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Science & Solutions

Prevention Is Better Than Cure

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7 Tips on Sow Lameness

Mycotoxin Threats: Zearalenone and Fumonisins

Editorial

Improving the Health of Gilts and Sows

Very often, farmers, consultants and nutritionists have questions about the models of modern sow production. What are some of their questions?

Questions about how to stay naturally ahead by improving breeding results, overall sow performance, quality and quantity of milk, litter size and piglet weaning weights are often asked. In trying to find the right solutions for these queries, we have to start from the very beginning, focusing on the young animals who represent the new genetic material for our main herds. Modern sows come from highly productive sows under proper preparation during the rearing period.

In this issue of **Science & Solutions**, we look at how innovative BIOMIN solutions can naturally support gilts and sows to enhance their performance.

One current challenge is mycotoxins, which have a big impact not only on fertility, but also on the whole immune system. High contamination of trichothecenes, together with zearalenone and fumonisin, can cause many negative effects. The Mycofix® product line consists of specially developed feed additives that protect animal health by deactivating the mycotoxins found in contaminated feed.

Another question often asked is about lameness and hoof quality issues. A well-formulated and balanced ration, matched to the maintenance requirements and balanced by the content of all the essential nutrients, is one of the factors that determines the correct growth and function of limbs and hooves.

We hope you enjoy reading this issue of **Science & Solutions**, keeping you naturally informed.

Enjoy reading!

Anita Urbańczyk MSc
Swine Technical Sales Manager

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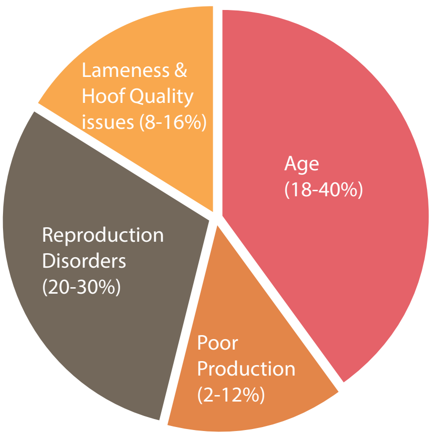
Reduce Sow Culling with These 7 Lameness Tips

Lameness is a growing problem on swine farms with sows being culled from the herd in the most severe cases. But the causes of lameness can be reduced and eliminated by following seven basic rules as Anita Urbańczyk explains.

By **Anita Urbańczyk**, MSc, Technical Sales Manager Swine

Lameness and hoof quality issues are becoming an increasingly common problem on a greater number of swine farms, leading to more culling of sows. Health problems associated with limb injuries are most common in bedding-free systems where uneven, wet and slippery floors increase the risk of both limb injuries and infections. Based on the available literature, limb weakness, lameness, paresis, inability to walk, and hoof injuries account for approximately 8-16% of all culling. Reproduction disorders (20-30%), sow age (18-40%) and poor production (2-12%) account for the other major reasons for culling (*Figure 1*). However, alongside the trend towards greater intensification of production, problems linked to lameness are becoming more common.

Figure 1. Major reasons for sow culling.



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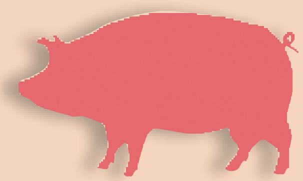
Maintaining limbs and hooves in the best possible condition is crucial to limiting production losses.

Figure 2. Symptoms of lameness.

- **Cracks on the parietal hoof**
- **Erosion of the heel**
- **Heel cracks**
- **Cracking of the hoof sole**
- **Horn separation**
- **Lesions due to excessive growth of the hoof capsule**



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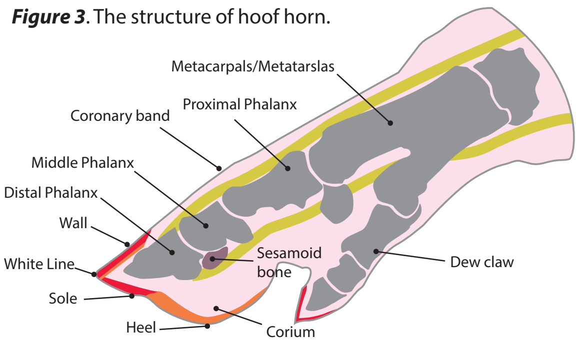
Lameness reflects pain of an injury (*Figure 2*). For example, incorrect slat widths in slatted floors can cause inflammation if hooves get stuck between them, resulting in abrasions or injuries. Analysis of hoof and limb condition in the sow herd, and the level of sow culling due to hoof and limb issues, provides us with important feedback on the correct husbandry and management of a herd, which directly impacts production efficiency.

