Winning the war against mycotoxins – a challenge for dairy farmers

Up until the 1980s, the impact of mycotoxins – secondary metabolites including yeasts, mushrooms and moulds that are produced by fungal species in feed under stressful production conditions – was only studied in monogastric animal species.

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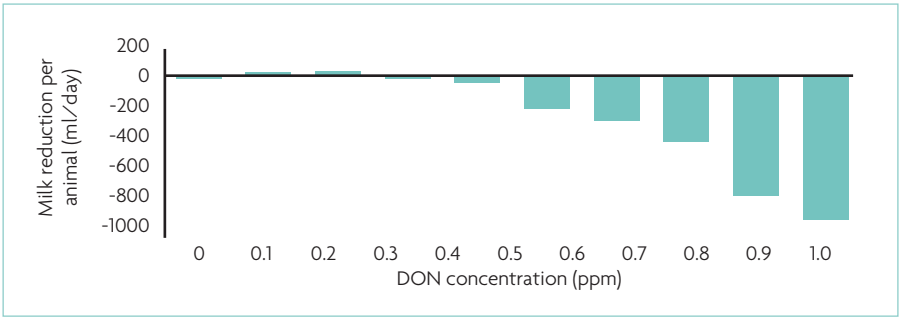

Fig. 1. Effect of increasing DON concentration on milk production in dairy cows (300 herd study of 50,000 cows, North Carolina State University).

The reason that there has been less concentration on the impact on cattle is that research from the 1980s showed that ruminants were more tolerant to the adverse effects of acute (high dose and rapid) or chronic (slow development of infection) mycotoxicosis and that this was due to the ability of rumen microbiota to detoxify the mycotoxins.

However, additional research has shown that not all mycotoxins are metabolised to non-toxic components, that some are hardly changed (aflatoxin, fumonisin) and also that some rumen metabolites like that of zearalenone are more toxic than the parent compound. Also, while adult cattle seem to be better equipped to deal with ingested toxins than their monogastric equivalents, calves do not have a fully functioning rumen and are at risk.

Diets rich in ready fermentable carbohydrates also reduce the number of micro-organisms in the rumen drastically, disabling the mycotoxin deactivating capabilities even in adult cows. Also, mycotoxins that exert antimicrobial effects – such as patulin – are of great significance in ruminants as they impair ruminal function.

This results not only in malnutrition but also facilitates absorption of other mycotoxins, which normally would not have passed the rumen.

Dairy cows also have to produce much more milk per cow today than they did back in the 80s, which means that there is a very high dry matter intake (DMI) per cow per day and much more risk of mycotoxin poisoning.

Other mycotoxin challenges

Although mycotoxins rarely occur in isolation and are generally more risky when combined, it is useful to understand their individual impact on cattle productivity.

The individual mycotoxins of greatest concern to dairy cattle, and common symptoms, include:

- Ergots produced in small grains, fescue, and other grass – produce nervous disorders and tremors, and impact fertility.
- Aflatoxin, which is generally produced by Aspergillus mould, and which can cause reduced feed intake, weight loss or lower growth rate and poor reproductive performance. Milk production can also drop dramatically. Chronic exposure to aflatoxin is characterised by unthriftiness, anorexia, drying and peeling of skin on the muzzle, liver damage, elevated levels of blood constituents and oedema in the abdominal cavity. Calves are more susceptible than older animals and almost any level of aflatoxin-contamination in the ration may lead to some liver damage. Prolonged exposure at low levels can have a large impact.
- Deoxynivalenol, zearalenone, T-2 toxin, and fumonisins, which are produced by fusarium mould and cause issues ranging from digestive, feed intake and milk production issues through to gastro-enteritis, intestinal haemorrhages, abortion, vaginitis, poor reproductive performance, endocrine and exocrine system malfunction, immune system suppression and mammary gland enlargement.
- Ochratoxin, PR toxin, mycophenolic acid, and roquefortine C produced by Penicillium moulds. In the rumen of adult cows, protozoa degrade ochratoxin A rapidly into

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Table 1. Occurrence of type of mycotoxins per diet component.

