

Establishing a Sudanese Aflatoxin Research and Control Network (SAfNet)

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Outlines

- Introduction : what are aflatoxins?
- Risks of aflatoxins & difficulties to manage
- Favourable conditions for aflatoxin formation
- Groundnuts & sesame cultivation in Sudan
- Studies on aflatoxins in Sudan:
- What is the plan of Sudanese National Academy of Sciences (SNAS)?
 - a: Sudanese Aflatoxin Think-Tank
 - b: Sudanese Aflatoxin Network (SAfNet)
 - c: An active database (portal) system,
 - d: Intensive and continuous educational programs
 - e: The primary objectives of the multi-disciplinary network

Introduction

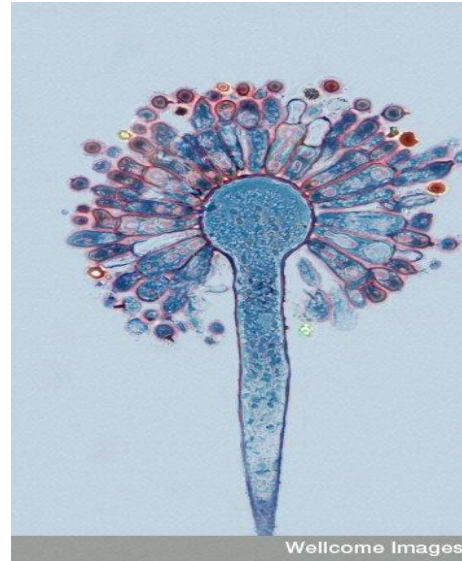
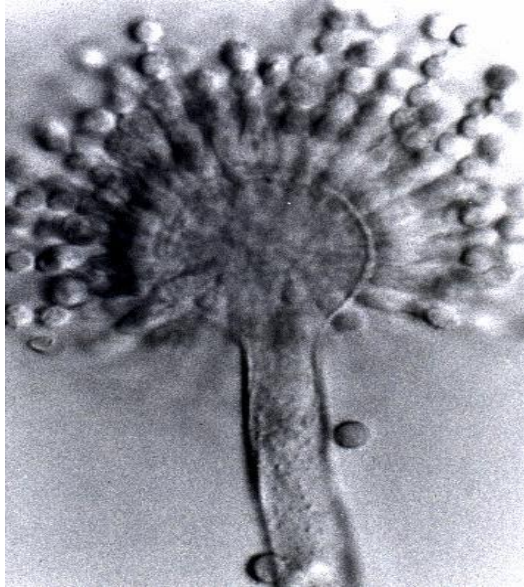
- Aflatoxins are produced by fungi of *Aspergillus spp.* in humid & warm conditions in the environment which survive in the soil, on plants, fruits & stored seeds.
- They have severe toxic effects on humans & animals, & can cause liver cancer in humans.
- Groundnuts, sesame & many other agricultural food products are widely affected by these contaminant moulds.
- Contamination of agricultural products with toxins is causing economic loss to farmers and merchants, & ultimately national loss through export reduction & rejection.
- Difficulties in marketing of agro-food products for Sudan, both locally & for export, is due to quality control standards specified for the local & importing markets

- Tackling the aflatoxin problem is mainly an awareness issue that should involve farmers, livestock dealers, merchants, consumers and the many stakeholders in the supply chain of agricultural food productions.
- There is need for enhanced surveillance & testing of commercially sold food products.
- There is also need to intensify links between research institutions, the Sudanese private small- and large- scale sector businesses, consumers and farmers in the society at large.