Carrying the weight

The hoof horn is a cutaneous appendix (*Figure 3*) that serves as a barrier protecting the internal structures of the phalanges, and secures the hardness and flexibility of the hoof. Sows must support their entire body weight on the relatively small surface of the horn sole. Maintaining limbs and hooves in the best possible condition is crucial to limiting production losses.

Figure 3. The structure of hoof horn.



Source: BIOMIN

In bedded floor systems, problems arise from excessive hoof horn growth due to insufficient wearing of the horn layer. Over-grown hooves alter limb positioning and shift the animal's weight from the sole surface to the soft heel at the back of the hoof. This leads to heel injuries, often with subsequent inflammatory conditions.

The hoof horn should be hard whereas the sole should be flexible. On bedded floors, attention should be paid to bedding moisture; if the surface is too wet, the hoof may undergo malacia. The hoof will harden when the animal is moved onto a dry surface, however the hoof then loses its previous elasticity, and cracks and fissures may develop, predisposing the animal to further infections.

Diet is the key

As the last point in *Figure 4* suggests, a well-formulated, balanced ration matched to the maintenance requirements of sows, and containing all the essential nutrients, vitamins, minerals and trace elements, is a key factor in determining the correct growth and function of limbs and hooves. Trace minerals (e.g. copper, iron, manganese, zinc, molybdenum, chromium, fluorine, silicon and selenium) require special attention as they play a crucial role in the proper functioning of the body; they are closely associated with hoof horn development, ossification and proper limb development.

Pitfalls with trace elements

A deficit or an excess of trace elements can negatively impact sows. Copper is a part of many enzymes, as is manganese, but it also has an impact on the reproductive process and supports bone development. Excess copper may impair the function of the liver and muscles, causing symptoms including reduced growth rate, poor hair condition and neurological disorders reflecting the intoxication state. Zinc also plays a significant role in the ossification and healthy growth of the hoof horn. Zinc deficiency presents with excessive fragility of the horn,

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Figure 4. Seven basic rules help to maintain hooves and limbs in good health.

1. **Maintain and control floor quality in pens**
   Remove sharp edges (or file sharp edges when necessary)
   Ensure the correct slat width in slatted floors
   Keep the floors non-slippery by providing dry and clean resting areas
2. **Minimize social and hierarchy clashes**
   Introduce husbandry solutions that will prevent hierarchy clashes
   Provide sufficient pen space and free space per number of animals
3. **Integrate gilts ready for reproduction**
4. **Follow correct cleaning and disinfection procedures**
5. **Set up hospital pens for diseased sows**
   Clean and disinfect areas where sick sows are kept, disinfect wounds
   Bathe hooves in copper sulphate solution
6. **Do proper hoof trimming**
7. **Adjust the nutrition for physiological requirements of sows;**
   when needed, additional supplementation may be introduced

The use of organic forms of trace elements in sow nutrition results in a significant increase in production parameters as well as a visible improvement in hoof and limb quality.

visible colour changes and skin keratinization, while overdosing results in reduced appetite and arthritis. These examples highlight the importance of providing the correct amounts of trace minerals required by each production group.

Getting the balance right

While formulating and balancing the rations, the antagonistic effects between the trace elements should be considered, e.g. between iron and manganese or between iron, copper and zinc. A reduction of iron and manganese levels should be accompanied by a decreased dose of copper and zinc as the requirements of the animals dictate. The goal is to deliver optimal amounts of required trace elements in the most accessible form without putting any excessive pressure on the body.

Numerous data indicates that chelates, which are the organic forms of trace minerals, are the most bioavailable. By administering chelates, the animal can ingest the amount needed of a given compound while eliminating any excess together with an inactive part of the chelate. The use of organic forms of trace elements in sow nutrition results in a significant increase in production parameters as well as a visible improvement in hoof and limb quality. It is thus worth considering the introduction of additional supplements containing specific chelate compounds into the sow ration. Such products are administered as top dressings, namely in addition to a regularly fed diet.

