

Toxin risk management: Current challenges and what works against them

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How do mycotoxins affect poultry production?



The last straw that broke the camel's back



- Acute mycotoxicosis → rare
- Subacute mycotoxicosis → daily situation

Immune impairment

Gut barrier disruption

Oxidative stress

Reduced nutrient absorption



**Impact on
health, welfare,
performance,
and profitability**

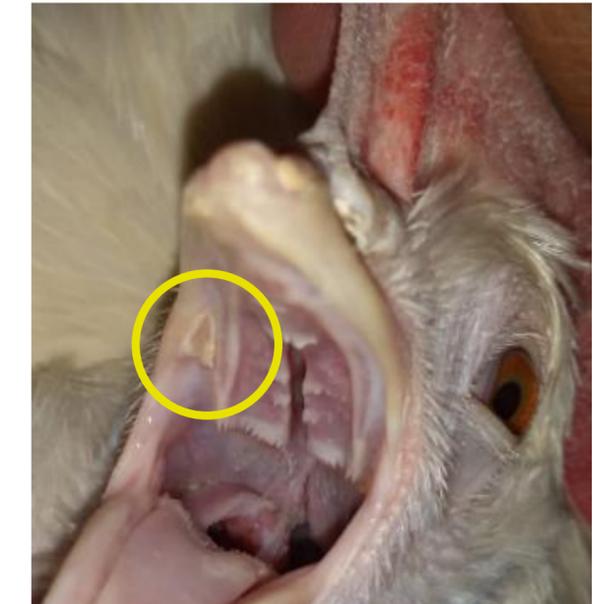
How do we identify mycotoxin issues on farms?

High levels of toxins (acute toxicity)

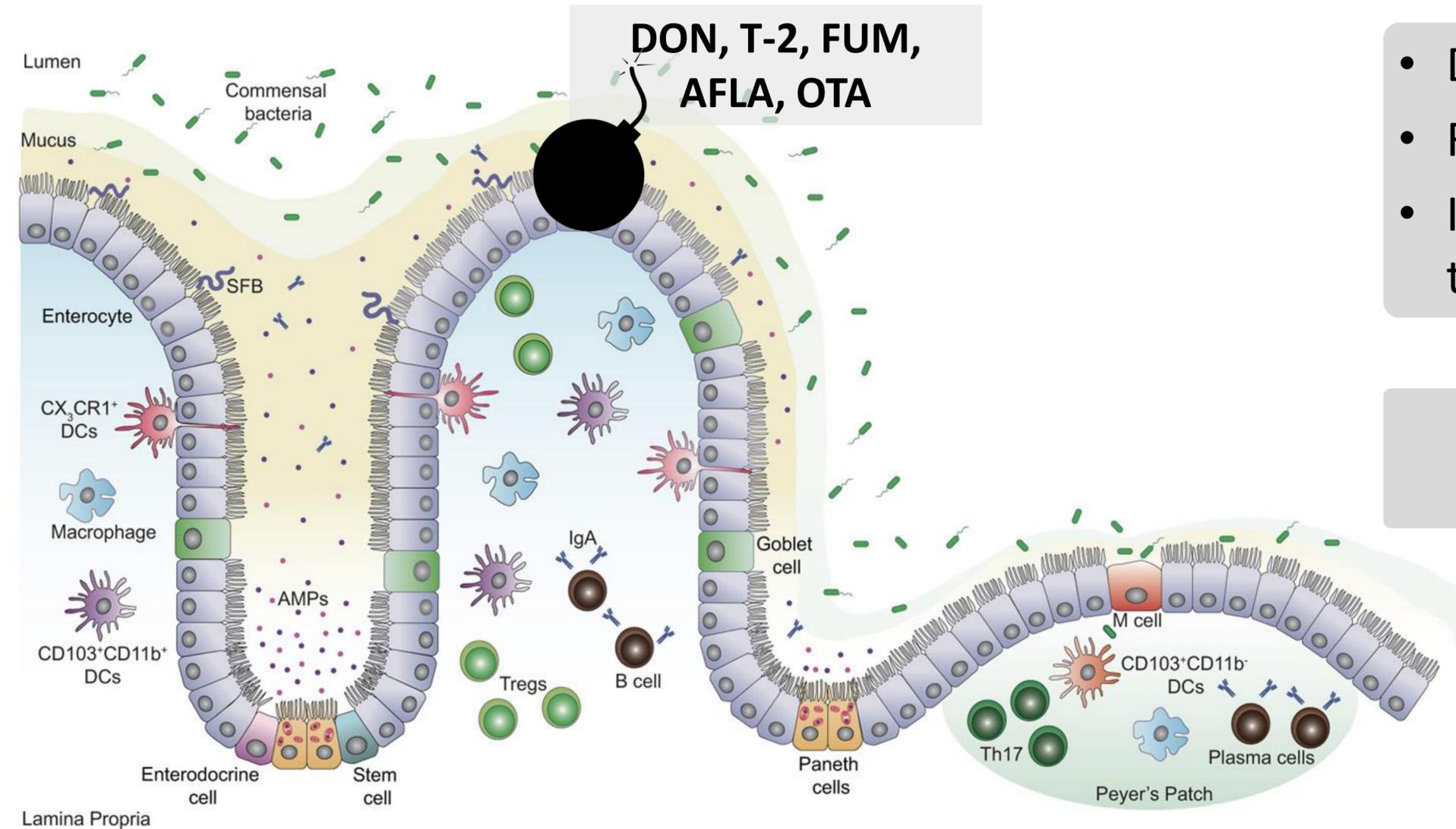
- Clear and visible symptoms, e.g.:
 - Pale liver with aflatoxins
 - Oral lesions with T-2 toxin
 - Enlarged kidneys with ochratoxins
 - ...

