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Food Safety: The Case of Aflatoxin

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Executive Summary

Naturally occurring toxins such as aflatoxins pose profound challenges to food safety in both developed and developing countries. The knowledge that aflatoxins can have serious effects on humans and animals has led many countries to establish regulations on aflatoxins in food and feed in the past few decades to safeguard public health, as well as the economic interests of producers and traders.

A wide range of aflatoxin standards and corresponding regulatory requirements exist worldwide, illustrating the drastic differences in risk perceptions among different countries. In general, more stringent aflatoxins standards are found in wealthy industrialized countries with more developed market economies than in developing countries where subsistence farming still prevails. Countries in the European Union (EU) have historically had the most stringent regulations for aflatoxins in the world. Their newly adopted harmonized aflatoxin standards have set tolerance levels much lower than those in the developing countries and the Codex Alimentarius.

The setting of aflatoxin regulations is a complex activity that involves many factors and interested parties. For developed countries, increased food safety standards have long been associated with higher income, but for developing countries, considerations such as food security and trade benefits are often of particular concern. When food supplies are limited and alternative diets are not possible, stringent regulatory measures to lower aflatoxin contamination may put extra burdens on the country's food system and lead to food shortages and higher prices. In a global context, since the perception of tolerable health risks are not likely to converge among different countries, trade disputes over regulatory requirements on aflatoxins are likely to persist.

To minimize the risk of aflatoxin contamination and ensuing trade frictions, private and public investments are needed to promote process-based guidelines such as Good Agricultural Practices (GAPs) before harvest and good manufacturing practices (GMPs) after harvest. Meanwhile, efforts to facilitate transfer of technology and technical assistance

from the developed to the developing countries in meeting food safety standards are necessary.

Aflatoxin regulations raise a number of important questions and considerations. Because higher standards on aflatoxins emanate primarily from the developed world, different views exist on their implications for food safety in the developing countries. In the trade arena, questions on whether there should be or could be a global harmonization of aflatoxin regulations are debated.

Given that the regulatory limits and standards concerning the accepted limits of aflatoxins (and mycotoxins in general) in food and feed products will continue to differ across countries and regions, your assignment is to recommend policy changes for the following three groups when their food safety regulations are in conflict with each other: the EU, the developing countries, and parties involved in the Sanitary and Phyto-Sanitary Standards (SPS) of the World Trade Organization (WTO) or the Codex Alimentarius (harmonized standards).

Background

Aflatoxin and Pathology

Aflatoxins are a group of structurally related, naturally occurring toxic compounds generated metabolically by the molds *aspergillus flavus* and *aspergillus parasiticus*. The term "aflatoxins" was coined in the early 1960s when the death of more than 100,000 turkeys ("Turkey X" disease) on a poultry farm in England was attributed to the presence of *A. flavus* toxins in groundnut meal imported from South America.

Aflatoxins belong to a larger family of mycotoxins, which, in addition to aflatoxins, also include deoxynivalenol, fumonisins, ochratoxins, and zearalenone, etc. Mycotoxins including aflatoxins can be produced in crops before harvest, during and immediately after harvest, and during storage. Uncontrollable weather conditions such as high temperatures, moisture, monsoons, unseasonal rains during harvest, and flash floods, as well as poor harvesting practices, improper storage, and less than optimal

conditions during transportation and marketing can all lead to fungal growth and mycotoxin proliferation (Bhat and Vasanthi 2003). Factors that decrease the host plant's immunity such as insect damage, poor fertilization, and drought can also cause production of mycotoxins. Mycotoxin or aflatoxin contamination in crops is most common in Africa, Asia, and South America, which have warm and humid climates, but it also occurs in temperate areas of Europe and North America.

Among mycotoxins, aflatoxins are of the greatest concern for human and animal health. They are prevalent in a wide variety of stored agricultural crops, such as maize, peanuts and peanut products, cottonseed and its extractions, and to some extent, chilies, peppers, and tree nuts (pistachio nuts, pecans, walnuts, and Brazil nuts). Aflatoxins that pose the highest human health risks are designated B1, B2, G1, and G2. A metabolite of aflatoxin B1, aflatoxin M1, is also considered a source of contamination. It occurs in milk, eggs, and meat products if obtained from livestock and poultry that have ingested aflatoxin-contaminated feed.