However it should be considered that vitamin-mineral additives, commonly used in feed mixtures, should provide the animals with all necessary elements in a basal ration; the decision to introduce additional supplementation should be taken in justified cases to solve any already existing problems. Specialized products with desired elements are administered for a specific period, e.g. three to four months, and not on a continuous base.

By observing the basic rules of welfare, hygiene, husbandry and management of the herd, in many cases it is possible to avoid the additional costs associated with problems resulting from limb or hoof injuries. Some predisposing factors can be eliminated in advance which then helps to achieve better performance and protect the producer against potential losses further on in the production cycle.

Zearalenone – a known but underestimated risk in gilts

Feeding ZEN-contaminated feed to gilts can have huge negative implications on animal health and performance. Konstantinos Sarantis explores the literature to explain why ZEN is so harmful to gilts and why a mycotoxin risk management program is essential.

By **Konstantinos Sarantis**, MSc, Technical Sales Manager Swine

Zearalenone (ZEN) is a mycotoxin produced by *Fusarium graminearum*, *F. culmorum*, *F. crookwellense*, *F. equiseti* and *F. semitectum*. This mycotoxin regularly co-exists with deoxynivalenol (DON), as the same fungi (*F. graminearum* or *F. culmorum*) can produce both compounds. ZEN contamination in grains varies. According to the BIOMIN quarterly survey, there is a worldwide occurrence of ZEN at different levels and in different grains (*Figures 1*, *2* and *3*).

The guidance levels for ZEN in animal feed, introduced by the European Commission, are 0.25 mg/kg in complementary and complete feeding stuffs for sows and fattening pigs, and 0.1 mg/kg in the same commodities for piglets and gilts.

Once ZEN is ingested, part is transformed to its metabolites, α-zearalenol and β-zearalenol. In pigs, the main metabolite is α-zearalenol. The toxicity of this metabolite is four-fold higher, which explains the higher sensitivity of pigs to ZEN. The effects and intoxication of ZEN depends on the amount ingested, length of exposure, age and reproductive phase of the animal.

The main effect of ZEN is on reproduction, by

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Figure 1. Prevalence of mycotoxins detected in corn samples globally.

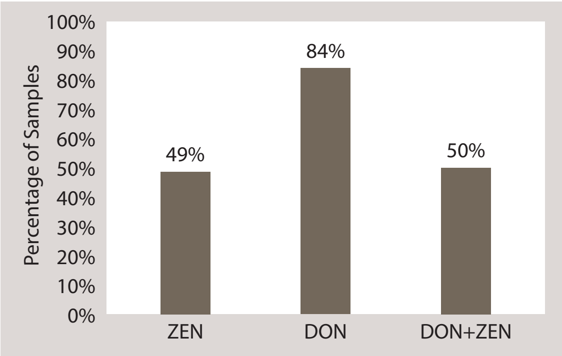

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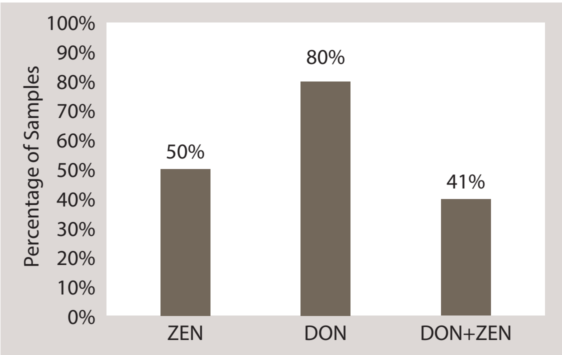
Figure 2. Prevalence of mycotoxins detected in wheat samples globally.



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blocking the normal synthesis of hormones. ZEN resembles the estradiol molecule and competes with it for estradiol receptors (estrogenic receptors). These receptors can be found in different organs such as the liver, kidneys, testis, prostate gland, hypothalamus gland, pituitary gland, ovaries and intestines.