Low levels of toxins (subacute toxicity)

- Unspecific symptoms:
 - Loss of performance (poor growth, reduced egg production)
 - Higher susceptibility to diseases, impaired vaccination
- Difficult to diagnose, but the main obstacle to productivity!



Effects of mycotoxins on the intestine



- Damaged villi
- Reduced cell renewal
- Inhibition of nutrient transporters

Poor FCR
Pathogen colonization

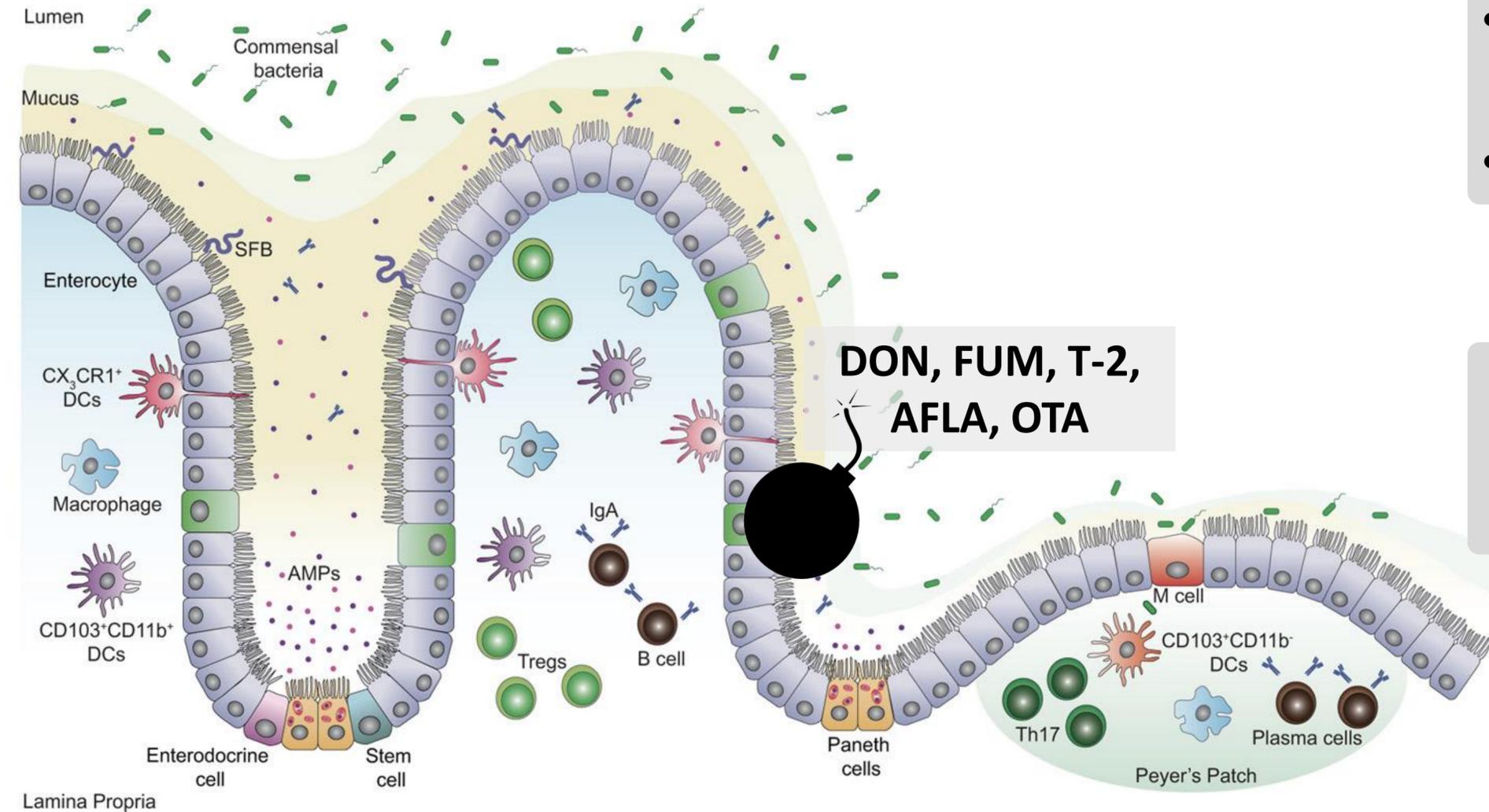
NUTRIENT ABSORPTION

GUT BARRIER

IMMUNE SYSTEM

OXIDATIVE STRESS

Effects of mycotoxins on the intestine



- Fewer goblet cells and mucus production
- Weakened tight junctions

↓
Pathogen colonization
Increased pathogen translocation

NUTRIENT ABSORPTION

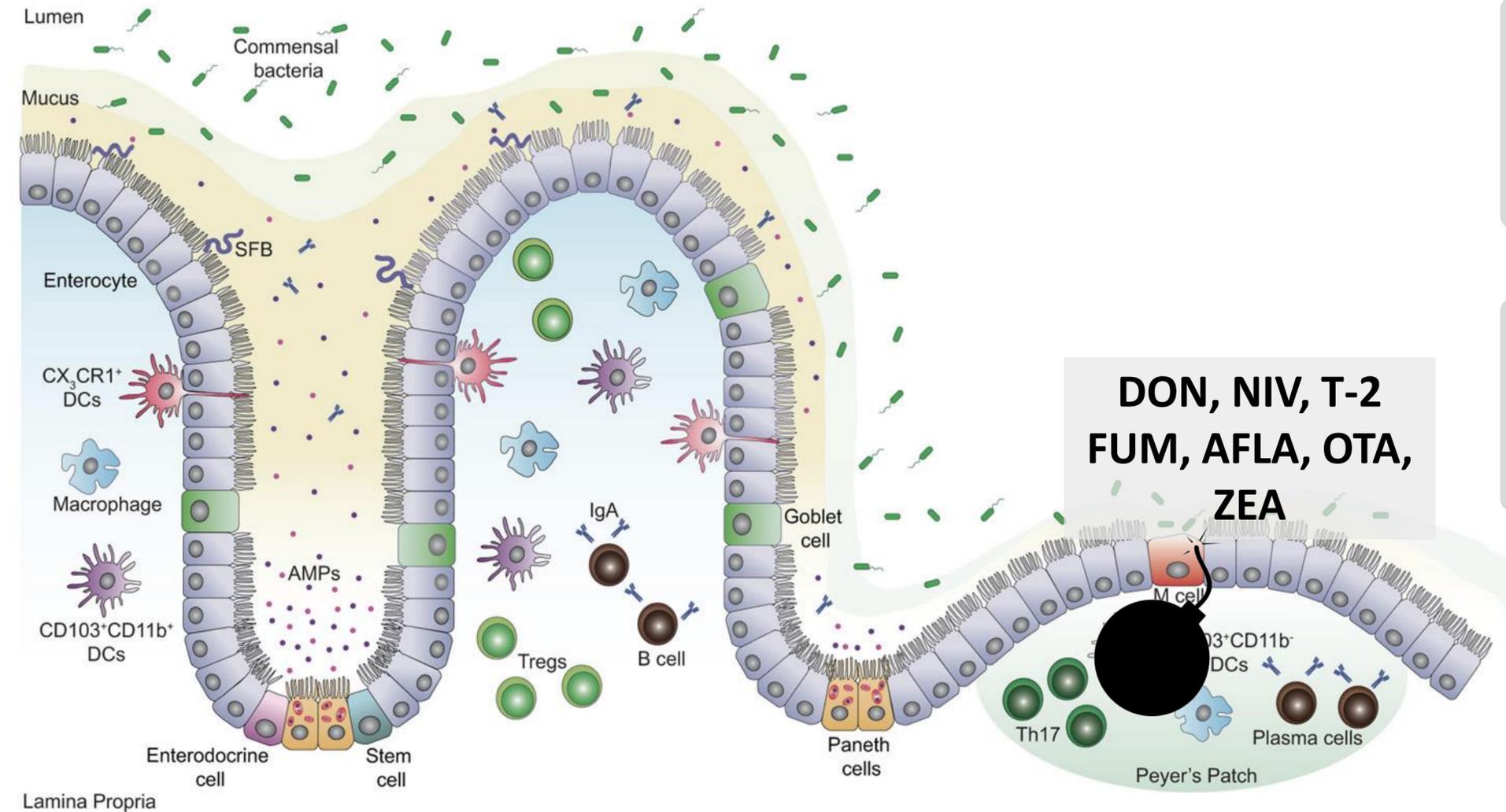
GUT BARRIER

IMMUNE SYSTEM

OXIDATIVE STRESS

Adapted from Muniz et al., (2012) and Antonissen (2025)

