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# Technical Bulletin

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volume 08.08

## Understanding Mycotoxins

by Ron Cravens MS, DVM

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### Managing Mycotoxins in Livestock Production

Mycotoxin contamination at some level can be present in virtually all feedstuffs at any time. Levels vary from high to low with wide variation in what particular toxins are present. If one toxin is present, it is probable that many others are also present.<sup>1</sup>

Mycotoxins are naturally occurring toxic substances produced by various molds commonly found in animal feedstuffs. Whereas molds are living organisms that can be killed by certain treatments (heat, acid, etc.), mycotoxins are stable toxic chemicals that are nearly impossible to destroy in non-laboratory environments.

Mycotoxins have always been present in feedstuffs but their detrimental effects are more recognized today for various reasons.<sup>2</sup> New grain testing technologies allow pinpointing toxins at extremely low levels that were previously undetectable. With today's testing capability some mycotoxins can be detected in parts per million (ppm) or even parts per billion (ppb). For perspective, one part per million is equivalent to one kernel of corn in 14 bushels, while one part per billion is equivalent to one second in 31 years.

Agronomic practices such as no-till farming and tube and bunker silage may also increase or concentrate mold spores over time and ultimately

increase mycotoxin levels.

Most importantly, as we stress animals for ever greater performance, the negative impacts from variable environmental factors and disease agents, including mycotoxins, cause more clinical disease and take a larger toll on profits.

### What Level of Mycotoxins Should Concern Me?

In the United States and most other countries worldwide, specific levels of some individual toxins are prohibited in feed or at least strongly warned against being fed to particular species and age or

production groups.<sup>3</sup> The Council for Agricultural Science and Technology has identified the potential for as many as 30,000 unique mycotoxins, most of which we do not have tests available to measure today.<sup>4</sup> The commonly measured and widely studied mycotoxins are aflatoxin, zearalenone, vomitoxin (DON) and fumonisin. Most published research relates to individual mycotoxins that are evaluated in well controlled studies using relatively high levels of purified toxins.

A consistent finding from field mycotoxin outbreaks is that the amount of toxin required for clinical effect is significantly less when naturally contaminated feed is used versus adding purified

#### CONDITIONS THAT FAVOR MYCOTOXIN PRODUCTION

##### In the field:

- Drought stress and insect damage
- Wet and/or delayed harvest
- Early frost or hail

##### In transport, storage and silage:

- Broken and exposed grains
- Overly moist feedstuffs at any temperature
- Warm, humid storage

toxin to an otherwise mycotoxin free diet. The reasons given for the difference in toxicity between naturally contaminated feedstuffs and purified toxins vary. Natural conditions usually produce multiple toxins and there is proven synergistic interactions among various mycotoxins leading to enhanced toxicity.<sup>5,6,7,8,9</sup> Mycotoxin exposures in typical livestock production situations are not well controlled. It is common for multiple mycotoxins to be present in the ration and it is the probable basis for clinical effects with even low measured toxin levels.

From the above, it is apparent that Total Toxin Load in the ration is an important contributor to clinical effects seen in the animals. Therefore it is important to recognize that testing for one or a few mycotoxins may best be used as an indication that toxins are present and that clinical effects are possible. Also, indirect effects of mycotoxins, like immunosuppression, can lead to outbreaks of diseases associated with common bacteria, (*E. coli*, salmonella, etc.) and viruses (AI, BVDV, PRRS, etc.).

