AFLATOXIN: QUALITY INSTITUTIONS IN THE GROUNDNUT VALUE CHAIN IN GHANA

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Introduction

- Peanuts are commonly contaminated by aflatoxin in many areas of Africa
- Users are seldom aware of the contamination extent
- Peanuts are an important source of plant protein

The importance of aflatoxin contamination is measured by its effects on people - it:

- stunts growth in children
- suppresses the immune system,
- leads to carcinoma, and
- in large doses results in acute aflatoxicosis causing death.

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Introduction - cont.

Peanut economic importance in Ghana:

- farmers produced 495,000 metric tonnes (MT) of groundnuts on 346,900 ha in 2009;
- the production may have tripled between 1995 and 2005;
- in the two regions, Northern and Upper East, about a fifth of farmers name groundnut as one of the two most important crops.

Objective

We examine farmer practices in the primary peanut growing area in Ghana, the Northern Region in the context of recommended management or cultural practices for the pre-harvest aflatoxin reduction in peanuts using the survey data collected in 2010.

We draw a comprehensive pre- and postharvest aflatoxin reduction plan and propose a sequence of implementing various elements to maintain coherence necessary for the comprehensive program to be effective, yet possible to implement by farmers.

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Area of the Ghana Farm Household Survey

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Aflatoxin

- **Aflatoxin is a metabolite of the fungi from *Aspergillus flavus* and *Aspergillus parasiticus*; indigenous to soils in Ghana and soil is the primary source of the inoculums;**

- **spores are present virtually everywhere because they are airborne;**

- ***Aspergillus* grows on the outer surface of the peanut pod in the soil; and spreads inward;**

- **conditions suitable for fungi growth prevail during most of the year in Ghana;**

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Aflatoxin – cont.

Consequently, undetectable levels of aflatoxin at harvest do not guarantee aflatoxin-free peanuts later.

- **Ghana applies international standards to commercially processed and packaged peanut products,**
- **consumers purchase fairly small quantities of peanut paste almost daily;**
- **the cottage industry is not subject to the existing regulations,**
- **<u>therefore</u>, the prevention and reduction of peanut contamination in the field is particularly important.**

Data

The study is based on information collected through questionnaires from 252 farmers through face-to-face interviews in Ghana's Northern Region from the villages in districts surrounding Tamale between July 18 and July 24, 2010.

Discussion

Optimal plant health limits Aspergillus growth on roots reducing chances of the subsequent pod penetration;

various combinations of cultural practices have been recommended to reduce pre-harvest aflatoxin contamination,

BUT

seldom confronted with farm realities because of absence of systematically collected data about existing farmer practices (reasons, accessibility, abilities, specific efforts, modes, timing sequence).

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Farm characteristics- area planted

The average farm planted peanuts on 3.86 acres; the area ranged from one acre to 20 acres;

26% reporting two acres,

6% reporting 3 acres, and

14% reporting four acres

>10% planted on an area larger than seven acres. Nearly all (90%) planted peanuts at a single location.

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Labor and farmer gender

Field work mostly done by hand;
only about 4% reported owning a tractor;
some farmers hired a tractor to do the ploughing or ridging on peanut fields.

Differences between genders in choosing a variety:
men tend to plant Simabligu / Mani Pinta (also called Abain or Agric) or Bugla, while women prefer Simkarzie because it is easier to pull plants from the ground once harvest begins.

The farmer receives the money from peanut sales making farmer gender relevant for pre-harvest aflatoxin reduction.

<u>Implications for aflatoxin reduction</u>:
farm advisers must interact directly with persons in charge of a peanut field; reaching female farmers with aflatoxin resistant varieties that are easy to harvest is important in reducing contamination risk.

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Variety selection and variety-relevant attributes

Farmers plant several varieties of peanuts in Ghana and some planted more than one variety. Variety selection reflects production risk aversion:

1) various varieties mature at different times preventing the accumulation of field work;

2) in case of unfavorable growing conditions, different varieties help distribute the production risk and improve chances that some peanuts will be produced;

3) husbands and wives plant different varieties, which require varying physical strength during harvest.