Detection and control of aflatoxins in food is difficult since the molds can grow, become established, and remain with the food anywhere along the production, storage, transportation, and processing chain. The food safety risks of aflatoxins can be high, for the absence of visible mold does not guarantee the food is free from such toxic substances, and normal cooking or processing of the food does not necessarily reduce aflatoxin contamination. Conditions that increase the likelihood of aflatoxicosis in humans include environmental conditions that favor fungal development in crops and commodities (as already discussed), limited availability of food, high cost of decontamination or detoxification, lack of resources and regulatory systems for aflatoxin monitoring and control, and poor human health.

Human exposure to aflatoxins through consumption of foods from contaminated crops or livestock can produce acute as well as long-term health problems. Acute aflatoxicosis is characterized by vomiting, abdominal pain, pulmonary edema, convulsions, coma, and death with cerebral edema and fatty involvement of the liver, kidneys, and heart. Evidence of acute illness in humans from aflatoxins has been reported in many parts of the world, especially developing countries. For example,

aflatoxin contamination of rice in Taiwan led to 3 deaths in 1967; aflatoxin contamination of maize resulted in more than 100 deaths in India in 1974.

The possible long-term effects of exposure to low levels of aflatoxins are of greater concern than acute illnesses. Aflatoxins, especially aflatoxin B1, have proven to be extremely potent mutagenic and carcinogenic substances. In 1988, the International Agency for Research on Cancer (IARC) placed aflatoxin B1 on the list of human carcinogens. This action is supported by epidemiological studies conducted in Africa and Asia demonstrating a positive association between dietary aflatoxin B1 and liver cell cancer (LCC). The impacts of aflatoxin-related diseases on humans may be influenced by factors such as age, sex, nutritional and health status, and concurrent exposure to other causative agents such as viral hepatitis or parasitic infestation. For example, stunted and underweight children are more susceptible to aflatoxins contamination and people with hepatitis B have a much higher rate of liver cancer than others when exposed to aflatoxins (Bhat and Vasanthi 2003).

In animals, ingestion of aflatoxins can reduce production efficiency, reduce feed conversion efficiency, and increase the death rate. Like humans, the susceptibility of animals to aflatoxins also varies considerably depending on species, age, sex, and nutrition. Young animals at the nursing stage may be affected by aflatoxin M1, a metabolite conversion from aflatoxin B1, excreted in the milk of dairy cattle. The induction of cancer in animals by aflatoxins has been extensively studied, and different types of aflatoxins including B1, M1, and G1 have been shown to cause various types of cancer in different animal species.

Aflatoxin Regulations

Since the discovery of aflatoxins in the 1960s, many countries have established regulations on mycotoxins in food and feed to safeguard the health of humans and animals, as well as to protect the economic interests of producers and traders. The first limits for mycotoxins were set in the late 1960s for aflatoxins. By the end of 2003, approximately 100 countries had developed specific limits for aflatoxins (and for mycotoxins more generally) in foodstuffs and feedstuffs, and the number continues to grow.

Table 1: Medians and Ranges of Maximum Tolerated Levels and Numbers of Countries with Regulations, 1995 and 2003

Category	1995			2003		
	Median (µg/kg)	Range (µg/kg)	No. of countries	Median (µg/kg)	Range (µg/kg)	No. of countries
BI in foodstuffs	4	0–30	33	5	1–20	61
BI+B2+G1+G2 in foodstuffs	8	0–50	48	10	0–35	76
M1 in milk	0.05	0–1	17	0.05	0.05–15	60
BI in feedstuffs	5	5–50	25	5	5–50	39
BI+B2+G1+G2 in feedstuffs	20	0–1,000	17	20	0–50	21

Source: FAO 2004.

Countries with mycotoxin regulations mostly set regulatory limits with respect to aflatoxins, especially aflatoxin BI, which is considered the most toxic aflatoxin.¹ These aflatoxin regulations are often detailed and specific for various foodstuffs, for dairy products, and for feedstuffs. Table 1 compares the medians and ranges of maximum tolerated levels for different types of aflatoxins and numbers of countries with legally established limits for aflatoxins in foodstuffs and animal feedstuffs in 1995 and 2003. The numbers shown in the table are compiled from an international inquiry conducted by the Food and Agriculture Organization of the United Nations (FAO) in 2002–2003.