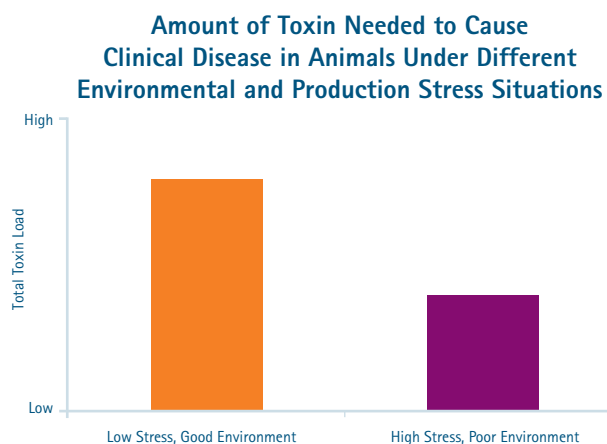
### Effects of Multiple Mycotoxins on Animals

The health effect of different toxins or, more importantly, combination of toxins is highly variable by species. Effects often include reduction in milk, meat, and egg production, reduced feed consumption, immunosuppression (which can lead to other common diseases), infertility and liver damage. The term “clinical effect” is used to describe these and other generally recognizable symptoms and signs of animal sickness.

Just because toxins are present does not mean that a given animal will be clinically affected. As with other diseases, clinical problems are caused by an interaction between the animal, its environment and the disease agent or toxin. For example, an animal will tolerate more toxin exposure when in a low stress, clean, comfortable environment than when in a cold, wet or muddy environment under heavy production stress (Figure 1).

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FIGURE 1



It is important to remember that a group (herd or flock) of animals is made up of individual animals all with their own ability to resist disease. As a result some animals show clinical symptoms while others do not, even when they are all exposed to the same disease agent or toxin. This is typical of biological systems in which individual animals are more or less susceptible than other herd mates. In general, immature animals are particularly sensitive to low levels of toxins that go unnoticed in older members of the herd or flock.

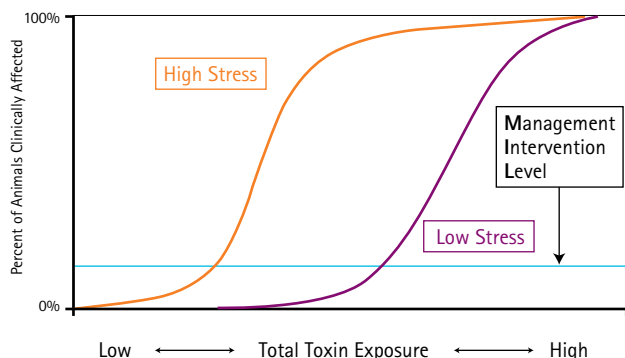
The number of clinically affected animals in the herd varies with the amount of total toxin exposure. As Total Toxin Load increases, the number of animals showing clinical signs will increase, yet the relationship is not directly one-to-one. That is, exceeding a certain level of total toxin exposure dramatically increases the number of animals affected (Figure 2).

The overall performance impact is minimal or acceptable at lower levels of mycotoxin exposure, but progression past a certain level causes significant negative impacts on animal performance. We call this the Management Intervention Point.

The Management Intervention Point (MIP) is the point at which the herd level of clinical disease is sufficient to create negative effects in terms of health and/or productivity such that overall operational profits are significantly reduced. It is highly variable between herds and over time. It is dependent on

FIGURE 2

**Percent of Animals in a Herd Showing Clinical Disease at Different Total Toxin Exposure Levels Under Different Production Stress Situations**



the animal’s ability to resist or tolerate disease and the amount of exposure or disease challenge. Environment also relates to reducing or increasing animal resistance or disease challenge.

