Exposure to mycotoxins present in food and feed crops has long been recognised as a serious threat to human and animal health. And, according to a 1996 United Nations report, “Freedom from mycotoxins in food ... is an indicator of sustainable development.” Nevertheless, the sheer pervasiveness of the problem in developing countries, along with the cost of potential solutions in a sea of competing priorities, has led to a certain degree of pessimism on the part of agricultural and health authorities. Radical solutions that take into account the needs and conditions of developing countries are urgently needed.

Mycotoxins are chemical substances naturally produced by a modest number of species of fungi that grow on crops either in the field or in storage. In sub-Saharan Africa, two important crops are commonly contaminated: maize and groundnuts – major food crops and cash earners for millions of small-scale farmers. The best known of these chemical substances is aflatoxin, produced by *Aspergillus flavus*, found in both maize and groundnuts. More recently, fumonisin, produced by *Fusarium verticillioides*, was discovered in maize in southern Africa. Exposure to these mycotoxins may occur simultaneously. In animal studies, the effect of aflatoxin is promoted by the concurrent presence of fumonisin. In humans, interaction between the two toxins is not understood.

**Multiple health risks**

For centuries, farmers in Central America reduced their exposure to aflatoxin, knowingly or unknowingly, by treating their maize with lye. Unfortunately, this procedure did not accompany maize on its eventual journey to Asia and Africa and is in any case not feasible where water is in short supply.

The exposure of people and animals to aflatoxin and fumonisin presents multiple health risks, both proven and probable (Cardwell, 1999). Aflatoxin, which damages DNA, is the most potent chemical liver carcinogen known. Many people in developing countries are infected by hepatitis B and C which are probably even more potent liver carcinogens. The combination of the two agents, aflatoxin with hepatitis B and C, is synergistic, raising more than tenfold the risk of liver cancer compared with each attacking alone. Acute aflatoxicosis occurs in poultry, swine, cattle and people. At lower but chronic exposures, aflatoxin may damage the liver, lower appetite, promote diarrhoea, inhibit growth and suppress the immune system. Recent studies conducted in West Africa are shedding light on the potential for aflatoxin-induced immune suppression in humans.

Fumonisin interferes with critical lipid pathways affecting cell function including the transport of critical vitamins such as...
Mycotoxins can also harm human health in other ways. First, domestic animals such as poultry and swine are very sensitive to aflatoxin and deoxynovalenol, respectively. The presence of these toxins in the poorest-quality leftover grain, which farmers feed to their livestock, reduces animal productivity and therefore the family food supply. The resulting protein-energy malnutrition increases disease prevalence, further undermines people’s ability to cope with mycotoxin exposure. Second, the loss of income from lower animal production leads to greater poverty, thus reinforcing the conditions conducive to poor human health.

**Contributing factors and research priorities**

Improper storage is understood to enhance mycotoxin concentrations in maize and groundnuts. Evidence suggests that in sub-Saharan agroecosystems, mycotoxin-producing fungi in the soil invade plant roots, particularly when the host plant is stressed by short-term drought. Soil degradation, inappropriate farming practices and choices of crop varieties may affect the quality of the subsequent crop.

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There are indications that poor rural people who consume stored, homegrown maize and groundnuts are among the most affected. Crops handled by government agencies may be better inspected and thus safer for consumption. In some cases, farmers sell their high-quality produce, keeping mycotoxin-contaminated food for their own consumption. Furthermore, because the poor rarely have the luxury of diversifying their diets, their exposure to mycotoxin-laden crops is often greater than that of the reasonably well-off.

In 1997 and 2001, the Joint Expert Committee on Food Additives published evaluations of aflatoxin and fumonisin, respectively. This is a committee of the World Health Organization and the Food and Agriculture Organization of the UN, and decisions of JECFA are referenced by the World Trade Organization. According to JECFA, nearly all Africans would for some or all of their lives be exposed to aflatoxin levels known to affect population health. Again in Africa, the average exposure to fumonisin is estimated to exceed the tolerable daily intake and for about 10% of the population it is exceeded by three times. No estimate was made of the effect of concurrent exposures.

Urgent action by researchers is needed on several fronts:
- Observation of human diets in high-risk communities, to assess levels, seasons and sources of exposure to mycotoxins;
- Evaluation of health impacts of mycotoxins, particularly in food-insecure communities that depend on degraded soils for sustenance;
- Definition of social and economic structures that differentially expose one or more sub-groups to mycotoxins;
- Studies of soil ecology with a view to preventing mycotoxin-producing fungi from invading crop roots.

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While we think we know what tolerable levels are, in Africa there is no meaningful possibility of achieving them in the near term. So a further priority is to determine what interventions are necessary to make an intolerable situation better.

In the decade from 1985 to 1996, IDRC made important contributions to a number of technical and policy-development initiatives on mycotoxins in developing countries. These included collaborative R&D in China and significant multilateral policy work on mycotoxins in Southeast Asia (with Australia), in South America (with the International Maize and Wheat Improvement Center), and in Africa (with Denmark). These initiatives have created national capacity and helped to foster the development of key research efforts among researchers in many countries.

Other projects have also been funded and are under way. They include a critical study of the impact of aflatoxin on infectious disease, supervised by Chris Wild at Leeds University and Kitty Cardwell, formerly of the International Institute of Tropical Agriculture; studies of analytical methods for mycotoxins developed by Maya Pinereo (FAO); and a project to understand the factors that affect the formation of fumonisin in maize, involving researchers all over the world, including David Miller’s group at Carleton University. We are looking for resources to do critical studies on birth defects and oesophageal cancer in South Africa and develop effective interventions.

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**Reference**