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The three main varieties are not original varieties because farmers use either a portion of their own peanut seed or purchase seed in the market:

-*Simkarzie* planted by 52% of respondents; small kernel size; preferred by women because the plants are easily pulled out of the soil at harvest;

-*Simbaligu*; originates from Mani Pinta (also called Agric or Abain) planted by 38% of respondents; introduced through government agencies several decades ago; high oil content; second to *Simkarzie* in trade volume;

-*Bugla*; traditional local variety planted by10% of respondents; large kernels; low oil content; highly valued for its taste; sells at a premium over the other varieties, but is not grown by many farmers.

Farmers growing more than one peanut variety still selected Simkarzie (55%) followed by Simbaligu (33%), and Bugla (13%). None of the interviewed farmers grew more than two varieties.

Implications for aflatoxin reduction: ability to purchase certified seeds of aflatoxin resistant varieties - small farms may have to be targeted for certified seed.

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Planting decision

Planting decisions are made:

"after few rains" (71 percent) followed by

"after first rain" (24 percent);

"after maize" and "other" - each named by slightly more than two percent of respondents.

<u>Implications for aflatoxin reduction</u>:

-the importance of rain prior to planting is underscored by the lack of irrigation;

-the timing of planting is important to limit pre-harvest aflatoxin contamination under rain fed conditions;

-soil temperature and moisture affect pre-harvest aflatoxin contamination and early planting resulted in higher yields and lowered aflatoxin concentration;

-communicating about optimal planting time could involve radio, but among the surveyed farmers few reported having a radio; a single text message send to an individual in a village, who then informs others; such approach must be locally acceptable;

-the same communication channel can be used to inform farmers about possible insect infestation or conditions favoring diseases.

Yield

High yield was ranked as very important by 90% of 248 farmers who responded to this question, while about 2% named it as not important.

The average yield was 13.68 bags per acre; yield by variety:

Simkarzie - the reported yield by 118 farmers was, on average, 10.68 bags per acre; between 534 kg and 900 kg per acre;
Simbaligu – the average yield of 15.82 bags per acre was reported by 101 farmers; between 791 kg and 863 kg per acre;
Bugla variety and its yield of 13.5 bags per acre was reported only by 10% of farmers; the range between 684 kg and 750 kg per acre.

<u>Implications for aflatoxin reduction</u>:
-demonstrating the link between early planting/recommended planting and yield;
-introduce new varieties and comparing their yield to existing varieties.

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Price and price-relevant attributes

The high price was very important to nearly 83% of farmers and unimportant to less than 1% of farmers - with *proper incentives* farmers are likely to be responsive to production and postharvest practices consistent with the supply of safe aflatoxin-free peanuts.

However, during the interviews with farmers and along the peanut value chain, none of the participants mentioned standards for grades of peanuts. Therefore, farmers lack guidance regarding market quality expectations.

Prices recorded at the markets in Tamale shortly after the farmer survey showed a four percent difference in per bowl prices between Simbaligu and Simkarzie with the latter sold at a discount. There was no difference between old and new crop peanuts for the same variety although old crop was scarce. Per sack prices showed a reverse relationship between Simbaligu and Simkarzie: Simkarzie was sold at an 18 % premium. Bugla was sold at nearly the same per sack price as Simkarzie.

Price and price-relevant attributes –cont.

Farmers do not see benefits from choosing a variety based on buyer preferences and make their decisions using personal criteria stemming from their experience, beliefs, gender, or resource base.

<u>Implications for aflatoxin reduction</u>:

-the lack of price difference creates an opening for the introduction of a pricing scheme that would offer higher prices for growing an aflatoxin-resistant variety;

-the lack of established and applied standards for grades that account for resistance to aflatoxin contamination;

-peanuts are separated primarily according to size and buyers use quality assessment criteria on an inconsistent basis;

-although farmers shell and sort peanuts before sale, the sorting allows a sizable portion of poor quality kernels to enter the marketing channels (incentive to under sort).

