Journée d'information sur les MYCOTOXINES
Un enjeu de filière, une concertation nécessaire

A Tale of Contrasting Economic Reaction to Mycotoxin in Maize and Wheat in the Same Agricultural-System in Ontario, Canada

Victor Limay-Rios, Ph. D., *Université de Guelph*, Ontario
Collaborateurs : A. W. Schaafsma, D. Hooker et L. Tamburic, *Université de Guelph*, Ontario

Mycotoxins are secondary metabolites produced by fungi that when ingested at low concentrations are harmful to human and animal health. Toxins from *Fusarium graminearum* [deoxynivalenol (DON), zearalenone (ZEA)] are commonly found in wheat, barley and corn and their derived products. In Ontario, widespread occurrences of mycotoxins and substantial economic losses have occurred during periodic epidemics of *Fusarium* rendering grain unsuitable for human or animal consumption. The root causes of the epidemic and the consequent mycotoxin accumulation in grains are complex and multi-factorial. This paper makes comments on why we believe there is a contrasting approach between these two cropping systems within the same region.

In 1996 Ontario experienced the worst *Fusarium* epidemic in recent history in wheat resulting in direct losses of well over $100 million Canadian dollars (CDN, Schaafsma 2002). The market focus remains primarily food grade. As such, the awareness of DON entering the food change has influenced marketing and trade. To address the fear of toxin contamination, several market restrictions for DON have been set. The Chicago Board of Trade will only accept up to 5 ppm DON (spring 1998), while a new limit of 0.5 ppm DON has been exercised in some breakfast cereal markets. The 1996 event precipitated a gathering of industry stakeholders including producers, grain handlers, millers, crop protection industry, breeders, government at both provincial and federal levels and academia to design strategies to collectively prevent further harm to the sector. The stakeholders supported and developed an integrated management system to diminish the effect of mycotoxins during future epidemics. Over 13 years this strategy has yielded significant progress on: breeding for more tolerant varieties, an improved variety registration system, implementing fungicide recommendations and improving application technologies, developing a pre-harvest forecasting system (DON-Cast) as well as setting up surveillance strategies and mycotoxin testing.

In contrast, more than 20 years have passed since the first severe epidemic of Gibberella (Fusarium) ear rot in corn in 1986 and very little progress has been achieved toward the development of an integrated approach as was evident in the severe epidemic of 2006. The episodic event of 2006 cost Ontario's corn industry over $60 million (5.08 million t at $12/t). This does not account for the multimillions lost in the swine industry because of limited access to clean corn and increased cost of replacing contaminated corn. The lack of an early warning system and poor communication tools caused a delayed reaction in the industry to the crisis until harvest time. The lack of coordinated effort created dissentions and tension amongst industry stakeholders. In our study, among the 2029 corn samples analyzed in 2006, 83.4% contained toxin levels ranging from 0.5 to 54 ppm. The average concentration (4.8 ppm) exceeded levels for recommended tolerance specified in the Canadian regulatory guidelines for swine, young calves and lactating dairy animals. Furthermore, 27.2% were contaminated with DON levels greater than 5 ppm exceeding levels for recommended tolerance for grains and grain by-products destined for ruminating beef and feedlot cattle older than 4 months and chickens (not exceeding 50% of the cattle or chicken total diet).

The use of susceptible wheat cultivars and corn hybrids is largely responsible for incidence of *F. graminearum*. Under epidemic conditions, agronomic practices have modest impact on the disease (Miller, 2008). In wheat, all varieties must be recommended for registration by the Ontario Cereal Crop Committee, disease factors for registration include some resistance to *Fusarium* compared to a check variety. On the other hand, the corn hybrid registration requirements were abandoned approximately 10 years ago resulting in corn hybrids with a huge range in their response to DON accumulation. On average, in 2006, only 28.7% of commercially available corn hybrids were moderately resistant to DON accumulation, whereas 61.8% and 9.6% were susceptible and highly susceptible to DON contamination, respectively. The advent of transgenic corn and the logistical challenges of handling seed inventory led to a narrow genetic pool of widely adapted high yielding hybrids, perhaps at the expense of some disease resistance.