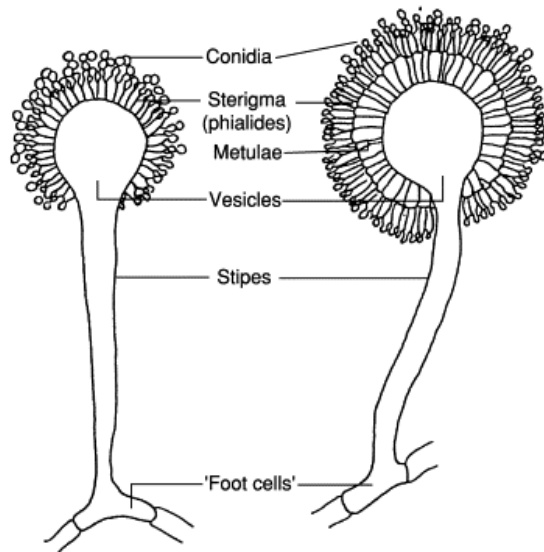
What are Aflatoxins:

- Aflatoxins are a family of toxins produced by certain fungi which grow on agricultural crops e.g. maize (corn), peanuts, cotton-seed & other vegetables.
- *Aspergillus flavus* & *A. parasiticus* are the main fungi that produce aflatoxins as secondary metabolites toxic to humans & animals, & are abundant in warm & humid regions of the world.
- *Aspergillus* species are filamentous fungi that are commonly found in soil, seeds & grains, & feed on decaying vegetation.

Fungus & spores:



Conidial head, 1000x light microscopy, stained with lacto-phenol cotton blue.



Macroscopic colony appearance

<https://www.aspergillus.org.uk>

Aspergillus spp.

- Fungus spores are present in the air we breathe; but do not cause illness in normal people.
- In people with a weak immune system, damaged lungs or with allergies, *Aspergillus* can cause disease.
- Common *Aspergillus* infections include invasive aspergillosis of sinuses.

Diseases due to Aspergillus:

- Types of diseases are varied, ranging from an allergy-type illness to life-threatening generalized infections.
- Severity of disease is determined by many factors: the most important is the immune system of the person.
- Infection of the nasal passages.
- Allergic bronchopulmonary aspergillosis (ABPA) and "fungal asthma" (SAFS)
- Aspergilloma & chronic pulmonary aspergillosis.
- Invasive aspergillosis with low immunity e.g. HIV
- Others...

<http://www.LIFE-Worldwide.org>

Toxicity of Aflatoxin in humans:

- Chronic intake can cause cancer in liver & other organs.
- Intake of large doses cause acute poisoning (aflatoxicosis)
(e.g. 1 mg/kg for 1-3 wks.)
- Can cause birth defects in children.
- Can cause immune suppression (reducing resistance to diseases & affects vaccination).
- Affect DNA of bacteria (mutagenic)
- With other factors (e.g. diseases & malnutrition) can cause stunting in children

In animals:

- In poultry:

Liver damage, less egg production, increased susceptibility to diseases.

- In cattle:

Reduced weight, damage liver & kidneys, lower milk yield, increased susceptibility to diseases

Conditions for *Aspergillus* fungi to form aflatoxin

- Air/oxygen
- Moisture content between 18-20%,
- Water activity $> 0.82^*$ (a measure for water used by microorganisms)
- pH 3.0-8.5.
- Ambient temperature 12 - 40°C (optimum 25-30°C)
- Nutrition factors (e.g. carbohydrate, nitrogen sources, phosphates, zinc, & other trace metals) can also affect the production of aflatoxins.

Detecting aflatoxicosis in humans & animals:

- Difficult: different clinical signs & other factors (effect on immune system by other infections)
- Two techniques are used in humans:
 - a - Measures a breakdown product in urine (only present for 24hrs after exposure),
 - b - Measures the level of an AFB-albumin compound in blood serum, for exposure over wks.)

These biomarker measurements are important in outbreaks where aflatoxin contamination is suspected.