Importance of variety attributes

The size of kernels was important to 50% of farmers; not important to 20% of farmers, while about 30% were indifferent.

Yet, the expressed importance of kernel size did not reflect the planting of varieties that had large kernels (Bugla). The market does not discriminate according to kernel size likely because peanuts are mostly ground into paste.

The maturity time, however, was very important or important to 71% of farmers and unimportant only to 15% of them. Immature peanuts are more susceptible to aflatoxin contamination. Size is not necessarily an indication of immaturity.

<u>Implications for aflatoxin reduction</u>:
-training needed in recognizing signs of plant maturity for various varieties.

Insect resistance was neither important nor unimportant to 36% of respondents and not important to 35% of the interviewed farmers. The minority, 29%, viewed insect resistance as important. Insect feeding sites facilitate the penetration of fungal spores and lead to aflatoxin contamination.

Implications for aflatoxin reduction:

-the timing of a needed insecticide application typically precedes the availability of cash (from the sale of harvested crops) to purchase an insecticide. Only households with adequate accumulated cash could consider insecticide application if the farmer recognizes the need for application or is informed about conditions favoring infestation. The potential reduction of aflatoxin contamination requires that information from a weather monitoring system is promptly transmitted to makers of crop management decisions.

The importance of disease resistance was ranked similarly to insect resistance. Diseases weaken a plant and contribute to Aspergillus colonization leading to aflatoxin contamination.

Drought tolerance was very important or important to 44% of responding farmers and ranked as unimportant by 31% of farmers. The share of farmers not concerned about drought appears large. The end-of-season drought may not be perceived as having much effect on the crop, but favors peanut fungal infection and aflatoxin contamination.

<u>Implications for aflatoxin reduction</u>:
seeds of varieties that may have improved resistance to aflatoxin do not reach farmers.

Seed purchase

When asked how much seed was used in the 2010 planting season by the source of seeds:

-156 farmers named using own seed. Among them, 106 saved on average 18.73 bowls of seeds. Another 50 farmers reported using, on average, 3.23 sacks of own seeds, but the majority (54%) used only one sack;

-81 farmers bought by the bowl at a local market, and purchased, on average, an amount almost identical to the amount of own saved seed, namely 18.38 bowls.

Also, the average volume of seeds purchased by sack was close to the volume saved from own production, and amounted to 3.44 sacks (but only 25 farmers purchased by sack and 48% of them bought only one sack of seeds).

Seed purchase – cont.

Under the current conditions, it is quite plausible that a substantial portion of seeds is inoculated by Aspergillus flavus known to stunt the growth of peanut plants causing yellow mould of seedlings.

<u>Implications for aflatoxin reduction</u>:

-an establishment of a healthy peanut seed supply system because aflatoxin is also suspected in lowering seed viability leading to lower yields;

-among surveyed farmers, those who bought peanut seeds at the market paid about 66 cedis for 18 bowls (average reported price of 3.15 cedis). It could be that premium prices could be charged for better seed viability and inoculation with competitive strains of fungi limiting the presence and growth of Aspergillus.

Intercropping. Corn, cassava, millet, and sorghum, all susceptible to Aspergillus colonization, are intercropped with peanuts and risk peanut contamination. About 75 percent of the interviewed farmers intercropped peanuts with other crops.

Implications for aflatoxin reduction:

-to reduce the threat of aflatoxin contamination of peanuts, farmers would have to limit intercropping, possibly lowering the presence of Aspergillus in the soil of a particular field;

-intercropping increases competition among plants for nutrients, especially nitrogen, and water, and weaker peanut plants are easier for Aspergillus to colonize;

-resigning from intercropping could affect food supply for the household.

Fertilizer application. Out of 246 farmers who responded to whether they applied fertilizer to peanuts, only one responded in the affirmative. Many indicated that the price of fertilizer was, in general, too high for them to afford.