Diet component	Mycotoxins
Concentrates (cereal grains, corn gluten, soybean products, etc)	Aflatoxin, Fumonisin, Zearalenone, Trichothecenes (T2/HT2/DON), ergot alkaloids
Pasture grasses	Lolitrems, Paspalitrems, Penitrem, Ergovaline (Ergot alkaloids), Trichothecenes, Citrinin
Preserved feed (silages, hay, straw)	Aflatoxins, Patulin, DON, Zearalenone, Mycophenolic acid, Penicillic acid, Roquefortins, Marcfortine, Andrastin, Gliotoxin, Ergot alkaloids, Citrinin

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ochratoxin-α, which has little effect. In calves, however, this causes polyuria, depression, lower growth, low specific gravity of urine and dehydration and it has a negative impact on the kidneys and immune system.

The extent of the problem

Recent statistics indicate that at least 25% of all crops are estimated to be affected annually by mycotoxins, resulting in financial losses of ~$5billion every year.

Apart from the obvious loss of feed, there is the cost of inspection and analysis before and after shipment of raw materials, costs of detoxification and productivity losses. When combined, the expense of dealing with mycotoxins could be 'staggering' whatever the species.

Conserved forages and concentrates by their very nature attract mould growth and multiple mycotoxins. Even though cereals and concentrates regularly contain multiple mycotoxins, it is estimated that over 80% of mycotoxins fed to cattle are from forage and straw.

Grazing systems cannot be considered completely safe as fresh grass can also be contaminated with mycotoxins.

Research has shown that mycotoxins are becoming more prevalent as more complex ingredients/by-products are used in feed to control animal production costs.

Products like Dried Distillers Grains and Solubles (DDGS), a byproduct of ethanol production that is commonly used to reduce the cost of protein in the diet, have amplified levels of mycotoxins that are formed in already infected corn during fermentation process, especially in times of drought.

Contamination with mycotoxins can happen both before harvest (90%) because of extreme weather conditions (drought, excessive rain or heat) or after during grain storage.

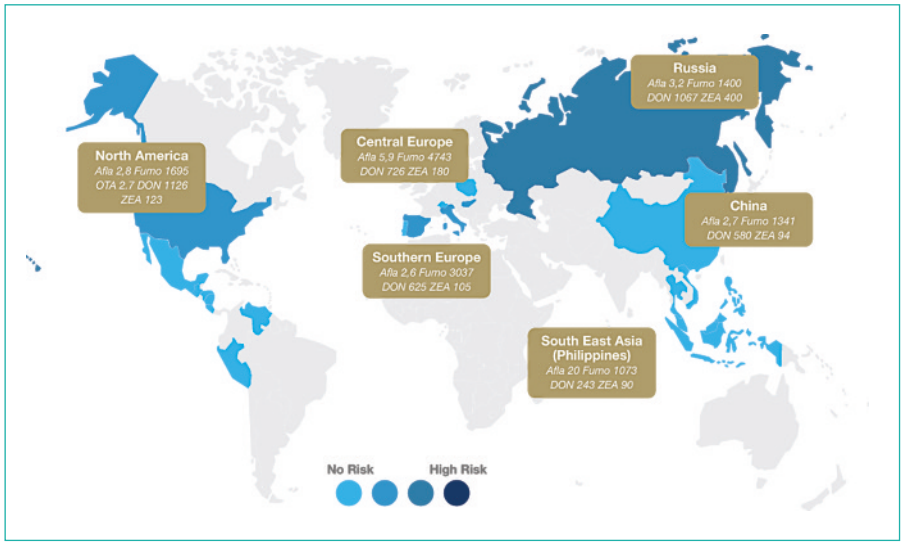

Fig. 2. Prevalence of different mycotoxins per region in the world in 2015.

The occurrence of mycotoxins shows a geographical pattern and some countries are more impacted than others (Fig. 2).

Aspergillus species meet optimal conditions in tropical or sub-tropical regions, whereas fusarium and penicillin species are adapted to moderate climates (North America, Europe, Asia). However, worldwide trading of feed means mycotoxin problems can be seen anywhere.

The extreme weather conditions that generally cause mycotoxins are much more common today than when they were first discovered in the 1980s.

Extreme precipitation, storms and floods create moist conditions that encourage fungal growth, drought weakens the seed kernels of plants, allowing greater fungal contamination and increased temperatures promote fungal growth.

Winning the war before it begins

We can not eliminate mycotoxins altogether but the following factors will help you get some control over the situation. For example, good land management, particularly pre-harvest will lessen the risk.