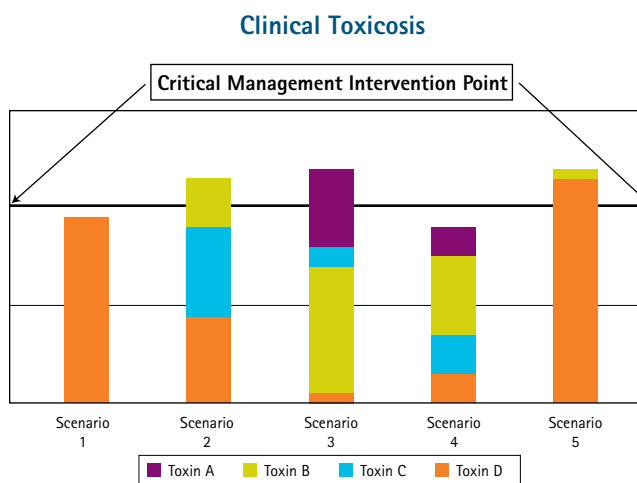
To optimize animal performance, livestock managers need to prevent widespread clinical effects of mycotoxins in the herd. Some action or “intervention” by managers is necessary before reaching the MIP. When and how to intervene depends on a combination of the factors previously discussed: production stress, Total Toxin Load, and herd toxin tolerance.

For our discussion, Total Toxin Load (TTL) is defined as the combination of all the identified and un-identified mycotoxins in the total ration that the animal is consuming. This includes all the concentrates, roughages and premixes that make up the daily ration. The implications for intervention are significant because it is difficult to know the TTL at any given point in time. Figure 3 provides a hypothetical series of different scenarios where the total mycotoxin load is made up from one to four different toxins. It is not necessary to know what the specific toxins are, only that they are present in various amounts and mixtures. As previously discussed, the MIP is the point at which it is economically important to implement a control program to mitigate the negative effects of mycotoxins in the herd or flock.

For simplicity, the MIP has been set at a constant level for all scenarios. Scenarios 1 and 4 represent levels of mycotoxin contamination below the MIP and go unnoticed in the herd. In contrast, Scenarios 2, 3 and 5 are above the MIP and cause considerable problems in a high percentage of animals. In these three scenarios, management intervention is necessary to prevent significant production losses. Notice that Scenarios 2 and 3 are caused by a mixture of mycotoxins while Scenario 5 is caused by one main toxin.

The objective is to reduce the total toxin level below the MIP. Therefore total elimination of any one toxin is not necessary, rather even small reductions in several toxins will eliminate clinical effects. Recall that the intervention point varies from farm to farm, and between seasons and animal groups based on overall management practices, i.e., animal stress levels. A key conclusion is that identifying and eliminating a single mycotoxin is often not the most effective management strategy.

FIGURE 3



**How do I guard against future mycotoxin problems?**

An essential part of any good mycotoxin management plan is the selection and/or harvest of quality feed ingredients and ensuring their proper delivery and storage. This is basic to lowering the probability of mold and mycotoxin contamination and mold growth. In climates or seasons with

overly wet, dry or otherwise damaged feedstuffs, an affordable mycotoxin testing and screening program can provide cost-effective warning signs of mycotoxins. In such cases, including products designed to lower the Total Toxin Load in the ration can help maintain animal performance before significant problems occur and also protect your investment in other key nutritional and health products such as vaccines and antibiotics.

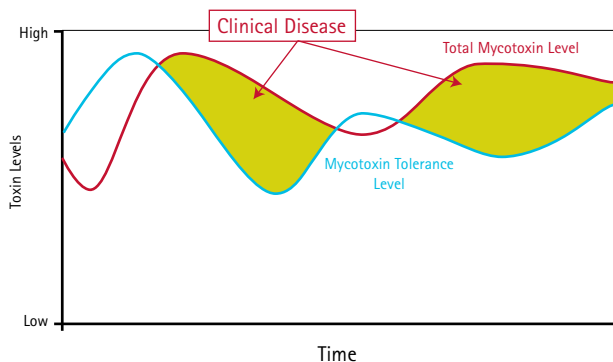
## Conclusion

We can say that some level of mycotoxins are almost always present in feedstuffs, but the mixture