Implications for aflatoxin reduction:

-a combination of gypsum, sorghum crop residues, and biocontrol agents seemed most effective among the tested approaches to reduce aflatoxin contamination, but requires knowledge and resources to purchase amendments;

-if gypsum price is competitive, teaching the use of gypsum and sorghum residue is a more realistic option that, over time, can lead to fertilizer use.

Herbicide spraying. About one third of the interviewed farmers sprayed peanuts with herbicides and applied 1.98 gallons of the spray per acre, on average;

but 59% sprayed one gallon;
14% sprayed two gallons, and
only about 17% sprayed more than two gallons per acre (of 81 farmers providing a response).

The price of the agro-chemical per gallon:
- the average price was 20.39 new cedis;
-60% of farmers did not pay more than 13 new cedis per gallon
-a wide range of prices, from two new cedis to 84 new cedis;
-it is plausible that farmers purchase diluted substances.

Implications for aflatoxin reduction:
-weed control indirectly reduces the aflatoxin contamination threat by eliminating competition for nutrients;
-the application of herbicides teaches application of chemicals, and may encourage the application of insecticides to control insects facilitating Aspergillus infection.

Plant maturity evaluation.

-78 % indicated the plant is mature “when half of leaves turn yellow”

-20 % selected the option “when almost all leaves turn yellow”, and

-2 % indicated “other ways to determine the harvest.”

When asked for details on how they decided to harvest, those responding most often indicated the number of days or months it took for a particular variety to mature,
one farmer uprooted a plant to check the maturity before making the decision whether to harvest.

Implications for aflatoxin reduction:
-poor harvest timing, either too early or too late, risks of aflatoxin contamination because immature pods are more susceptible to aflatoxin contamination prior to and after harvest, while Aspergillus flavus can cause mature pods to rot in the soil if harvest is delayed;
-train farmers in recognizing the time peanut plants of different varieties mature if aflatoxin contamination is to be reduced.

Containment strategies

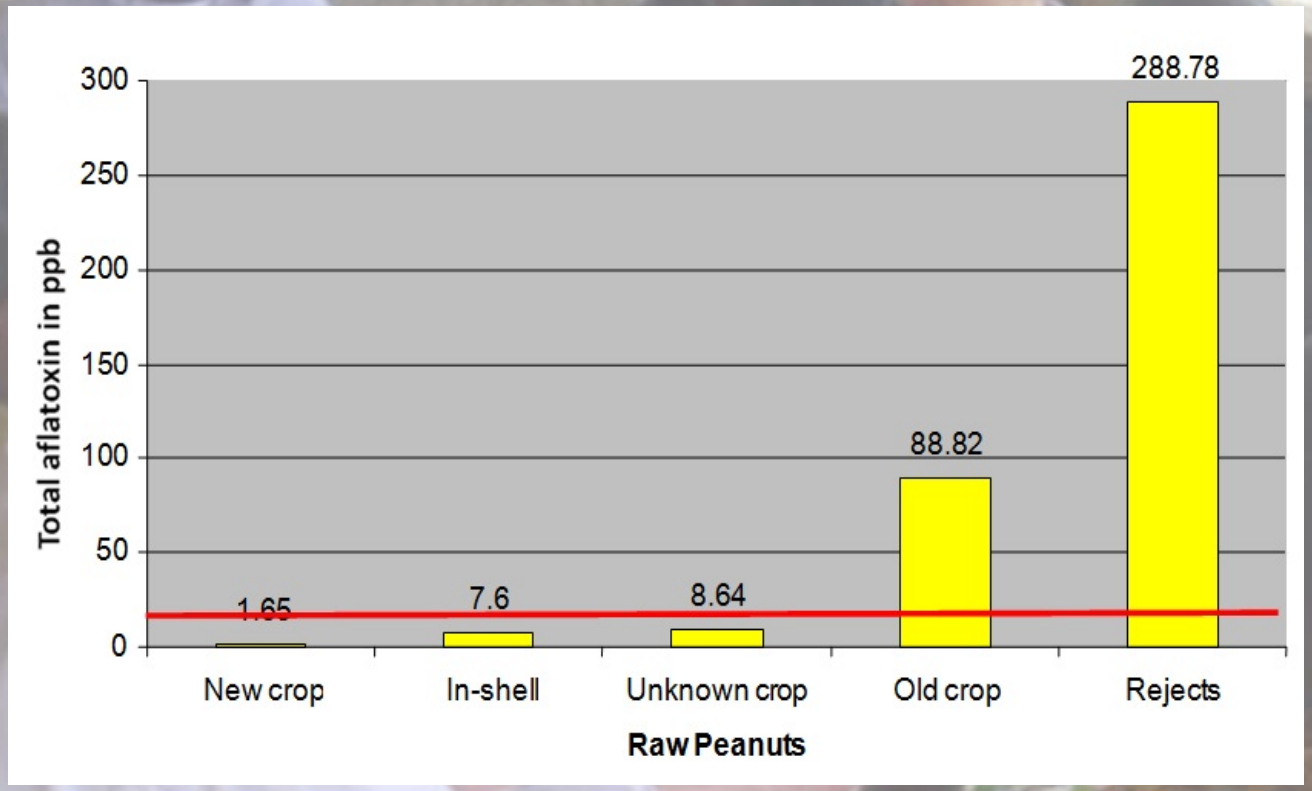
The majority of farmers asked if there were any detrimental health effects of consuming peanut paste responded that “eating too much groundnut paste" is harmful and most commonly mentioned affliction was gastric upset.