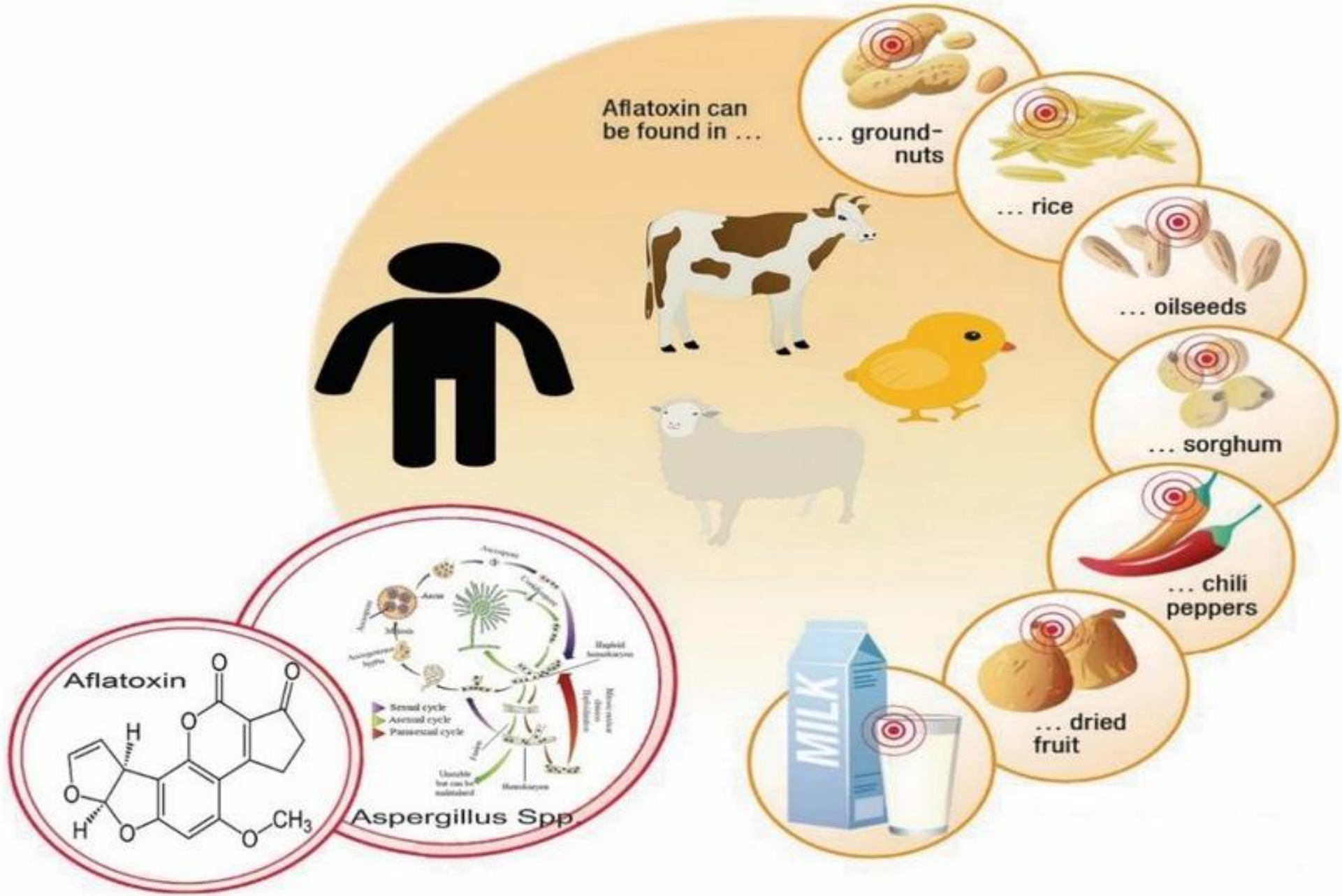
Detecting aflatoxins in food & feed:

Many studies to develop very specific & practical techniques as needed:

- **Methods for regulatory testing in labs e.g.**
HPLC-MS [high-performance liquid chromatography-mass spectrometry]
- **Rapid test kits for factories & grain storage e.g.**
ELISA [enzyme-linked immunosorbent assay]
- **New tests e.g.**
Dip-stick kits, hyper-spectral imaging, electronic noses, molecularly imprinted polymers, biosensors (small organic molecules that can bind to specific target molecules).