This estrogenic effect disrupts the endocrine system, disturbing the hypothalamic-pituitary-ovarian axis and supressing follicle-stimulating hormone secretion in the ovaries.

ZEN effect in gilts

Due to their undeveloped endocrine system, gilts are even more sensitive to the estrogenic effects of ZEN. The results of ZEN ingestion are; hyperaemia and vulva swelling (hyperestrogenism), uterus mass increase, ovarian follicle atresia and atrophic ovaries, and vaginal or rectal prolapse.

Hyperestrogenism has been documented in gilts at different ages (from post weaning to ovulation) and at various contaminated feed levels. In four-month-old gilts fed ZEN contaminated feed, mild hyperestrogenism

Figure 3. Prevalence of mycotoxins detected in soyabean meal samples globally.

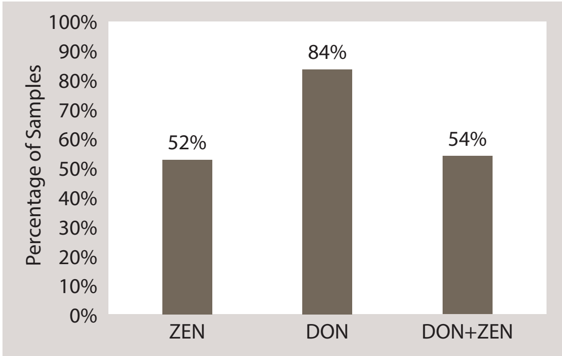

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Figure 4. Effect of ZEN on vulvar volume.

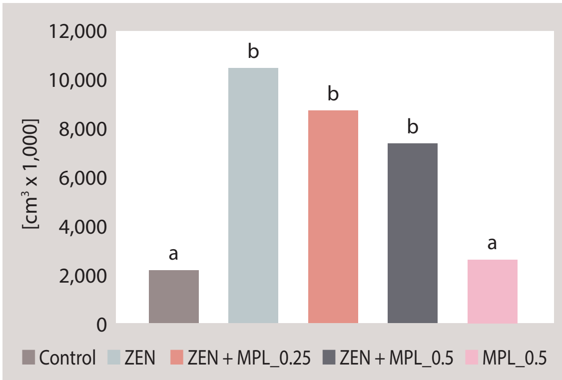

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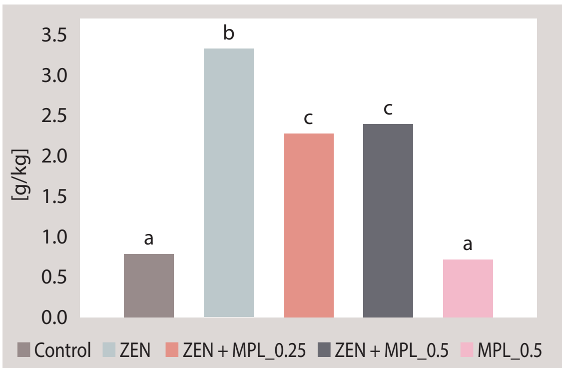
Figure 5. Effect of ZEN on reproductive tract weight.



Source: BIOMIN

occurred a few days after ingestion (Obremski *et al.*, 2003). In another study (Oliver *et al.*, 2012), weaned gilts fed ZEN had a 2.4 times heavier total reproductive tract and 50% greater endometrial gland mass. This hyperestrogenism would delay oestrus onset and compromise the fertility and subsequent reproductive life of the gilt.

In-house research conducted by BIOMIN gave the

Table 1. The main effects of ZEN in pigs.

	Effects	Signs/symptoms
Female swine	Reproductive	• Affects reproduction cycle, conception, ovulation and implantation • Affects reproduction cycle, conception, ovulation and implantation • Pseudo pregnancy, abortion, anoestrus, nymphomania • Embryonic death, inhibition of fetal development, decreased number of fetuses (reduced litter size) • Enlargement of mammary glands • Swelling and reddening of vulva • Rectal and vaginal prolapse
	Pathological	• Atrophy of ovaries • Uterus hypertrophy
Male swine	Reproductive	• Feminization • Enlargement of mammary glands • Impaired semen quality • Testicular atrophy • Swollen prepuce
Piglets	Reproductive	• Reddened teats (females) • Swelling and reddening of vulva (females)
	Teratogenic	• Splay legs

