Systems thinking to reduce **groundnut aflatoxin exposure**

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To many African people, the groundnut (Arachishypogaea L.) is the most important legume providing them with much needed dietary nutrients and income. Groundnuts, also known as peanuts, are consumed in a variety of snacks and are a major ingredient in ready-to-use therapeutic food (RUTF), one of the most effective home-based nutritional therapies for children and HIV/AIDS patients, particularly in the developing world (Magamba et al., 2017).

The quality and safety of groundnuts is however often compromised by aflatoxin contamination. Aflatoxin is produced by *Aspergillus flavus* and *A. parasiticus* and represents a group of structurally related mycotoxins that are among the most potent naturally occurring substances known to mankind (Kendra, 2007).

The toxin is generally heat stable and is not destroyed during most processing stages (Matumba, 2017). Aside from causing acute poisoning at high doses, chronic exposure to lower-level doses can cause liver cancer and stunted growth in children (Gong *et al*. 2002; Meissonnier *et al*., 2008; Turner *et al*. 2003).

Aflatoxin contamination may also lead to a significant reduction in crop yield and is a cause of economic losses. According to the Partnership for Aflatoxin Control in Africa (PACA), the continent is reported to lose more than $670 million per year in export earnings due to the presence of aflatoxins on food.

For developing countries that produce over 60% of the world's groundnuts (Magamba *et al*., 2017), this may impede their progress towards attaining food security and a reputable standing. Moreover, contaminated foods that do not meet export standards are often sold in the domestic market or used for household consumption, increasing the health risks associated with aflatoxin exposure in local communities (Njoroge *et al*., 2017).

Strict limits imposed

The Food and Agriculture Organization (FAO) of the United Nations estimates that 25% of food produced worldwide is contaminated with aflatoxins. To limit exposure, countries across the world have set and enforced maximum tolerated levels (MTLs) of aflatoxin in traded groundnuts.

Limits for individual countries range from 4 to 20 parts per billion (ppb) for total aflatoxin content. A stringent limit of 4ppb for total aflatoxins in foods is enforced in the European Union (EU). During 2015 and 2016, five groundnut consignments from South Africa were rejected at the EU border. The total aflatoxin content in one of these consignments was 330ppb.

Since its discovery in the 1960s, researchers, governments, investors and the like have looked into factors that contribute to aflatoxin production, use of preventative measures and upscaling regulatory enforcement. In the last

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decade alone, 38 800 peer reviewed scientific papers have addressed this topic. As significant as the research is, it has rarely examined how complex and interconnected groundnut food systems really are. A different kind of analysis that requires various forms of knowledge to identify which parts of the food system are at the root cause of the problem have hence become a necessity.

Mapping the groundnut system

The food system is not only comprised of the sum of activities of the groundnut value chain, but also has an outcome on and is influenced by socio-economic and environmental factors (Van Berkum *et al*., 2018). In order to find sustainable solutions for a safe supply of groundnuts, one should start by mapping the food system, showing its constituent parts and how they interrelate.

The groundnut system is made up of a number of activities that leads to a supply of peanuts that are safe to consume. These activities include the value chain (production, processing, trade and consumption), as well as things such as business services and an enabling environment. Business services include providers of agricultural inputs (fertilisers, pesticides, biological control agents, etc.), technical advice, extension services, availability of analytical facilities and financial support.

An enabling environment again would typically relate to food safety regulations and legislation in other countries with which trade contacts exist (Van Berkum *et al*., 2018). The set of activities mentioned here are aimed at preventing the growth of the aflatoxin producing *Aspergillus* species. These strategies are based on good agricultural practices (GAP), which represent the primary line of defence against aflatoxin contamination in the field, followed by the implementation of good manufacturing practices (GMP) during the handling, storage and distribution of mature groundnuts.

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Contamination drivers and controls

Equally important is the influence of socio-economic factors on the groundnut food system. These include income, employment and level of education, to name a few. An emerging farmer may, for instance, not have the financial means to pay to test aflatoxin contamination levels. *The Agricultural Products Standards Act*, 1990 (Act 119 of 1990) controls and promotes specific product quality standards for the local market and for export purposes.

With respect to aflatoxin contamination (Regulation R1145 governing tolerance for fungus produced toxins in foodstuffs), the Perishable Products Export Control Board (PPECB) has been appointed and authorised to test groundnuts. Based on 2018 figures, laboratory fees for analysing 10kg groundnuts amount to R1 130.

Environmental factors such as climate and rainfall are also critical drivers for fungal colonisation and aflatoxin contamination. Climate change will certainly have a significant impact on this. The late 2015 drought could, for example, account for the increased number of European market rejections of South African produced groundnuts.

Lastly, the food system itself has an outcome on socio-economic and environmental factors. The activities related to the groundnut value chain provide employment to farm workers, raising their incomes. This could, in effect, lead to higher education levels and an enhanced awareness of food safety, which benefits the farmer in the long run. However, excessive and irresponsible use of agrochemicals may also be harmful to the environment. All these factors affect the functioning of the food system.

Future aflatoxin control and mitigation efforts, in addition to GAP and GMP, should also take other interrelated factors into account. This may be useful for improving our understanding of the various routes of aflatoxin contamination, of the critical factors causing aflatoxin contamination, and of the interactions governing the specific behaviour of the groundnut value chain, to design context-specific interventions. One solution will not suffice.

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