Compared with the situation in 1995, the number of countries that had established tolerance levels for aflatoxins in each category in 2003 had significantly increased. Though the medians of the maximum tolerated levels for aflatoxins in foods and feeds remain similar, the ranges have changed. For aflatoxin BI in foodstuffs, the range of limits narrowed from 0–30 micrograms per kilogram (µg/kg) in 1995 to 1–20 µg/kg in 2003. In the 21 countries with total aflatoxin standards for animal feeds, the tolerance levels ranged from 0 to 50 µg/kg, a significant drop from 0 to 1,000 µg/kg in 1995. There was an increase in the range of maximum tolerance levels for aflatoxin M1 in milk (0.05–15 µg/kg).

While the wide ranges of tolerated levels for aflatoxins may seem scientifically unrealistic in some cases, they nonetheless illustrate the drastic differences in the regulatory requirements for aflatoxins among different countries. In general, more stringent aflatoxin standards are found in wealthy industrialized countries with more developed market economies than in developing countries where subsistence farming still prevails. Table 2 shows the current aflatoxin standards (total and separate for aflatoxin BI) set by Africa, the European Union, the Southern Common Market (MERCOSUR), the United States, and the Codex Alimentarius.

The United States was among the first countries to establish aflatoxin limits. The country began regulating the concentration of aflatoxins in food and feed in 1968 following some of the early incidents of animal and human health problems related to aflatoxins. U.S. aflatoxin limits are set only for the sum of aflatoxins BI, B2, G1, and G2. The standard for total aflatoxin is 20 parts per billion (ppb) for human food and animal feed (maize and other grains) intended for immature animals or unknown destinations. In other categories, the standards are less stringent. For example, the maximum total aflatoxin levels can be as high as 200–300 ppb for maize and other grains intended for finishing livestock. Except for mandatory aflatoxin testing on U.S. maize exports, aflatoxin testing for domestically produced or imported foods and feed ingredients is not required by law.

¹ Less frequently, specific regulations exist for aflatoxin M1 in milk and milk products, and other mycotoxins such as patulin, ochratoxin, deoxynivalenol, diacetoxyscirpenol, zearalenone, T-2 toxin, chetomin, and fumonisins.

Table 2: Maximum Allowable Aflatoxin Levels by Africa, the EU, MERCOSUR, the United States, and the Codex Alimentarius

Product	Standard (µg/kg)	Product	Standard (µg/kg)
<u>United States</u>		<u>European Union</u>	
Raw peanuts (industry standard)	15	Groundnuts, nuts, dried fruit, and processed products thereof, intended for direct human consumption or as an ingredient in foodstuffs	4 [2]
Human food, maize, and other grains intended for immature animals (including poultry) and for dairy animals or when its destination is not known	20	Groundnuts to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	15 [8]
For animal feed, other than maize or cottonseed meal	20	Nuts and dried fruit to be subjected to sorting, or other physical treatment, before human consumption or use as an ingredient in foodstuffs	10 [5]
For maize and other gains intended for breeding beef cattle, swine, or mature poultry	100	Cereals and processed products thereof, intended for direct human consumption or as an ingredient in foodstuffs	4 [2]
For maize and other grains intended for finishing swine of 100 pounds or greater	200	Feed materials and complete feedstuffs with the exception of:	[50]
For maize and other grains intended for finishing beef cattle and for cottonseed meal intended for cattle, swine, or poultry	300	• feed materials from peanuts, copra, palm-kernel, cottonseed, maize and products processed thereof	[20]
<u>Africa (average)</u>		• complete feedstuffs for dairy cattle	[5]
Groundnuts		• complete feedstuffs for pigs and poultry (except young animals)	[20]
<u>MERCOSUR</u>	44 [14]	• other complete feedstuffs	[10]
Foodstuffs			
<u>Codex Alimentarius</u>	20		
Peanuts intended for further processing	15		

Note: Standards reported are for total aflatoxin B1+B2+G1+G2. Figures in parentheses are separate standards for aflatoxin B1. EU standards are after harmonization in 2002.

Sources: Dohman 2003, Otsuki et al. 2001, and FAO 2004.

