

# POLICY BRIEF



## Eliminating the Health and Economic Effects of Aflatoxins: The Holistic Approach



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## What are aflatoxins?

Aflatoxins are toxic substances produced mostly by the moulds or fungi called *Aspergillus flavus* and *Aspergillus parasiticus*. Aflatoxins are likely to be produced when crops are exposed to extreme conditions such as high temperatures, drought, high moisture, high oxygen concentration, and insect infestation. Aflatoxin production can occur on the farm before crop harvest and after harvest. During the storage of crops, high levels of moisture and temperature conditions create a suitable environment for the rapid growth of moulds, which in turn produce aflatoxins. Physical damage to crops and other food products during weeding, harvesting, drying, transportation, storage, and marketing can cause decay that enhances mould growth and aflatoxin production.

In Ghana, aflatoxins have been detected in various food products including groundnuts, groundnut paste, maize, maize flour and dough, *agushie* (white melon seed), rice, sorghum, millet, *kokonte* (dried partially fermented cassava), khabab powder, pepper powder and other spices. However, groundnuts and maize are the most highly affected staple food products. Animal and fish products can also be contaminated with aflatoxins if livestock, poultry and fish are fed with contaminated feed.



*Aspergillus moulds in groundnuts*



*Aspergillus moulds in maize*

## What are the health and economic effects of aflatoxins?

Exposure of human and livestock to very high levels of aflatoxins result in acute health effect known as aflatoxicosis, which presents symptoms such as internal bleeding, acute liver damage, vomiting, abdominal pains, coma, and death in severe cases. The largest outbreak of aflatoxicosis reported in the world during the last 40 years, occurred in Kenya in 2004 where 317 people were affected and 125 died. Aflatoxin is a cancer-causing toxin that is known to cause liver cancer and other liver diseases leading to the impairment of liver function. Liver damage by aflatoxins can have devastating health consequences because of the important functions the liver performs, which include synthesis and storage of food nutrients, detoxifying chemicals and eliminating many toxins from the body. The World Health Organisation estimates that in 2014, Ghana recorded 1,923 liver cancer cases and this increased to 2,753 in 2018 according to the GLOBOCAN statistics. In 2014, liver cancer was found to be the commonest type of cancer among Ghanaian males representing 21.1% of all cancers.

Chronic exposure to aflatoxins has also been linked to immune system suppression, growth retardation and stunting in children, decreased protein synthesis, delayed recovery from kwashiorkor, and increased susceptibility to infections. Studies conducted in animals show that aflatoxin reduces the bioavailability of liver and serum vitamin A, zinc and selenium and hence can lead to micronutrient deficiency. All these health conditions impact productivity and increase health costs to individuals, households, and governments.

In livestock and cultured fish, aflatoxins can cause health problems, weight loss, and death. Chickens fed with aflatoxin-contaminated feed lay 70% fewer eggs than those on normal diets. Aflatoxins pose a barrier to trade due to the rejection of contaminated products by importing countries. African Union estimates that African continent loses up to USD670 million annually due to aflatoxin contamination. In Ghana, aflatoxin contamination accounts for losses of about 319,000 tonnes or 18% of Ghana's annual maize production.





## What measures are available for controlling aflatoxins in food and feed?

**A**flatoxin contamination can occur at both pre- and post-harvest stages therefore its control should cover all stages of the value chain.

### A. PRE-HARVEST STRATEGIES FOR CONTROLLING AFLATOXIN

**Good agricultural practices** such as crop rotation, planting of drought and disease-resistant and treated seeds, pesticide application, soil fertility and moisture management, disease and pest control, irrigation, timely application of soil nutrients (fertilisers), and timely harvesting are effective for the prevention and control of aflatoxins contamination.

**Biological control** strategies entail the application of non-toxic strains (strains of *Aspergillus flavus* that do not produce aflatoxins) to the field during crop production. When applied under appropriate conditions, the non-toxic strains displace the aflatoxin-producing strains. In Ghana, a biological control product called Aflasafe Gh02 has been developed and is now commercially available. Aflasafe has been shown to reduce aflatoxin contamination by over 90%.

**Breeding and selection** of aflatoxin-resistant and stress tolerant crop varieties usually through genetic engineering can potentially reduce aflatoxin contamination. It requires moving resistance genes from one species into a crop variety with acceptable agronomic properties. This strategy has shown promising results for maize and groundnuts. However, an improved understanding of resistance mechanisms is required to help improve the selection of resistant germplasm.