Effects of mycotoxins on the intestine



- Altered innate and adaptive immunity
- Inflammation

Higher susceptibility to infectious diseases
Vaccination failure

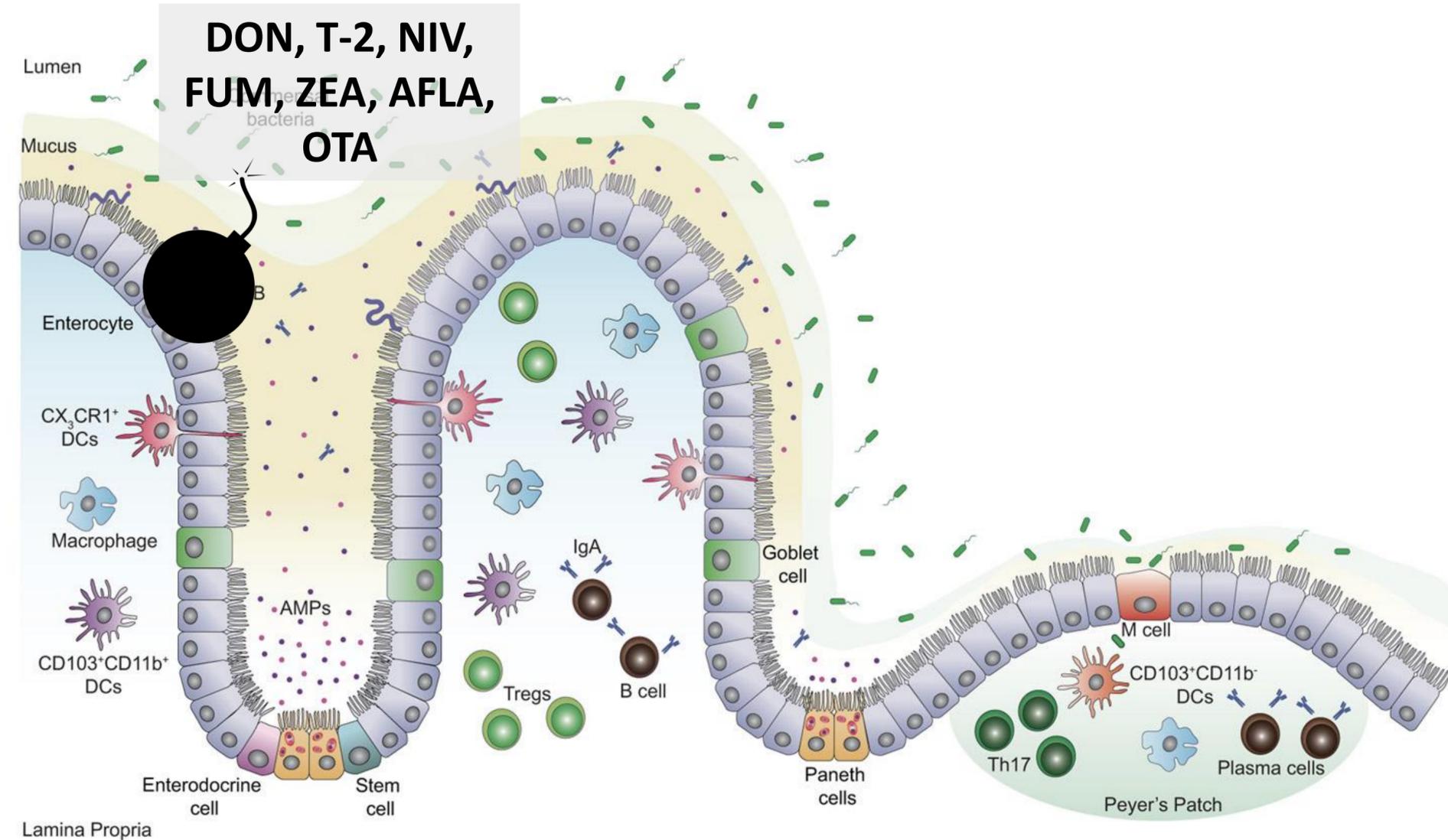
NUTRIENT ABSORPTION

GUT BARRIER

IMMUNE SYSTEM

OXIDATIVE STRESS

Effects of mycotoxins on the intestine



- Disregulation of the immune response
- Malabsorption of dietary antioxidants

Immune troubles
Villi damage
Pigmentation issues