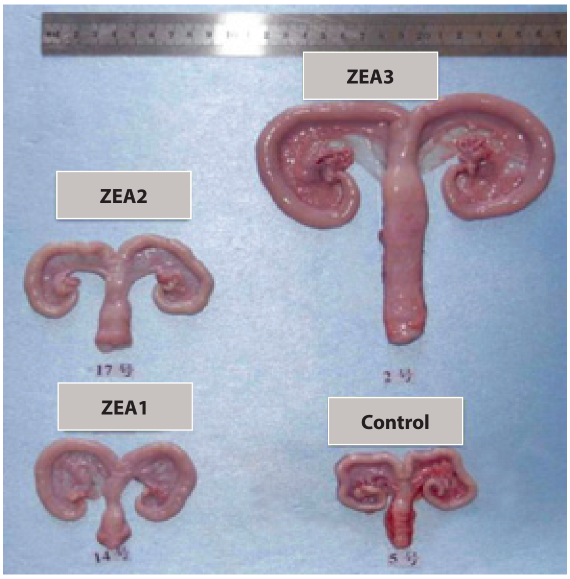
Source: BIOMIN

same observations in Mycofix® Plus product efficacy trials. Gilts that ingested ZEN had a higher vulva volume (*Figure 4*) and reproductive tract weight (*Figure 5*). In addition, histopathological examination showed tissue degeneration in the presence of ZEN.

In addition, ZEN could compromise corpora lutea, ovary size, fertility, and increase abortion rates in first parity (Zwierzchowski *et al.*, 2005). In a recent paper, when ZEN was ingested by post weaning gilts, the luteinizing hormone decreased in a dose dependent manner. Other clinical signs were hyperplasia of submucosal muscles, a decrease in the size of the cortex follicle, and degeneration and structural abnormalities of the reproductive tract (Chen *et al.*, 2015, *Figure 6*). Moreover, high doses of ZEN may lead to anoestrus, which is a result of early puberty with infertility (no ovulation) (Kanora & Maes, 2009). Tiemann and Dänicke (2007) report similar results in a review. Fifty percent of gilts confirmed anoestrus. Corpora lutea were maintained, mimicking pregnancy. Thus, ovulation could not occur and gilts were in a pseudo-pregnant state with uterus weight 2-fold heavier.

ZEN, as a mycoestrogen molecule, has multi-specificity. This means that it has more than one biological target. Estrogen receptors are distributed among different tissues and organs. ZEN and its metabolites, as well as the negative effects they can have on the reproductive system, can influence gene expression, the immune system and gastrointestinal tract.

Figure 6. Effects of different levels of ZEN on genital organs (ovary + cornu uteri + vagina-vestibule) of gilts (Chen *et al.*, 2015).



Gastrointestinal tract

ZEN and its metabolites are an endocrine disrupting chemical, interacting with tissues and cells involved in the hormonal system. ZEN is not bio-transformed in the gastrointestinal tract.

It is bio-transformed into its metabolites mainly in the liver and then it passes into the blood circulation. It then accumulates in different parts of the digestive tract

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Table 2. Effect in immunity parameters for gilts intoxicated with combination of DON and ZEN

Treatment	Negative Control	Toxin Group	Trial Group	Positive Control
Deoxynivalenol (DON) [µg/kg]	0	1000	1000	0
Zearalenone (ZEN)[µg/kg]	0	250	250	0
Mycofix® Plus [kg/t]	-	-	1.5	1.5
Chemotactic Index	4.24[a]	2.07[b]	4.42[a]	4.20[a]
% phagocytic macrophages	27.6[a]	20.8[b]	25.6[ab]	25.2[ab]

Source: BIOMIN

including the duodenum, jejunum and descending colon. However, ZEN interacts with estrogen receptors that are present in the gastrointestinal system. These receptors control cell proliferation and differentiation. As a result, apoptotic mechanisms are induced, leading to cell death and microflora imbalances. In addition, ZEN interaction with estrogen receptors impairs gastric motility, decreases intestinal permeability and inhibits intestinal secretion. Lowering the pace of gastric emptying creates tension in the anus, which may explain rectal prolapses.