The amount of toxin produced depends on physical factors (moisture, relative humidity, temperature and mechanical damage), chemical factors (carbon dioxide, oxygen, composition of substrate, pesticide and fungicides) and biological factors (plant variety, stress, insects, spore load).

The most important factors influencing mould growth are moisture (water activity), temperature, availability of nutrients and

oxygen. Pre-harvest conditions are critical. Another important factor is reducing infection pressure in the field through crop rotation, tillage and avoidance of susceptible varieties. For instance, growing corn on corn can multiply by 5 to 10 the amount of deoxynivalenol compared with growing corn after peas or beets.

Also, the type and use of fertiliser can impact fungal contamination. Weeds can contain a broad range of fusarium species, but killing the weed does not decrease the fusarium incidence because it will increase the plant debris on the soil. Insects also carry fungal spores so cautious use of pesticides can help.

Changes in planting date or ripening of the variety can also impact fungal infection and mycotoxin contamination, but weather changes can undo this potential advantage. For wheat and barley, avoid plant varieties that mature late in the growing season.

Earlier harvests result in lower concentrations of mycotoxins. Also the time of day of harvesting will influence the humidity of the crops.

Avoid mechanical damaging and where possible remove visibly infected material to minimise fungal infection during storage. Because fusarium spores are present in the soil, the cutting height of the harvester machine will be an important factor reducing soil contamination.

Ploughing and tillage will decrease DON content in the following crop, burning of the crop residues will reduce the soil contamination. To minimise mycotoxin issues in silage, it is important that the crop being preserved has the optimum moisture content for ensiling (650-700g/kg for pit silage and 500-550g/kg for baled silage), that the crop is compacted/packed tightly and the cover adequately restricts oxygen access/preserves anaerobic conditions.

Baled silage must be handled carefully to avoid damaging its cover and to keep pests out. For clamped silage, the solo front should be removed during feed to avoid over-exposure of any one area.

Establishing problems and identifying the best solutions

● Testing feed

Taking samples of feed to test for the six more common mycotoxins found in dairy diets, aflatoxin, deoxynivalenol (DON), zearalenone (ZON), ochratoxin, fumonisin, T2 without any prior knowledge of the potential mycotoxin challenge is the greatest source of error in quantifying mycotoxin contamination. Mycotoxins may occur in feedstuff despite negative analytical results.

Mycotoxins are also not homogenously dispersed in feedstuff; they are often concentrated in small areas in corners of feed stores, in the top layers of silage clamps, in very small packets of dry feed or in small areas of a field where crops are diseased or stressed and so can easily be missed. The only way to avoid this is to increase sampling frequency. The effectiveness of a control plan greatly relies on the number of samples analysed. It is therefore important to get access to or to generate a significant number of records to be able to identify trends in raw materials.

● Use anti mycotoxin additives (AMA) as a preventative measure

The usual approach is that producers and farmers introduce AMA as a preventative measure, sometimes administering it all year round.

For this strategy to make any difference, you will need to use a technically relevant inclusion rate – not 0.5kg/mT as if you really have mycotoxins in your feed, 0.5kg of any product will not solve the issue. The relevant inclusion rate for preventive use should be around 1.0-1.5kg/mT feed (when products are enzyme, plant extract, yeast or aluminosilicate based).

● Taking control by accurately predicting the extent of your issue

The only way to keep cost under control is to combine preventive use of AMA with a decent mycotoxin control plan based on an online pattern database showing potential risks for harvests in different geographies. This way, if the mycotoxin load in raw material increases, one has a chance to adapt AMA inclusion rate accordingly.

We suggest the most cost effective way to manage mycotoxin risk in your operations would be to use a Lateral Flow Device (LFD) to check your own materials.

This data can then be added to the online database and reports run that can help you discard contaminated raw materials before they enter your operations or allocate them to different species who are less sensitive to the particular mycotoxins that are contaminating the feed.

Conclusion

No ruminant feed is completely free from mycotoxins. Additionally, no feed can be expected to contain only one mycotoxin. But rather than despairing, we should celebrate the fact that in the past few years, scientific innovations have resulted in improvements in mycotoxin detection including high performance liquid chromatography (HPLC) and mass spectrometry (MS). We can now detect levels as low as 1ppb or even less.

Taking account of mycotoxin contamination patterns in feed materials via a global online database can also be a great help in helping you achieve control in a more proactive, efficient and cost-effective way. ■

References are available from the author on request