The association between peanut paste consumption and health problems presents an opportunity to introduce farmers to avoid possible sickness and encourage changes in the selection of seeds, cultural practices, and harvesting methods that have the potential to reduce afflictions due to aflatoxin contamination.

Tests of collected samples confirmed that the new crop groundnuts contained allowable levels of aflatoxin, but old crop was contaminated.

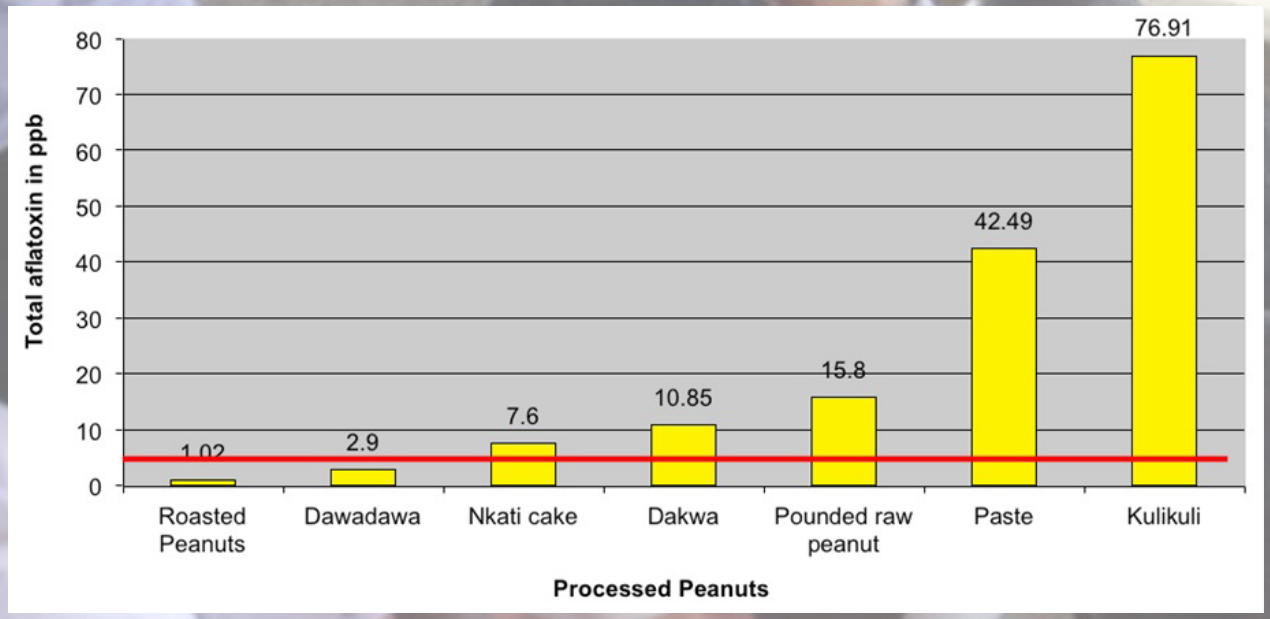
Also, a variety of products were contaminated, with peanut paste and kulikuli showing contamination exceeding the allowable limits multiple times.