Immunity

ZEN may also affect innate and adaptive immunity. As well as reproductive organ inflammation, ZEN can induce inflammation in immune organs. In ZEN exposed gilts, inflammation in mucosa and epithelium cells occurs, impairing intestinal defence.

Marin *et al*. (2010), conducted *in vitro* studies in which ZEN reduced neutrophil viability and triggered an oxidative response. Both parameters play a pivotal role on the innate immune defence system. In a later *in vivo* study by the same group (2013) in weanling piglets, the effect of ZEN on immunocompetent tissues was studied. In the liver, ZEN mainly impaired functionality resulting in a hepatotoxic effect, and secondly reduced inflammatory response resulting in an immunotoxic effect. In the blood, lymphocyte proliferation was reduced and the synthesis of inflammatory cytokines increased. In the spleen, induction of an inflammatory response did not allow an adequate response to oxidative stress that was induced by ZEN.

The full role of ZEN on the immune system has not been fully investigated, especially the role of ZEN on vaccination efficacy. However, in-house research has shown that ZEN and DON have a negative impact on innate immunity parameters (chemotactic index, macrophage activity) when ingested in weaning piglets (*Table 2*).

In this text, the effect of ZEN has been reviewed focusing in pre-pubertal gilts. Reflecting the frequency in which more than one *Fusarium* toxin is detected in feeds, the synergies between *Fusarium* mycotoxins should not be neglected. Co-contaminations, regardless of whether they show additive or synergistic effects, could cause further negative effects in animals, especially in the highly sensitive pig species. Therefore, a proper mycotoxin risk management program is obligatory.

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Successfully Confronting the Fumonisin Surge

While difficult to detect in pigs, fumonisins often pose a threat to pigs globally. Where binders fall short, a mitigation technique known as biotransformation offers a field-tested, proven solution.

By **Michele Muccio**, MSc, Product Manager

Due to their gastrointestinal and immunosuppressive effects, fumonisins can seriously compromise swine performance. Fumonisin contamination in swine is difficult to detect mainly because it tends to occur at subclinical levels—necessitating measurement of the sphinganine—sphingosine (Sa/So) ratio, a scientifically recognized biomarker for identifying fumonisin exposure in pigs.

Multiple studies conducted in recent years report the extreme sensitivity of swine to fumonisin contamination even at levels below the European guideline of 5,000 parts per billion (ppb). Direct examples of the immunosuppressive effects of fumonisins in swine are the development of porcine pulmonary edema (PPE) and the decreased resistance to certain pathogens such as *Pasteurella multocida*.

Fumonisins and *Pasteurella multocida*

There is a link between fumonisins and increased susceptibility to *P. multocida*, a pathogen responsible for respiratory disorders, e.g. lung inflammation. A 2005 study highlighted how the sensitivity of piglets exposed to *P. multocida* increased exponentially in the presence of fumonisins. During the trial period, piglets exposed to the pathogen alone did not show significant symptoms such as lung lesions and a decrease in weight gain. However, animals challenged with *P. multocida* in combination with dietary fumonisins at a concentration of 0.5 mg/kg of body weight displayed delayed growth, coughing and a higher cell count in the bronchoalveolar lavage fluid (BALF). An

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Average fumonisin levels in maize exceeded 2,500 ppb: a concentration that can significantly affect pigs.

Table 1. Mycotoxin occurrence and levels in all grains worldwide, January to June 2017.

	Afla	ZEN	DON	T2	FUM	OTA
Number of samples tested	7,038	7,142	6,568	3,676	6,094	2,853
% Contaminated samples	26%	52%	81%	19%	71%	18%
% Above risk threshold	17%	25%	69%	3%	49%	3%
Average of positive (ppb)	25	130	798	37	1840	9
Maximum (ppb)	10,918	8,113	28,47	976	46,515	889

Source: BIOMIN Mycotoxin Survey

increase in the number of lymphocytes and macrophages was reported as well. Greater lung lesions in the form of subacute interstitial pneumonia were detected in the group that received both the fumonisins and the pathogen.