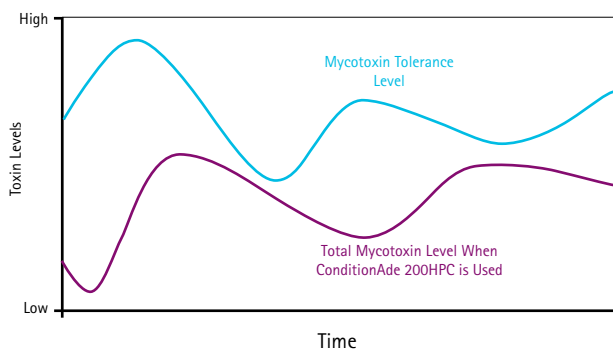
FIGURE 4

### Managing Mycotoxin Clinical Disease

Both the animals' ability to tolerate total mycotoxins and the amount of total mycotoxins in the diet change with time.



When the total mycotoxin level exceeds the animals tolerance level you will see clinical disease.



Reducing the amount of total mycotoxins below the animals' tolerance level stops clinical disease.

is extremely difficult to quantify. Low toxin levels coupled with low production stresses typically do not affect animals. However, higher production stresses will lower animals' tolerance to bacteria, disease, and toxins and often lead to clinical effects with significant negative profit impact. Because both toxin levels and animal tolerance are highly variable and difficult to measure, an effective management strategy can be to treat feedstuffs with a product designed to lower the total toxin load when the threat of mycotoxins is high. Figure 4 summarizes these various concepts.

Contact your local nutritionist, veterinarian or feed supplier for information and recommendations on what interventions are right for your individual situation and herd.

<sup>1</sup> North Carolina Cooperative Extension Service. *Understanding and Coping with Effects of Mycotoxins in Livestock Feed and Forage*. Dec 1994

<sup>2</sup> The Mycotoxin Factbook D. Barug, et.al.; Wageingen Academic Publishings; The Netherlands, 2006

<sup>3</sup> Council for Agricultural Science and Technology (CAST). 2003. *Mycotoxins: Risks in Plant, Animal and Human Systems*. Task Force Report No. 139. January 2003, Ames, IA.

<sup>4</sup> CAST, et.al., pgs. 115-128.

<sup>5</sup> Bacon, C.W., Porter, J.K., Norred, W.P. and Leslie, J.F., 1996. Production of fusaric acid by *Fusarium species*. *Applied and Environmental Microbiology* 62:4039-4043.

<sup>6</sup> Smith, T.K., McMillan, E.G. and Castillo, J.B., 1997. Effect of feeding blends of *Fusarium* mycotoxin-contaminated grains containing deoxynivalenol and fusaric acid on growth and feed consumption of immature swine. *Journal of Animal Science* 75:2184-2191.

<sup>7</sup> Speijers, G.J.A. and Speijers, M.H.M., 2004. Combined toxic effects of mycotoxins. *Toxicology Letters* 153:91-98.

<sup>8</sup> Trenholm, H.L., Cochrane, W.P., Cohen, H., Elliott, J.I., Farnworth, E.R., Friend, D.W., Hamilton, R.M.G., Standish, J.R. and Thompson, B.K., 1983. Survey of vomitoxin contamination of 1980 Ontario winter wheat crop: results of survey and feeding trials. *Journal of the Association of Official Analytical Chemists* 66:92-97.

<sup>9</sup> Trenholm, H.L., Foster, B.C., Charmley, L.L., Thompson, B.K., Hartin, K.E., Coppock, R. W. and Albassam, M., 1994. Effects of Feeding diets containing *Fusarium* (naturally) contaminated wheat or pure deoxynivalenol (DON) in growing pigs. *Canadian Journal of Animal Science* 74:361-369.

<sup>10</sup> Cole, R.J. and R.H. Cox. 1981. *Handbook of Toxic Fungal Metabolites*. Academic Press, New York.



410 N. Michigan Ave., Ste. 400, Chicago, IL 60611

web: [www.amlan.com](http://www.amlan.com) email: [info@amlan.com](mailto:info@amlan.com)

phone: 312.321.1887 fax: 312.321.9525