Figure 1. Average total aflatoxin content in raw peanuts from samples collected in Ghana in July and August 2010.



Note: The European Union (EU) limit in raw groundnuts, shown in red, is **15 ppb**.
Source: Florkowski and Kollavali, 2013.

Figure 2—Average total aflatoxin content in cottage industry process groundnut products from samples collected in Ghana in July and August 2010.



Note: The European Union (EU) limit in raw groundnuts, shown in red, is **4 ppb**.
Source: Florkowski and Kollavali, 2013.

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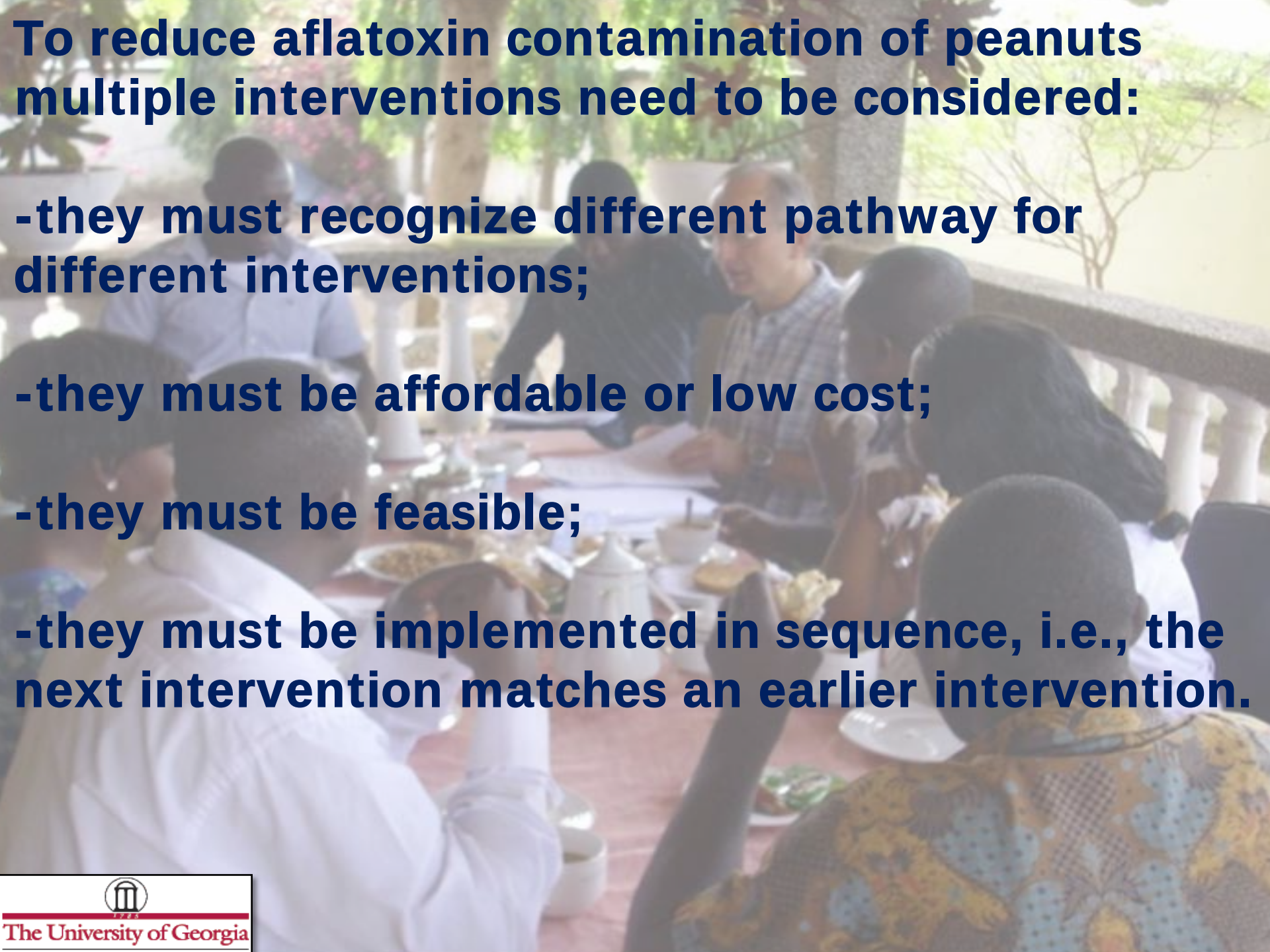