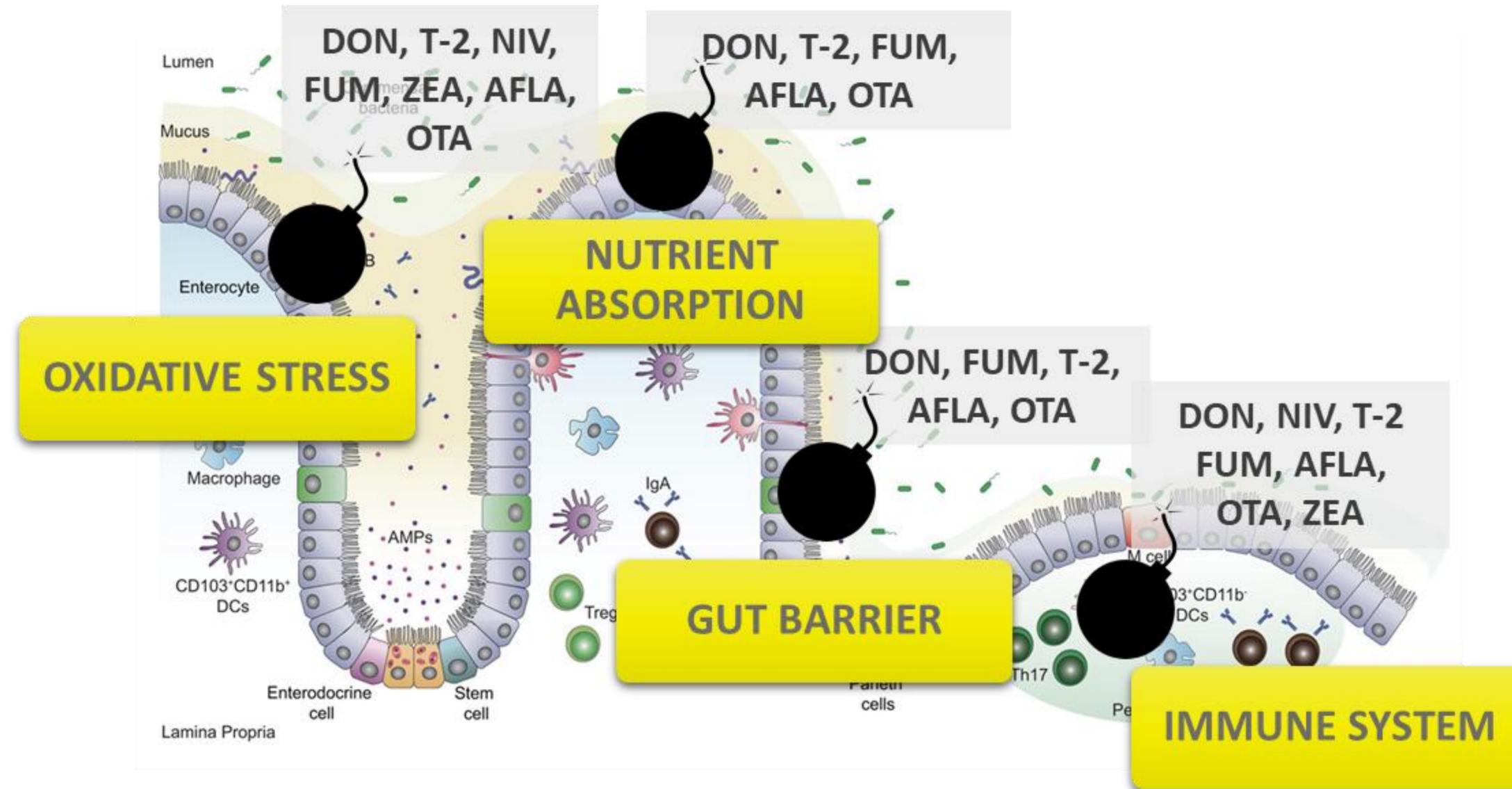
NUTRIENT ABSORPTION

GUT BARRIER

IMMUNE SYSTEM

OXIDATIVE STRESS

Effects of mycotoxins on the intestine



Mycotoxins are a bomb for digestive efficiency and gut health, costing a lot to the poultry industry!

Interaction between mycotoxins and bacteria

DON promotes *C. jejuni* proliferation with consequences on **bacterial translocation and gut health** in broiler chickens.