### B. POST-HARVEST STRATEGIES FOR CONTROLLING AFLATOXIN

**Rapid and adequate drying after harvesting crops** is important to ensure that the crops have moisture content at levels that will not promote mould growth. The appropriate

moisture content for maize is 12%, groundnut (in-shell) 9% and shelled groundnut 7%. Sun-drying of maize and groundnuts and other products is a common practice in Ghana and, together with the use of raised platforms, it is effective in reducing mould growth. A good replacement for open sun-drying is the use of solar dryers because they dry crops faster and more efficiently and provide a controlled environment that offers improved sanitation.

**Grain cleaning and sorting** techniques are used to reduce aflatoxin contamination by removing mouldy, damaged and discoloured grains. Sorting techniques include hand or manual sorting, which is commonly practised in Ghana. It has been shown to be effective when the grains have visible moulds on them. Hand sorting, however, needs to be done under hygienic conditions and away from the sand. Manual sorting of groundnuts could reduce aflatoxin concentrations by about 98%. Other sorting strategies are the use of high-capacity electronic optical sorters and specific gravity seed cleaning equipment and computer-based image processing techniques for screening and removal of contaminated grains.

**Product storage under good conditions** provides protection against moisture, pests, and excessive heat, which are factors that promote mould growth and aflatoxin production. Before storage, harvested crops should be promptly and adequately dried to attain safe moisture levels. Strategies to reduce aflatoxin levels during storage include (i) using clean, dry, and enclosed storage facilities; (ii) ensuring proper water drainage; (iii) ensuring well-aerated stores; and (iv) eliminating insects and other pests such as rodents and birds. Hermetically sealed storage bags, such as Purdue Improved Crop Storage (PICS) is effective for insect control as it increases insect mortality by 95–100% in stored maize. Storage materials with anti-fungal properties are also available. Mobile Utility Grain Storage facility, which is currently being promoted in Ghana, is effective in protecting grains against mould attack and postharvest losses.





**Pest control** is critical because pests can damage crops and other food products and increase their susceptibility to mould growth and aflatoxin contamination. Insects and rodents can be controlled by using appropriate storage facilities, maintaining hygienic and good sanitary conditions, and appropriate use of approved chemical and biological pest control methods.

**Inactivation or detoxification** strategies involves the use of heat treatment, gamma radiation, chemical treatment and biological control techniques to inactivate moulds and reduce aflatoxin levels in food and feed. (i) **Heat treatment** of food does not completely eliminate aflatoxins however some studies have reported various levels of reduction depending on the heat treatment method used. In a study on maize, most processing methods (i.e. boiling, roasting, baking and steaming) reduced aflatoxin to a considerable extent (50-70%). Dry heat treatments such as roasting and baking were more effective in reducing aflatoxin levels. Several studies have reported that gamma irradiation can be used to decrease aflatoxin content in foods. For example, aflatoxin level was reduced by more than 80% in red pepper and it was reduced in maize to an acceptable level without compromising animal and human health. (ii) **Chemical treatment** has been proven to be effective for the removal of aflatoxins from food. These include acetic acid, ammonia gas or ammonium salts, calcium hydroxide, hydrogen peroxide, liquid or gaseous ozone, and sodium bicarbonate. Ozone detoxification has been used in red peppers and groundnuts to degrade aflatoxins as well as prevent fungal infection, inactivate bacterial growth, destroy pesticides and chemical residues, and control storage pests. Nixtamalisation involves boiling maize in lime water (a mixture of water and slaked lime or calcium hydroxide) before processing into other products. It is widely practised in Mexico. Nixtamalisation could achieve 30- 58% aflatoxin reduction in tortillas (a Mexican dish) and 60-75% reduction in ugali (a popular dish in Eastern and Southern Africa), which are both maize products. (iii) **Biological control of aflatoxin contamination at post-harvest processing stages** entails the use of Lactic acid bacteria

(LAB) namely *Lactobacillus*, *Bifidobacterium*, *Propionibacterium*, and *Lactococcus* to bind aflatoxins in food and feed thus making them unavailable. Other microorganisms such as *Saccharomyces cerevisiae* have also been reported to bind aflatoxins, especially in fermented foods. (iv) **Extracts from plants** such as *Syzygium aromaticum* (cloves), garlic and onion, cinnamon and other herbs including thyme, star anise seeds, and black and white pepper have shown good results in inhibiting fungal growth in crops.

**Regulation** plays a critical role in aflatoxin control. Where established regulatory systems exist, implementation of intervention strategies is usually robust and aflatoxin contamination and its exposure is low. Enforcement and compliance with standards and regulations are critical for the management of aflatoxins.

**Diet diversification** is a good way to improve nutrition and health. A greater variety of foods will lower the risk of exposure by lessening the intake of staple foods such as maize and groundnuts, which are prone to aflatoxins contamination.