Prevalent worldwide

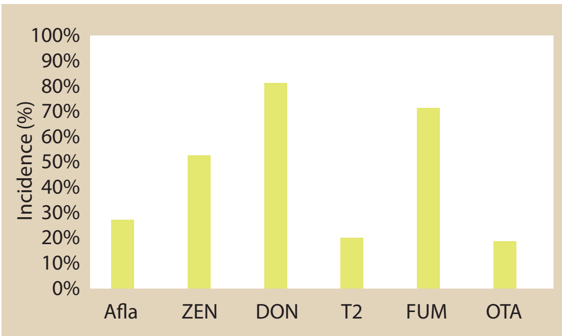
Worldwide concentrations of fumonisins in 2017 have already reached average values that can affect animal production (see *Table 1* and *Figure 1*). Maize and maize by-products such as dried distillers grains with solubles (DDGS) and corn gluten typically run a higher risk of fumonisin contamination. Average fumonisin levels in maize exceeded 2,500 ppb: a concentration that can significantly affect pigs (see *Table 2* and *Figure 2*).

Solving fumonisins

Mycotoxin binders cannot sufficiently address fumonisin challenges in real-life settings. They involve a neutralization process known as adsorption, adhering to toxins in order to limit their entrance into an animal's bloodstream. However, mycotoxin binders have shown an extremely low binding capacity of fumonisins at pH 6 and pH 7 common in a pig's gut.

Enzymatic biotransformation – the application of a purified enzyme to irreversibly biotransform fumonisins into non-toxic metabolites directly in an animal's gastro-intestinal tract – is the most advanced and effective method to counter the negative effects of fumonisins. The FUM*zyme*® enzyme in the Mycofix® product line is the only commercially available purified enzyme proven to biotransform fumonisins safely and effectively.

Figure 1. Mycotoxins incidence in all grains worldwide, January to June 2017; global results.



Source: BIOMIN Mycotoxin Survey

Field trial results

A recent field trial on fattening pigs at a commercial farm in Argentina illustrates the effectiveness of a biotransformation strategy to combat fumonisins. The trial started in the fattening phase when piglets were moved into new houses and pens. In total, 1,484 piglets with an average age of 113 days (+/- 3 days) were separated into two houses (House 1 males, House 2 females). Each house was equipped with two separated feeding lines. Both houses and both lines within each house received a mashed diet according to the nutritional requirements of the animals in this period. One line per house received 1 kg of the abovementioned mycotoxin strategy per tonne of feed additionally in the diet.

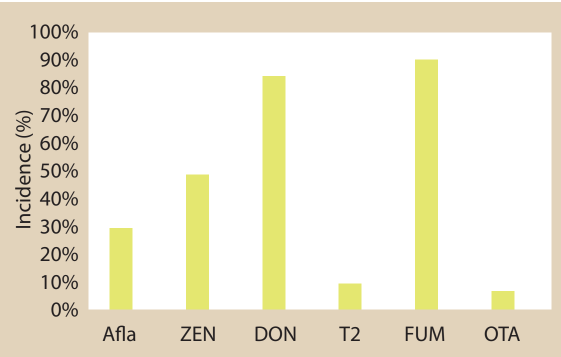
Enzymatic biotransformation is the most advanced and effective method to counter the negative effects of fumonisins.

Table 2. Mycotoxin occurrence and levels in corn worldwide, January to June 2017.

	Afla	ZEN	DON	T2	FUM	OTA
Number of samples tested	2,536	2,261	1,601	830	1,874	534
% Contaminated samples	29%	49%	84%	9%	90%	7%
% Above risk threshold	17%	26%	78%	4%	73%	2%
Average of positive (ppb)	11	134	744	90	2534	45
Maximum (ppb)	447	3,584	28,47	976	41,022	889

Source: BIOMIN Mycotoxin Survey

Figure 2. Mycotoxins incidence in corn worldwide, January to June 2017; global results.



Source: BIOMIN Mycotoxin Survey

Piglets were randomly allocated to two compartments with six pens each. The animals were fed experimental diets containing maize naturally contaminated with fumonisins. The highest concentration of fumonisin detected was around 700 ppb (total fumonisins). Application of product was 1 kg of the mycotoxin approach per tonne of feed.

During the six weeks of the trial, all the measured parameters in the groups treated with the mycotoxin product improved significantly and the general impact of the treatment on production showed positive results (see *Table 3*). Supplement-fed groups saw favorable improvements in parameters such as the number of animals sold due to unfavorable condition, feed conversion rate and kg produced per pig compared to the control groups.