To reduce aflatoxin contamination of peanuts multiple interventions need to be considered:

-they must recognize different pathway for different interventions;

-they must be affordable or low cost;

-they must be feasible;

-they must be implemented in sequence, i.e., the next intervention matches an earlier intervention.

The preharvest practices can be implemented if farmers receive information and advice about what to do, when to do it and how to do it:

-information about seed selection, timing of planting and selection of field need to be provided before planting season arrives;

-the use of gypsum and sorghum residue on peanut fields, crop rotation and cropping system need to be taught as farmers plan their planting;

-herbicide and insecticide application instructions follow planting although not all farmers can afford herbicides;

-information about timing the harvest once plants reach maturity.

Harvest:

-information about;

-the use of gypsum and sorghum residue on peanut fields, crop rotation and cropping system need to be taught as farmers plan their planting;

-herbicide and insecticide application instructions follow planting although not all farmers can afford herbicides;

-information about timing the harvest once plants reach maturity;

-proper drying of pods prior to placing them in storage under the prevailing weather conditions.

Yet, the current pricing does not differentiate peanut quality and encourages under-sorting along the value chain.

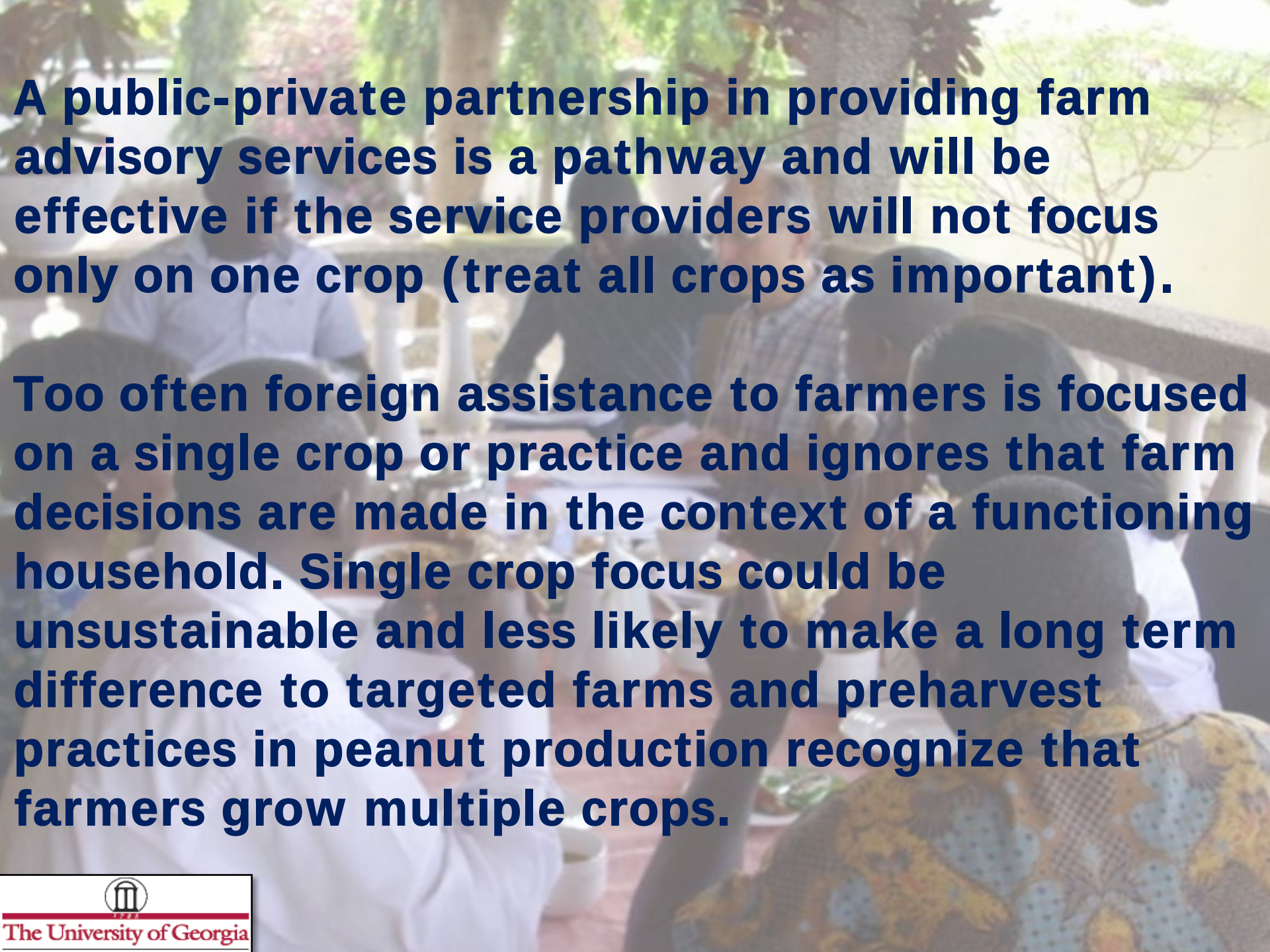
Farmers will be responsive to practices that alleviate health problems, but rewarded for supplying quality peanuts by price premium will accelerate the adoption of practices requiring additional inputs.