**Post-exposure management** interventions are required usually in emergency situations such as during the outbreak of aflatoxicosis where those affected would have consumed food with a high level of aflatoxins. Post-exposure management strategies include (a) **Enterosorption**, which entails the use of products that bind aflatoxin in the gut and prevent its uptake. An example is the NovaSil (NS) clay (sodium calcium aluminosilicate), that was piloted in Ghana in the 1990s. Overall, the use of NS clay during outbreaks of acute aflatoxicosis appears to be a safe and practical strategy for vulnerable populations at high risk. Further studies are required to assess the effects of aflatoxin dose and duration of exposure on efficacy and the safety of NS clay in vulnerable populations such as malnourished infants, children, and pregnant women. (b) **Chemoprotection or chemoprevention** involves the use of certain products to alter the susceptibility of humans to carcinogens. Examples of these products are dithiolethiones, oltipraz, sulforaphane, broccoli sprouts and green-tea





## RECOMMENDATIONS

Aflatoxins negatively impact health, food security, export drive, and the national economy. However, strategies exist for the management of aflatoxin contamination in food and feed. Some strategies have been proven to be very effective, some are still at experimental stages and need further research while others need to be widely disseminated and scaled up and out for maximum impact. No single strategy is adequate in managing aflatoxins hence there is a need to adopt a holistic approach and implement a combination of strategies along the value chain for effective control. To successfully combat aflatoxins and their effects, major collaborative and coordinated actions are required especially from the Ministry of Food and Agriculture (MOFA), Ministry of Trade and Industry (MOTI), Ministry of Health (MOH), and Ministry of Environment, Science, Technology, and Innovation (MESTI) and their Departments and Agencies.

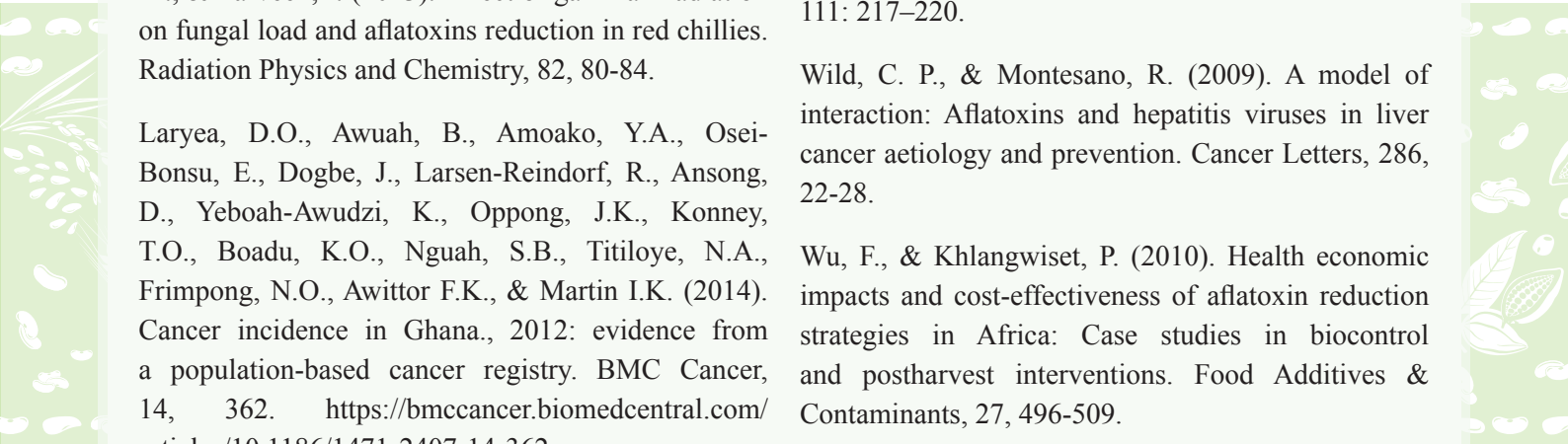
The following recommendations or actions are proposed for **government and its partners**, and the **private sector**:

1. Support and strengthen research and technology transfer on aflatoxins and its management.
2. Strengthen surveillance systems for the detection and management of aflatoxin-related diseases in humans, livestock and fish.
3. Increase public awareness and stimulate demand for aflatoxin-safe food and feed.
4. Support value chain actors to understand, adapt and invest in best practices and improved technologies for aflatoxins control.
5. Support the development of training modules and facilitate the training of value chain actors in the production, processing and marketing of aflatoxin-safe products.
6. Facilitate local production of drying and storage facilities and support value chain actors to access these facilities.
7. Facilitate the construction and establishment of warehouses and silos for product storage at farm gates, communities, market centres and other suitable locations.
8. Strengthen the capacity of regulators to enforce standards and regulations for aflatoxin management along the value chain.





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