Historically, the EU has had much more stringent standards for aflatoxins than other parts of the world. In 1997, the European Commission proposed a new harmonized standard for aflatoxins, setting acceptable levels of the contaminant in food and feed products. The proposed limits, implemented in 2002, were much lower than those in effect in most non-EU countries (including the United States) and some of the EU member countries. The harmonized regulation establishes a standard of 4 ppb of total aflatoxins (B1+B2+G1+G2) and 2 ppb of aflatoxin B1 in cereals (grains), edible nuts, dried and preserved fruits, and groundnuts (peanuts) intended for direct human consumption (Table 2). The levels for foodstuffs subject to further processing are set higher, in part as a result of the objections raised by some European trading partners. For example, the maximum total aflatoxin in groundnuts subject to further processing is set at 15 ppb (8 ppb for aflatoxin B1), and in other nuts and dried fruit subject to further processing at 10 ppb (5 ppb for aflatoxin B1). Despite the relaxation of the standards in certain food and feed categories, the levels set by the EU are still considerably lower than Codex Alimentarius recommendations (15 ppb for total aflatoxins) and the standards in many developing countries (20 ppb in MERCOSUR and 44 ppb in Africa for total aflatoxins) (Table 2).

Policy Issues

Difficulty in Setting Safety Standards

Food safety regulations regarding aflatoxins are contentious both within countries and internationally. It is preferable that aflatoxins be excluded from food and feed as much as possible to achieve best human and animal health protection. On the other hand, since the toxic substances are present in food and feed as natural contaminants, human and animal exposure cannot be completely prevented, and certain levels of aflatoxins must be tolerated. Given this dilemma, determining an appropriate tolerance level is the key to setting aflatoxin regulations. Indeed, for most countries, domestic and trade policies governing aflatoxins have taken the form of a product standard in which tolerance levels for the amount of aflatoxins are established.

Many factors, however, may influence the establishment of the tolerance levels, complicating the

policy setting for aflatoxins. According to FAO (FAO 2004), these factors are based on either scientific or socioeconomic grounds and typically include the following: (1) availability of toxicological data including hazard identification and hazard characterization; (2) availability of data on the occurrence of aflatoxins within and across commodities; (3) availability of analytical methods; (4) domestic trade interests and foreign trade regulations; and (5) domestic food supply situation. While the importance of each factor varies across countries and for each country over time, all of them are relevant and should be taken into account and weighed if proper regulations on aflatoxins are to be made. Clearly, scientific factors such as toxicological data and analytical methods on aflatoxins matter in their own right, but for developing countries, political and economic considerations such as food security and trade benefits are often of particular concern.

Food Safety and Food Security

Food security remains a critical issue for many developing countries. It is estimated that more than 800 million people in developing countries were still food insecure during 2000–2002 (FAO 2005). Growing food safety concerns exacerbate current food insecurity because the amount of food affected by hazardous agents or contaminants and thus considered unsafe for human consumption is substantial. For aflatoxins alone, a recent FAO estimate shows that as much as 12,000 tons of rice and 16,000 tons of maize are contaminated per year in Southeast Asia (FAO 2004). In India, 37 percent of groundnuts and 47 percent of maize would be considered unfit for human consumption under Codex standards (Bhat and Vasanthi 1999). These countries have significant food insecurity, and their dietary staples are heavily concentrated in crops susceptible to aflatoxins. For them, a central ethical question is whether to expend already scarce resources on improving domestic food safety.

Caswell and Bach (2007) argue that improvements in domestic food safety can have direct and indirect benefits, in terms of better health and higher productivity, that will eventually lead to food security and enhanced welfare of citizens in poor countries. This argument implicitly assumes, however, that sufficient domestic food supplies are available in these countries. When food supplies are limited and alternative diets are not possible, as is the case for many poor countries, stringent regulatory

measures (such as those to lower aflatoxin contamination) may put extra burdens on a country's food system and cause food shortages and higher prices. Usually the poor are harmed disproportionately by these price increases since their food budgets are more constrained and their nutritional status is more vulnerable to reduced consumption. To avoid doing harm to the poor, policy makers should always keep food security in mind when setting food safety regulations, whether for aflatoxins or for other food-related hazards. Efforts to mitigate food safety risks should not be adopted at the cost of sacrificing food supply or diverting resources from agricultural production.

