural , Manufacturing, Cultural) must be user friendly
To be facilitated by **government** and **food and feed safety activists, farmers, feedmillers, exporters.**
- 2. ***Based on time of intervention= preharvest, postharvest, dietary and clinical(HBV vaccine)***
- ❖ **No ‘one-bullet option’ as solution .All these are inter-related and complementary**
- ❖ **MYCOTOXIN POLICY will address the menace**

Challenges of management

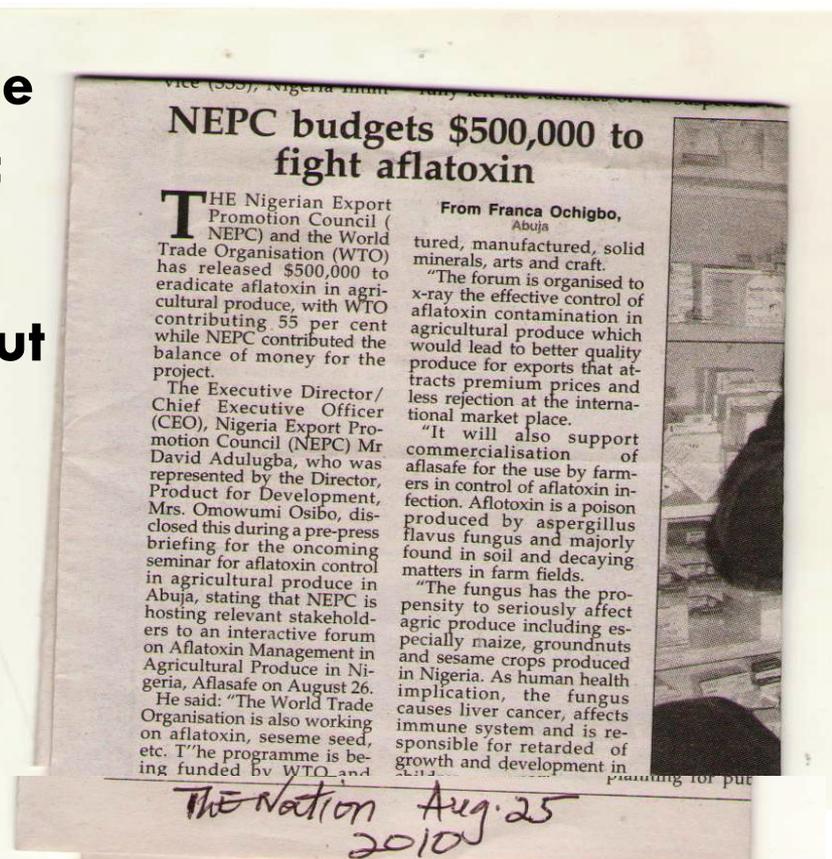
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- ❖ **There has been an incoherent response to mycotoxin control**
- ❖ **Aflatoxins (and other mycotoxins) have not been appropriately prioritised in Nigeria**
- ❖ **Technical agencies and policy-makers seem not to be communicating**
- ❖ **There is no conscious information flow on public health impacts, on market effects, on social and political implications, particularly from the government**
- ❖ **Insincere decisions on how best to invest in food safety**
- ❖ **No honest approach to the problem of food shortage**
- ❖ **Lack of awareness**

Conclusions

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- ❖ **Aflatoxins exist in Nigeria due the favourable climatic and economic challenges**
- ❖ **Most Nigerians do not know about the health hazards of aflatoxins therefore are exposed to contamination regularly.**
- ❖ **Conscious effort by government lacking, until recently.**



Conclusions contd.

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- ❖ **Since it has a global effect, international collaboration is very necessary**
- ❖ **An integrated ‘cocktail’ approach involving cultural practices, GAP, GPP, GMP, and biological control hold a promise for the management.**
- ❖ **Multisectoral participation**
- ❖ ***NIFST should get more involved in who is appointed Minister in charge of FOOD(like NMA, NBA in Health and Judiciary). Remember, ‘Bell is not a bell until you ring it; A song is not a song until you sing it’***

Some useful websites

- ❖ www.ngmycotoxin.org
- ❖ www.sfoodfeedf.org
- ❖ www.knowmycotoxins.com
- ❖ www.mycotoxins.org
- ❖ www.iarc.fr
- ❖ www.fda.gov
- ❖ www.codexalimentarius.net
- ❖ www.mycored.eu

Pictures' websites

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- ❖ **www.21food.com**
- ❖ **www.thumbs.dreamstime.com**
- ❖ **www.danielstrading.com**
- ❖ **<http://brisbanelocalfood.ning.com/forum/topics/raw-peanuts>**
- ❖ **www.agricultured.org**
- ❖ **<http://bio.illinoisstate.edu>**

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THANK YOU