Tests have to be simple, stable & easy to use in remote areas

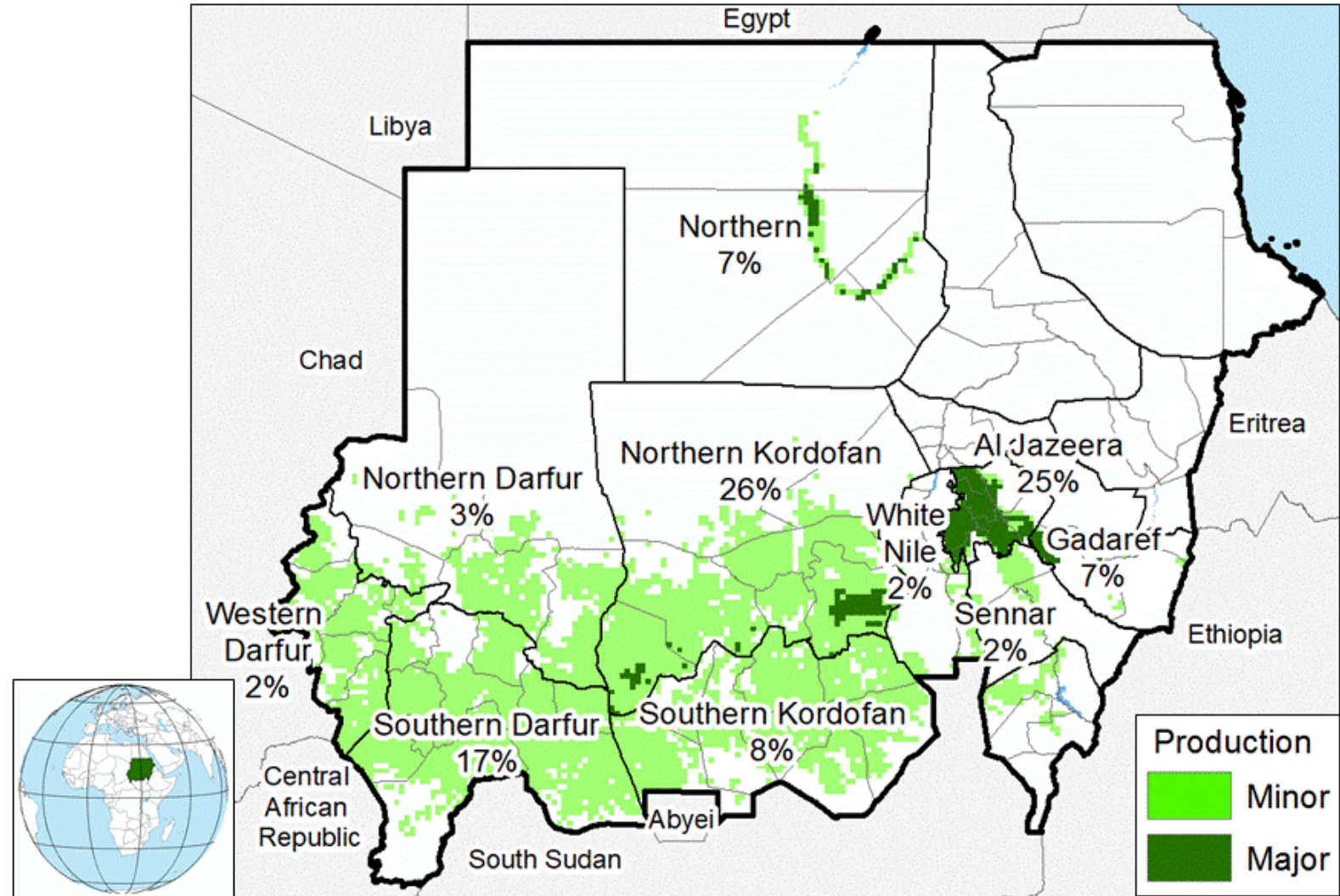
Life Cycle



Peanuts: الفول السوداني

- Sudan yields 14% of the world's total peanut production as one of the top five producers
- Cultivated land is about 35% of total cash crop area.
- Two varieties are grown:
 - a- Western Sudan, about 70% of country production (sand soil) higher content of protein & oil
 - b- Gezira & Eastern States (black soil)
- Peanuts are nutritious, widely eaten, for edible oils industry, as animal feed, & exported

Sudan Peanut Production



Foreign Agricultural Service (FAS)
Office of Global Analysis (OGA)
International Production
Assessment Division (IPAD)

Data Source: Production data from Spatial Production Allocation Model (SPAM) 2005 v3.1, IFPRI, <http://mapspam.info/>.
Percentage values indicate percent production of total production.

