AFLATOXIN MITIGATION CENTER OF EXCELLENCE

Preventing Health Hazards and Economic Losses from Aflatoxin

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Aflatoxins: Potential Health Threat to Humans and Animals

Mycotoxins are toxic compounds produced by naturally occurring fungi in grains, nuts, and oil seeds. Aflatoxins are mycotoxins produced by the fungi, *Aspergillus flavus* and *A. parasiticus*. Numerous variations of aflatoxin occur with the most potent being aflatoxin B1. The use of products contaminated with aflatoxin is regulated by action levels established by the FDA.

Corn, cottonseed, peanuts, tree nuts and their products can be contaminated by aflatoxin. Corn is the most widely grown crop that can be affected by aflatoxin contamination in the U.S. Heat, drought, high humidity and insect infestation predispose corn to infection by aflatoxin-producing fungi which often results in aflatoxin contamination of the grain. Every year these conditions occur somewhere in the U.S. with resulting aflatoxin contamination exceeding action levels which start at 20 parts per billion (ppb). While aflatoxin contamination of corn more commonly occurs in the South, under certain environmental conditions, its distribution can expand to negatively impact a significant portion of the total corn crop:

- Aflatoxin in Georgia corn ranged from 6 to 622 ppb and averaged 97 ppb in a survey conducted over a 28-year period.
- In Texas, recent aflatoxin surveys showed that more than 50 percent of the counties had one or more corn samples that exceeded action levels.
- Alabama, Louisiana, Mississippi and North Carolina as well as States in the Mid-South have experienced periodic severe aflatoxin contamination in their corn crop.
- As recently as 2007, aflatoxin contamination on corn was prevalent in the Corn Belt where widespread heat and drought occurred.

Aflatoxin is a potential health threat to:

- humans
- livestock
- poultry
- pets
- game birds
- trout
- deer
- other wildlife

Aflatoxin may cause:

- low rates of weight gain
- impaired immune systems
- reduced vigor
- death

Food and Feed Safety

Aflatoxin contamination endangers the food supplies and health of both people and livestock. This threatens the economic livelihood of crop producers, livestock producers, commercial feed users, and numerous feed and food industries.

Milk from cows that consume contaminated feed can transfer the toxins to humans. People can also consume the toxins through common foodstuffs derived from contaminated sources.

As recently as 2006, a national pet food manufacturer had to recall 18 products from over 20 states that were tainted with aflatoxin. U.S. corn exports are being rigorously tested by importing countries to insure their freedom from aflatoxin. Economic losses are borne by grain producers and handlers, distributors and shippers, and feed manufacturers and sellers. Farmers, ranchers and commercial feeders also bear the economic burden

because of poor animal performance, death following immune system damage, and litigation. Aflatoxin occurrences in the South limit the increased production of corn where it is otherwise well adapted.

Wild animals and birds (including large mammals such as white-tailed deer) consuming contaminated feeds purchased by the public as wildlife feed can suffer liver damage, reduced reproductivity, and impaired immune system function, which can cause death from secondary illnesses.

Economic Losses

The economic impact of aflatoxin contamination is difficult to measure, but the following losses have been documented. From 1990 to 1996, litigation costs of $34 million from aflatoxin contamination occurred. In 1998, corn farmers lost $40 million as a result of aflatoxin contaminated grain. In 2002, 30 million bushels of corn were discounted more than 25 percent. Millions of dollars are paid annually from crop insurance to corn growers who are adversely affected by having aflatoxin contaminated grain. In 2008, more than $15 million was paid out for crop losses due to aflatoxin contamination in corn. Every year where stress environments more frequently occur, corn is rejected at elevators because of the high level of aflatoxin contamination. As of now, the average direct loss is estimated at $200 million annually for corn. Indirect losses because of contaminated byproducts, such as distillers' grain, compound these losses. Ultimately, all contribute to increased costs to consumers.

Deer and other wildlife can become ill after eating contaminated feeds offered by well-meaning humans.

Meeting the goal of an ample, affordable and safe food supply.

Solving the Problem of Aflatoxin Contamination

Reducing the adverse impacts of aflatoxin in human and animal diets will have wide-ranging economic benefits. Research investments made today will reduce direct losses to corn growers, indirect losses from contaminated byproducts of corn bio-energy and the food and feed industry, and result in less expenditure for crop loss by crop insurance providers when solutions are deployed.

An integrated and focused approach can hasten solutions to substantially reduce the outbreaks of aflatoxin contamination. An Aflatoxin Mitigation Center of Excellence is proposed to facilitate field deployment of solutions to aflatoxin contamination in corn. Sponsors of the Center have met, reviewed the research conducted to date, and identified the following as specific components of this proposed multi-disciplinary research program:

- promoting and refining biological control and ecology,
- developing resistance through breeding and genetics,
- identifying best management practices, and
- improving and obtaining approval of remediation procedures for contaminated grain.