Food Safety and Food Trade

The stricter EU harmonized aflatoxin standards have generated wide concern among EU trading partners (many of them developing countries) and an intense debate on the trade-offs between human health and trade opportunities. Otsuki et al. (2001) find that exports of cereals and cereal preparations from nine African countries to the EU during 1998 would have declined by 59 percent, or US\$177 million, under the more stringent EU harmonized aflatoxin standards compared with pre-harmonization. Adoption of the less strict Codex standards would have increased exports of cereals and cereal preparations by 68 percent, or US\$202 million in 1998. For edible nuts and dried and preserved fruits, the estimated decline in African exports to the EU was US\$220 million (47 percent) under the EU harmonized aflatoxin standards. Under the Codex standard, the estimated increase of exports was US\$66 million (14 percent). The study also finds that the harmonized EU standards would reduce liver cancer deaths by 0.9 per billion per year relative to pre-harmonization. The death reduction would be 2.3 per billion per year relative to the Codex. Based on these estimates, the harmonized EU aflatoxin standards would save approximately 1 person from liver cancer per year in the EU, which has a population of half a billion. This number is very small compared with the approximately 33,000 total deaths from liver cancer in the EU each year.

These results suggest that high standards (in developed countries) can impose high costs on exporters (developing countries) even though the benefits of these standards for human health are

modest.² To balance the food safety and trade benefits, the WTO Agreement on Sanitary and Phytosanitary Standards advises member countries to harmonize national standards with international standards such as the joint FAO/WHO Codex Alimentarius for food safety. But for precautionary reasons the agreement also permits importing countries to determine their own levels of protection of human health and to impose more stringent measures than the international standards. Since perceptions of tolerable health risk are not likely to converge among the developed and developing countries in the near future, trade disputes related to the setting of regulatory standards on aflatoxins are likely to persist.

Trading Up or Trading Down

Worldwide aflatoxin regulations continue to be at the forefront of trade policy debates, and a number of important questions and considerations have been raised. As the discussion already shows, food safety concerns, such as those related to aflatoxins, emanate primarily from high-income consumers and producers in the developed world. What are the implications of these standards for food safety in developing countries? Are foods in developing countries becoming safer because of the higher standards set in the developed countries? Or is there a lack of such spillover effects?

Different perspectives exist on how food safety standards in developed countries affect those in developing ones. One perspective is that higher food safety standards in developed countries add additional health risk burden to the exporting countries since only the best-quality food leaves the country, leaving commodities with higher levels of contamination for the domestic population (a "trading-down" argument). An alternative perspective is that in order to meet the higher standards in the export market, investments in food safety must be made in the food system within a broader context of public health and nutrition, which could eventually raise domestic food standards (a "trading-up" argument). One case study on the Hazard Analysis and Critical Control Point (HACCP) standards in Brazil's fishery industry (Donovan et al. 2001) shows that many domestic

² The estimated trade impacts reported in Otsuki et al. (2001) have been questioned by others, including Jaffee and Henson (2004) who found smaller negative trade effects.

plants have adopted the system, which was originally required for exporting plants. In addition, investments in export infrastructure to enhance food safety can be expected to generate indirect health benefits through higher incomes.

Harmonization

A second question is whether there should be global harmonization of food safety standards given the existence of serious trade disputes due to drastic domestic regulatory differences. It is clear that a fragmented system of conflicting national standards and a lack of agreement on globally accepted regulation of food safety attributes, such as those related to aflatoxins, is a major source of trade friction. The rising number of notifications to the WTO about sanitary and phytosanitary barriers reflects this fact. Studies (such as Wilson and Otsuki 2001) have shown that a harmonized standard, like Codex, can significantly reduce friction and increase trade. Global harmonization of food safety standards offers apparent benefits, which can be critical for some developing-country exporters.

Yet even though global harmonization of standards may be preferable, it may not be possible. How can countries set common standards that are neither too high nor too low—that is, reasonable and acceptable to all? Countries, developed and developing alike, are faced with the difficulty of balancing reductions in human health risk against benefits from trade in setting aflatoxin standards, or food safety standards in general. Clearly, the criteria for determining “appropriate” or “reasonable” levels are likely arguable. In some cases, the health risks and trade losses associated with regulatory regimes cannot be quantified owing to a lack of data and an analytical framework. Even in cases where risks and trade losses can be quantified, social and political priorities attached to public health or gains or losses from trade tend to differ across countries and within countries over time, leading to policy measures favoring one against the other.

Despite efforts toward global harmonization, a common international framework and common criteria to weigh the benefits and costs of regulations are still elusive, and a convergence of standards is not likely to occur in the near future. The SPS Agreement of the WTO attempts to set general guidelines for trade in agriculture to ensure

that standards are based on sound science, but at the same time it allows members to set domestic standards at any level they deem appropriate. Even within the Codex, a harmonized standard can sometimes be problematic. For example, even though the Codex sets a maximum level of 15 ppb for total aflatoxins, a level that many countries consider “reasonable”, the genotoxic properties of aflatoxins, uncertainties in risk assessment, and precautionary practices have led many other countries to favor a lower limit of 10 ppb.