Sesame: السمسم

- Sudan is 4th largest world producer. It is a major cash crop. 10% of the world production.
- Grown in Darfur, Kordofan, Kassala, White & Blue Nile states.
- Classified into 2 types of farming:
 - a- Semi-mechanized rain-fed (large farming companies funded by government & banks, 62% of the country production)
 - b- Traditional rain-fed (family households farming for income & subsistence, 38% of country production)
- Depending on rain-fed cultivation, production/year varies (climate change effects)
- Valued for its oil, as a food (raw or roasted), in bakery products & other foods.

Sesame Cultivation in Sudan (mahgoubsons.com)

1-Darfur, 2- Kordofan, 3- Gedarif,
4- White Nile, 5- Sinnar, 6- Blue Nile.



Studies on aflatoxins in Sudan

- Aflatoxins were discovered in the late 1950s/early 1960s,
- Found as causative agents of "turkey X" disease, (an epidemic in England caused deaths of turkeys fed diets containing peanut meals from South America).
- Publications in Sudan date back to 1970s, with extensive research mainly reporting contamination in agricultural products and food items (peanut).
- Progress in reducing risks of affected foods is not seriously realized till present.
- Most studies lacked holistic coordinated plans to involve all the stakeholders affected

Some factors for Aflatoxin spread:

- Traditional agricultural practices by small farmers.
- Poor storage by farmers and traders.
- Low standards of food preparation.
- Large scale agricultural producers, processing businesses & exporters separately seek to solve their immediate problems instead of a joint plan to control contamination.
- Collaboration between the stakeholders; researchers; industry and communities need strengthening to develop a holistic plan for safe food security in the country.

What is the plan of SNAS?

- SNAS will coordinate the stakeholders to form the 'Sudanese Network for Research and Control of Aflatoxin' (SAfNet).
- SAfNet will advise in upgrading of agricultural production practices, transport, storage, processing, sales and safe consumption.
- Identify priorities for research & facilitate local & international links with academic institutions & funding agencies.
- Coordinate between stakeholders to develop a feasible work-plan to reduce Aflatoxin contamination.

a: Sudanese Aflatoxin Think-Tank:

- A network of experts representing the different stakeholders & researchers to assess the current situation will be established
- Plan for a holistic approach leading to reduction of *Aspergillus*/ Aflatoxin contamination.
- Multidisciplinary thinking will motivate a better understanding of the extent of the problem; identify knowledge gaps & mismanagement in the process of supply chains & identify the urgent actions to be taken.
- Inspire innovative research ideas; introduce rapid affordable detection techniques; stimulate creative thinking of researchers and coordinate for sharing of facilities & material that are not accessible when working separately
- Draw a road map for activities leading to control of aflatoxins in agricultural products and raise awareness of the population using various media communication tools

b: Sudanese Aflatoxin Network (SAfNet):

- Collaboration among stakeholders will facilitate implementation of a dynamic quality control system along products supply & value chains for early detection contaminations rather than at end-point food quality analysis before export, industrial processing or consumption
- Collaboration will also assist in strengthening of the public-private dialogue and encourage partnerships to secure provision of safe foods to the people.

c- An active database (portal) system

- Accessible to all groups, containing pertinent information and activities to link the different stakeholders.
- Support innovative research in academic institutions to encourage young researchers' involvement in data collection and developing new techniques for detection of fungi and toxins

d- Intensive and continuous educational programs

- Raise awareness among the different population sectors.
- Local markets traders and consumers, children and families will be vital targets for education.
- Use of different media to reach communities in remote areas
- Review & issue stringent laws controlling local sales & export of aflatoxin contaminated products by '*Sudanese Standards & Metrology Organization (SSMO)*'.