Table 3. Performance evaluation during the trial.

	House 1 females		House 2 males	
	FUM diet	Mycofix®	FUM diet	Mycofix®
Total No. Animals	371	372	370	371
Culled animals (poor condition)	5	0	15	0
Mortalities	8	6	12	14
Successfully raised animals	358	366	343	357
Duration of fattening phase (days)	110	107	107	106
Days of life until slaughter	181	178	178	177
Daily weight gain in fattening phase (kg)	0.793	0.847	0.846	0.860
FCR	2.84	2.73	2.86	2.7
kg produced / pig	112.19	116.37	114.9	117.46

Source: BIOMIN

What's Wrong With My Pigs?

Cut & Keep Checklist

Part 9: Tail necrosis

Tail necrosis is a common swine affliction that occurs unpredictably and jeopardises performance. Tail necrosis can happen in very young piglets during the first days of life up to finishing pigs, often leading to culling and condemnation of carcases at the abattoir. The primary damage may result from abrasion, fight wounds or tail docking.

Causes of tail necrosis can be attributed to many environmental, nutritional and infectious agents that often coincide. A number of environmental factors can lead to tail necrosis including air humidity, small injuries from slatted or abrasive flooring, or a failure to rinse off strong (alkaline) disinfectants after use.

Pen mates may step on or bite the tail – a behavior more commonly observed with a lack of foraging activity or manipulating materials. High stocking density and competition for space also plays a role, potentially in response to discomfort caused by ambient temperature (too hot/cold), a lack of draught free areas, or in an effort to secure feeding space.

Cross-fostering, tail clipping and other environmental stressors may incite frustration from which vices such as tail biting develop. In terms of nutrition, an imbalanced diet, certain deficiencies, for example biotin or tryptophan, or a craving for salt, protein or some specific amino acids can influence tail necrosis. Excess energy and intestinal discomfort may also be contributing factors.

In some cases, naturally occurring toxins may be the cause, including endotoxins, mycotoxins (aflatoxin, trichothecenes, ergot alkaloids) and biogenic amines. Bugs can also be the culprit. Skin parasites (mites), streptococcosis (beta-haemolytic), staphylococcosis or erysipelas can be at fault. Bacteria penetrate into the skin causing inflammation and then block the blood supply, leading to necrosis. Prevention can be carried out by thoroughly revising management and feeding practices in order to avoid the identified environmental, nutritional and disease factors, and by maintaining good hygiene when tail clipping.

The only treatments that are available involve isolating the affected pigs and then providing local disinfection and parenteral antibiotics.

Factor	Symptoms	Detection
Toxins		
Mycotoxins, for example: • Aflatoxin • Trichothecenes • Ergot alkaloids	Depressed immune competent tissue. Reduction or refusal from direct neuronal depression of hypothalamic appetite nucleus, oral/dermal irritation, digestive disorders with ulceration and vomiting and visceral bleeding	Positive for Afla, DON, T-2, HT-2, FUM, Ergot; ELISA raw materials, HPLC feed. Origin of raw materials historically contaminated
Endotoxin	Agalactia, reduced piglet birth weight, piglet starvation, gangrene ears, tail, or feet	Epidemiology, signs, RT-PCR, ELISA for Gram-negative bugs
Biogenic amines	Restlessness, trembling, recumbence, tachypnoea, pale mucous membranes, blue ears, shock, death, nausea, headaches, rashes and changes in blood pressure	Digestibility of proteins
Environment		
	Overcrowding, ventilation, temperature, hygiene and rinsing, manipulating materials, mixing, fostering, hierarchy	Revise management practices
Disease		
Mange	Skin irritation, rubbing, ear shaking	Lesions, skin sample microscopy. Epidemiology, signs, RT-PCR, ELISA
Staphylococcus aureus H	Listlessness, skin reddening, vesicles, pustules, fever	
Streptococcus	Depression, incoordination, paddling, opisthotonos, convulsions, nystagmus, death	
Erysipelothrix rhusiopathiae	Depression, fever, stiff joints, anorexia, erythema	

For more information, visit **www.mycotoxins.info**

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