There is a distinct difference between the two commodities in their end use and the associated mycotoxin regulations (feed/industrial for corn versus food for wheat) and a different approach to grain trading giving more opportunities to mitigate mycotoxin problems by dilution in the corn market. In a feed marketplace where ethanol producers are not operating, corn-based feed can be partitioned into diets suitable for swine, cattle and poultry, following the respective CFIA and FDA guidelines, as appropriate, with swine preferentially accessing the lowest-contaminated material. In a marketplace where ethanol production is important, it would be likely that both swine producers and ethanol plants would compete for the least contaminated, most valuable corn. These types of structural changes have been observed in relation to *Fusarium* mycotoxins on other occasions. In Ontario where soft white winter wheat has been highly affected a number of times since 1981 by *Fusarium* head blight, a valuable component of the market (breakfast cereal production) sought the very best quality grain after a particularly severe *Fusarium* epidemic in 1996. Upto 1996 the dilution of grain had been common (although contrary to regulations), this practice stopped because of the buyer's risk involved (Schaafsma et al, 2009).

The presence of mycotoxins in corn and processing co-products derived from ethanol production affects their utility as animal feed supplements. Toxin concentration increases by a factor of 3 on a dry weight basis in distiller's dried grains with solubles (DDGS) compared to the starting corn. Our data also indicates that concentrations in the grain corn entering ethanol plants should be close to the dietary values recommended for swine in Canada and the United States for DON (1 ppm). As noted above, in bad Fusarium head blight / Gibberella ear rot years, the feed and ethanol plant markets will compete for quality corn (Schaafsma et al, 2009).

In *Fusarium* epidemic years, there are very large economic and social consequences to grain producers (yield loss, quality penalties), swine producers (higher feed costs, increased time to finish, increased disease), handlers and distributers (testing, litigation, occupational health issues); and society in general (regulatory oversight, increased testing, market instability, reputation loss in exports). As well, the effect of elevated levels of mycotoxins in feed on the health of individuals working in the barn is of concern. However, natural wide-spread epidemics also offer a unique opportunity to collectively investigate, validate and challenge our current level of understanding of the disease and the efficiency of different control measures under heavy pathogen pressure. Back in the late 80s and 90s significant research on corn disease management was carried out in our laboratory. However, much of this knowledge base has not been applied due to the lack of industry support. One possible approach to managing mycotoxin contamination in corn is the use of an integrated system. The wheat industry has, as a result of past experience, developed procedures for responding to future episodic events and this is a goal the corn industry should strive to develop.

Our project entitled “Development of an integrated mycotoxin management system in Ontario grains” seeks to build on this earlier knowledge base and what we learned from 2006 to develop an integrated mycotoxin management system in Ontario grains. Furthermore, it brings together industry, researchers, corn producers and hog farmers to develop and test the key preventive tools that will allow them to mitigate the impact of mycotoxin contamination in epidemic years.

This project stresses the importance of preventive measures to manage mycotoxin contamination in corn. The control system will include: 1) Evaluation of the contamination process through surveillance; 2) Investigation of practical and innovative analytical methods to improve the accuracy of mycotoxin determination using near infrared for DON and liquid chromatography techniques for multitoxin detection; 3) Evaluation of the sensitivity of commercial corn hybrids *to Fusarium* infection or mycotoxin accumulation for risk reduction purposes; and 4) Evaluation of early warning forecasting systems and fungicide management tools to control Fusarium infection and/or mycotoxins accumulation in wheat and corn field trials. Information on commercial hybrids will allow pork producers to select hybrids that may lower the risk of mycotoxicoses in swine and perhaps, keep the highly susceptible hybrids out of the food production chain. The information generated in this project will be essential in providing technical guidance to mitigate mycotoxin contamination in *Fusarium* epidemic years.

References:

Schaafsma Arthur W. 2002. Economic changes imposed by mycotoxins in food grains: case study of deoxynivalenol in winter wheat. Advances in experimental medicine and biology 2002, 504:271-276.

Miller J. David. 2008. Mycotoxins in small grains and maize: old problems, new challenges. Food Additive and Contaminants, 25(2): 219-230.

Schaafsma Arthur W, Victor Limay-Rios, Diane E Paul, J David Miller. 2009. Mycotoxins in fuel ethanol co-products derived from maize: a mass balance for deoxynivalenol. Journal of the Science of Food and Agriculture, 89 (9):1574 – 1580.