Due to the complexity of the aflatoxin problem and the diverse geography involved, it is important to investigate efforts on all four fronts to be able to attack the problem with a control package rather than relying on a single control factor.

Biological Control and Ecology

Biological control of aflatoxin is approved and is being used for peanuts and cottonseed. A specific bio-control has just been extended to include corn. The control works by applying a naturally-occurring atoxigenic (non-toxin producing) strain of the fungus to displace the toxigenic (toxin producing) strain of the same fungus, thereby greatly reducing the probability of contamination of the grain. The approval for use on corn comes from positive results obtained from controlled conditions. Optimum criteria for rearing substrate to use, application timing, dosage, strain selection, management options and a measurement of efficacy need to be determined and refined for the corn crop working with suppliers and the farming community. This co-evolving research needs to involve stewardship combing stakeholder input and extension outreach before the technology will be able to establish itself in the marketplace.

Resistance through Breeding and Genetics

Some very good sources of resistance have been developed but are agronomically unacceptable for commercial production. When the genes responsible for resistance have been identified, they must be recombined with superior germplasm to make them agronomically competitive. Successful breeding relies upon exploiting numbers and probabilities. This effort will require an increase in number of genetic combinations and environments sampled so that the best recombined material can be identified and released for use. Ultimately, these resources will allow the private sector to incorporate higher levels of resistance to aflatoxin accumulation into their own germplasm and develop better adapted corn varieties to combat aflatoxin contamination. This will allow for increased acreage of corn in the U.S. to contribute to an ever increasing demand for corn.

Inoculations to measure resistance are very labor intensive.

Researchers can identify atoxigenic fungal strains which can be used as biocontrol agents.

Best Management Practices

The goal is to develop a Corn Aflatoxin Risk Index (CARI). Since the initial work in this area was conducted, the landscape has changed requiring a possible reprioritization of factors that can influence aflatoxin contamination. These factors include: planting date, varietal maturity, varietal resistance, husk coverage, insect resistance, drought resistance, kernel composition, specific transgenic traits, row

spacing, irrigation, rotation, tillage, use of other controls, harvest procedures, drying and handling methods, commonly used control methods, and novel biocontrol methods. This index will be made publicly available to corn growers and handlers so they can determine the best management practice procedures available to minimize aflatoxin contamination. The CARI will be updated as needed to acknowledge changing agronomic or managerial options.

Remediation of Contaminated Grain

Research conducted in areas where aflatoxin is chronic has shown that certain clays, when mixed at low rates with grains, can bind aflatoxin and greatly reduce aflatoxin's effect on animals and humans. The remedy is inexpensive and easily disseminated. Analyses of the molecular structure of the toxin and the clay-specific lattices that can bind the toxin molecules have shown scientists how to extend the technology to a range of toxins and clay binders. However, extensive testing and refinement of the technology is needed to identify safe, effective clays, and the rates and methods of mixture for each food and feed with a cost-effective delivery and utilization system. Data on feed additives and best detoxification methodology needs to be developed to be able to promote an approved regional solution to aflatoxin contaminated grain that is accepted nationally.

Multistep processes used in the manufacturing of many corn products need investigation to determine the potential for site specific fractionization and elimination of aflatoxin from contaminated grain during the product's manufacturing.

Partners in Aflatoxin Mitigation Research

Alabama Farmers Federation
Alabama Soybean & Corn Association
American Farm Bureau
Corn Producers Association of Texas
Delta Wildlife
Georgia Agribusiness Council
Georgia Corn Growers Association
Georgia Farm Bureau
Louisiana Farm Bureau Federation
Louisiana Cotton and Grain Association
Louisiana Soybean and Grain Research and Promotion Board
Mississippi Corn Growers Association
Mississippi Corn Promotion Board
Mississippi Farm Bureau Federation
Mississippi Feed and Grain Association
National Corn Growers Association
North Carolina Corn Growers Association
North Carolina Farm Bureau
Southern Ethanol Council
South Texas Cotton & Grain Association
Southwest Council of Agribusiness
Texas Association of Dairymen
Texas Cattle Feeders Association
Texas Corn Producers Board
Texas Farm Bureau
Texas Grain and Feed Association

Resource Needs

Growers invest $1 million in public aflatoxin mitigation research projects seeking commercial solutions annually. Funding this Center compliments and extends the existing effort to bring aflatoxin mitigation solutions to the field. Annual funding of $5 million for five years from the National Institute of Food and Agriculture (NIFA) is requested to bring the benefits of biocontrol, resistant varieties, best management practices, and remediation technologies to address aflatoxin contamination in corn.