The working group will address these issues:

- Good agricultural practices to minimize soil contamination.
- Good harvest & storage practices especially among small farmer groups.
- Good processing practices at all levels.
- Safe products for humans' and animals' consumption.
- Research to develop & implement innovative tools for monitoring, detection & quantification of Aflatoxin levels in agricultural products at different phases of manufacture & consumption processes.
- Develop cost-effective techniques for cleaning & safe disposal or uses of contaminated batches of products.

- Strengthen and activate regulatory measures to restrict the use of Aflatoxin infested seeds & products material for food, feed & selling.
- Awareness raising of people at all levels to the high risk of consuming aflatoxin contaminated foods.
- Stimulate research on human and animal health related to Aflatoxin poisoning.
- Identify non-aflatoxin producing local varieties of *Aspergillus* spp. to compete with the toxin producers (Aflasafe) { started by private businesses).
- Search for other biological agents that can eliminate *Aspergillus* spp. and neutralize or remove aflatoxins.



Sudan - The Land and the People

El Obeid has a modern factory to crush oil from sesame (the family business dates to 1926) and since then one camel after another has ground a bag of sesame a day, producing oil for sale in the neighborhood and at the market. The sesame cake waste makes good fodder.

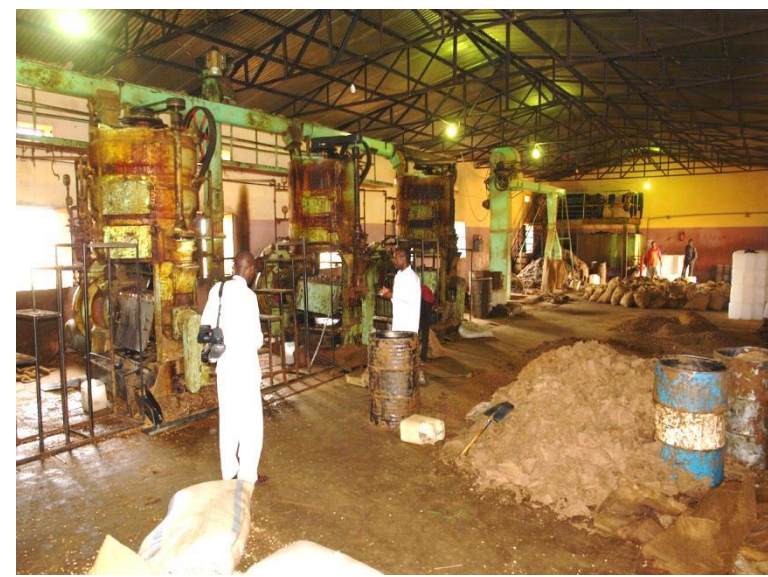
(Photo by:
Michael Freeman/Corbis
via Getty Images)

Which to buy ????



Traditional oil production industry (Khartoum peripheries)

(Dr. N. Shulgami, Consumers protection Society, Sudan)



Peanut butter production (Khartoum peripheries)



Local market in Doka, Gedarif State





Peanuts is our favorite snack & salad dish



A few ideas for studies

- Effects of aflatoxins & aspergillosis on liver diseases
- Burden of aflatoxins on communities & different age groups., especially children
- How can we diagnose in humans ?
- Detection in foods i.e. peanuts/dakwa eaten by all Sudanese, animal feed & in poultry, milk & meat etc...
- Amount of aflatoxin we ingest with our meals i.e. consumption in different groups & areas
- Awareness raising to include all the stages from pre-plantation
- What shall we do with contaminated products? i.e. use in industry not harmful to humans & animals

- Improvement of oil & food industries : small scale & large scale
- Improvement of exports
- Soil & agricultural studies for detection, cleaning & prevention of contamination
- Improve packaging & storage of products.
- Restrictions on moving infected soil & products to other areas.

Thank You