Stakeholders

Consumers and Producers

Aflatoxins pose health risks for individuals who consume contaminated food products. The possible negative economic impacts include productivity loss due to hospitalization (morbidity) and premature death (mortality), as well as the costs of public and private health care services. The human health costs of aflatoxins are difficult to quantify, however, partly because the exact relationship between aflatoxins and some of the chronic diseases they are suspected of causing has yet to be identified scientifically.³ For individuals affected by aflatoxins, there is also the intangible cost of pain, suffering, anxiety, and reduction of the quality of life due to aflatoxin-induced diseases.

Consumers are affected by domestic or foreign aflatoxin regulations. For consumers in an importing country, high domestic aflatoxin standards reduce the risk of poisoning, but they also increase the price of the relevant food products because of the decrease in the amount of imports that are susceptible to aflatoxin contamination. Consumers in an exporting country may be affected by foreign aflatoxin standards because these standards can affect their income (through trade) and are considered to have a trading-up or trading-down effect on the country’s food safety. Consumers can also affect the levels of food safety related to aflatoxin either indirectly through pressure for higher regulatory standards or directly through purchases in the marketplace (Caswell and Bach forthcoming).

³ The current available information on metabolic activation and detoxification of aflatoxin in various animal species does not allow the identification of a fully adequate model for humans.

Adverse economic effects of aflatoxins on farmers include lower yields and discounted selling prices for food and fiber crops. Losses to livestock and poultry producers from aflatoxin-contaminated feeds include the death of animals and the more subtle effects of immune system suppression, reduced growth rates, and losses in feed efficiency. In addition to these direct costs in production, indirect costs can arise from regulatory programs designed to reduce aflatoxin risk during various stages of the production chain and from rejected shipments in agricultural trade. Numerous studies are available assessing the economic impacts of aflatoxin contamination at the commodity, country, and global level, but it is difficult to estimate exact losses at disaggregate levels, and so far no comprehensive study exists that can provide a consistent and uniform assessment of the mycotoxin/aflatoxin-induced costs.

Like consumers, farmers are affected by domestic and foreign aflatoxin standards. In an importing country, high aflatoxin standards tend to have two offsetting effects on domestic farmers: they drive up farmers' production costs and they set barriers to protect farmers from foreign competition. The latter effect is, however, detrimental to farmers in an exporting country. In general, farmers are more political powerful than consumers and they can, to a larger extent, influence the setting of these standards.

Developed and Developing Countries

Food and feed contamination caused by mycotoxins, and in particular aflatoxins, has considerable social and economic implications for countries worldwide. Miller (1995) estimates that 25–50 percent of the world's food crops are affected by mycotoxins, of which the most notorious are aflatoxins. According to a recent study by the Council for Agricultural Science and Technology (CAST), annual crop losses from mycotoxin contamination for maize, wheat, and peanuts average US\$932 million in the United States (CAST 2003). Additional losses stemming from regulatory efforts to prevent and reduce contamination averaged US\$466 million. Livestock losses were estimated to be US\$6 million annually. In Australia, about 10–50 percent of total peanut production is affected by aflatoxin contamination. Postharvest treatment costs the peanut industry at least A\$1 million per year (Bhat and Vasanthi 1999). For countries with

significant aflatoxin contamination, the economic impacts increase substantially if the health costs and related economic losses from aflatoxin-induced human illnesses are taken into account.

Because molds occur more frequently in tropical and subtropical conditions than in temperate conditions, aflatoxin problems are particularly prevalent in some developing countries. For example, it is estimated that in Indonesia, the Philippines, and Thailand, 5 percent of maize and peanuts produced are discarded because of fungal contamination. The direct costs of aflatoxin contamination of maize and peanuts in these three countries amounted to A\$477 million annually, with most of the losses (66 percent) accounted for by maize (Bhat and Vasanthi 1999). The African Groundnut Council estimated that the annual cost of implementing a program to reduce aflatoxin contamination in its member countries could reach US\$7.5 million.