Attempts to supply peanuts through regulations are costly to implement and enforce. The enforcement will negatively affect the cottage industry providing employment and income to women.

A point of entry of rewarding for quality are formal processing plants. Their products reach well off consumers and open export markets.

Formal processors requiring a stable stream of quality peanuts can learn the existing simple, inexpensive sorting techniques and transfer that premarketing, pre-processing function directly to villages. Processor will receive sorted to order aflatoxin-free peanuts in exchange for price premium.

For processors to take advantage of such opportunities, a system of rapid testing labs in necessary. Government involvement is necessary in this area.



A public-private partnership in providing farm advisory services is a pathway and will be effective if the service providers will not focus only on one crop (treat all crops as important).

Too often foreign assistance to farmers is focused on a single crop or practice and ignores that farm decisions are made in the context of a functioning household. Single crop focus could be unsustainable and less likely to make a long term difference to targeted farms and preharvest practices in peanut production recognize that farmers grow multiple crops.

Concluding remarks

Technologies are currently available to control Aspergillus spp in the fields, but are unavailable in Ghana. The development of such products is specific to a region or area and involves an approval by government. Even if available, its effectiveness varies, while the cost is likely to be prohibitively high in the foreseeable future.

Pre-harvest control of aflatoxin complements the postharvest efforts to reduce aflatoxin contamination and both require training and cooperation between private and public sectors, but are achievable.