There are some estimates of the negative impact of aflatoxins on export sales in developing countries. For instance, Thailand was among the world's leading maize exporters during the 1970s and 1980s, regularly ranking among the top five exporters. Partly owing to aflatoxin problems, however, Thai maize sold at a discount on international markets in the 1980s cost Thailand about US\$50 million per year in lost export value (Tangthirasunan 1998). In India, it was reported that the export sales of groundnut extractions declined US\$32.5 million between 1980 and 1990 (Bhat and Vasanthi 1999). Otsuki et al. (2001) estimate that aflatoxin contamination can cost African exporters up to US\$670 million per year in lost cereal and nut export sales under the new harmonized EU safety standards. Of course, developed countries also suffer from welfare losses as a result of limited trade due to aflatoxin contamination and its regulations.

Policy Options

Enhancing food safety is important to improved health and nutrition in all countries. For developing countries where food security is still a compelling issue, an improvement in food safety poses an additional challenge. One strategy for fulfilling the dual tasks of lowering health risks and guaranteeing sufficient food supply is to instruct food producers and handlers on ways to reduce aflatoxin contamination "at source" and to encourage the adoption

of process-based approaches. Some examples are good agricultural practices (GAPs) before harvest, good manufacturing practices (GMPs) after harvest (Dohlman 2003), and the use of HACCP.⁴ Risk mitigation is thus achieved throughout the production, handling, and processing chain with limited impacts on the final output. Bhat and Vasanthi (2003) argue that prevention and control measures in developing countries should also be pro-poor, well focused, and cost-effective. To minimize the negative impact on the food supply and yield the greatest public health benefits, the focus should be on high-risk agricultural commodities during high-risk seasons in high-risk areas among high-risk population groups for selected aflatoxins.

In the arena of trade policy making, the misuse or abuse of a “precautionary approach” should be prohibited while more extensive use of science-based, risk analysis principles should be promoted. Under these principles, countries should conduct risk assessment to evaluate the degree of risk posed by a food safety hazard, apply risk management principles to identify effective regulatory measures to address the risk, and use risk communication to make the process transparent. By standardizing decision making using the risk analysis framework, countries can formally justify their decisions and eliminate inconsistencies in regulatory measures—for example, a too stringent or lax approach to mitigate a particular risk.

Despite efforts to focus their regulatory decision making through the use of risk analysis, rich countries still have more stringent regulations, which are likely to persist in the future. Overly stringent food safety regulations impose undue economic burdens on lower-income, food-exporting countries. These standards limit export opportunities because compliance is either too costly or unachievable given a lack of technical capacity, infrastructure, and food hazard management experience. To minimize the risk of aflatoxin contamination and reduce the likelihood that tolerance levels will be exceeded, the private and public sectors need to consider investing in basic infrastructure related to the implementation of process-based standards such as GAPs, GMPs, and HACCP.

⁴ In its 34th session held in 2002, a Codex Committee on Food Additives and Contaminants (CCFAC) report recommended that GAPs and GMPs be used to establish formal HACCP food safety systems to identify, monitor, and control mycotoxin (aflatoxin) risks.

Transfers of technology and technical assistance from developed to developing countries to help meet food safety standards would be needed. These efforts would increase safety for both importing and exporting countries while simultaneously expanding access to important agricultural markets for the developing countries.

The WTO disciplines suggest that harmonization and equivalence are the preferred methods of ensuring nondiscrimination in trade. If global harmonization is proven to be trade facilitating and welfare enhancing (which has been shown in numerous empirical studies) and the Codex standards, guidelines, or other recommendations are deemed science based, appropriate, and non-discriminatory (which is still controversial), then the WTO disciplines should be strengthened and progress must be made on harmonized international standards set by the Codex. A concerted effort is needed to identify key food safety standards that have not been harmonized by the Codex, and action to accelerate progress on this effort through international consensus would help avert trade friction caused by divergent national standards. If, however, the poor and the nonpoor have different opinions on food safety standards, it is unclear whose standards will prevail and eventually become the norm.

Assignment

Given the fact that regulatory limits and standards for aflatoxins (and mycotoxins in general) in food and feed products vary widely across countries and regions, your assignment is to develop policy responses of the following three groups when their food safety regulations are in conflict with each other: the EU, the developing countries, and parties involved in the Sanitary and Phyto-Sanitary Standards (SPS) of the World Trade Organization (WTO) or the Codex Alimentarius (harmonized standards).

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