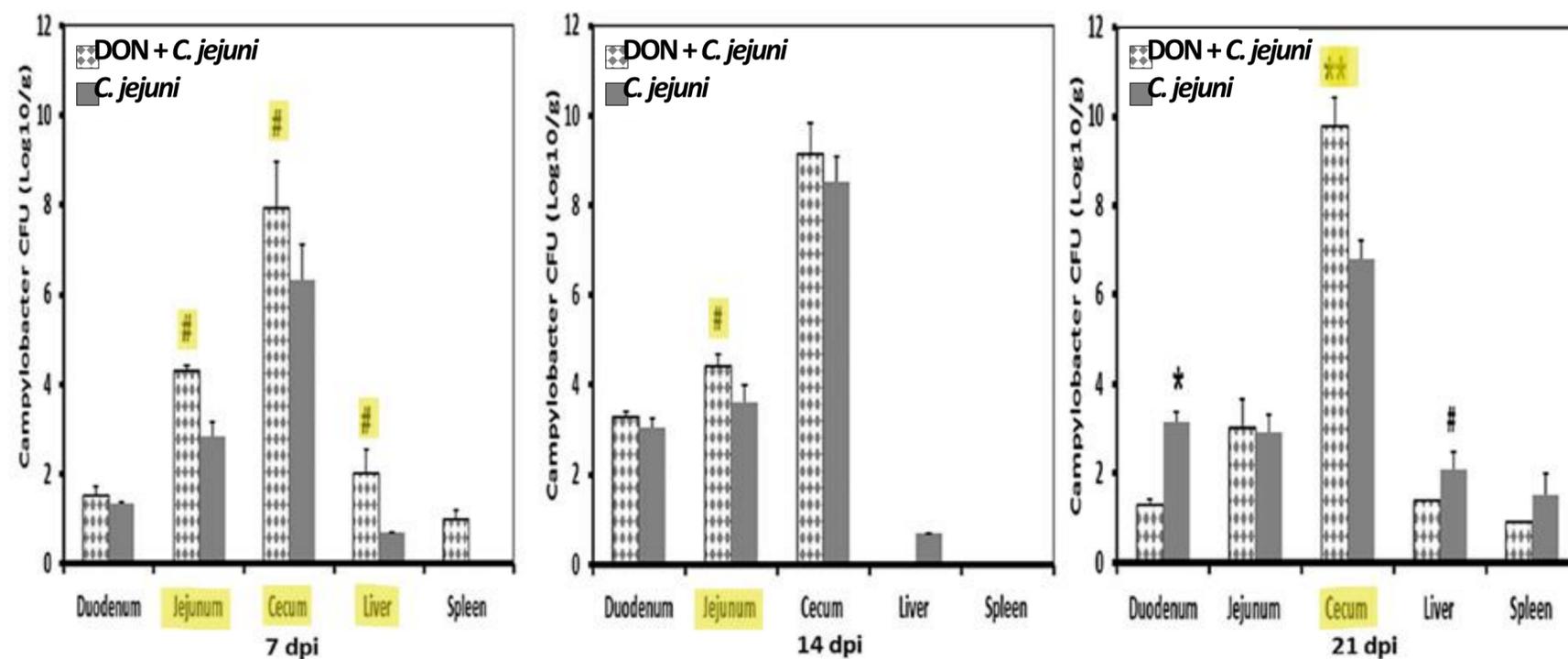


FIGURE 5 | *C. jejuni* counts at different time points post infection from duodenum, jejunum, cecum, liver, and spleen of infected birds fed with either control or DON contaminated diet. Results are presented as mean values and SEM ($n = 5$). Numbers of bacteria are expressed in logarithmic form of colony forming units (log CFU/g). Asterisks mark differences with # $P \leq 0.1$, or * $P \leq 0.05$.

DON increases the susceptibility to **necrotic enteritis** in broiler chickens.

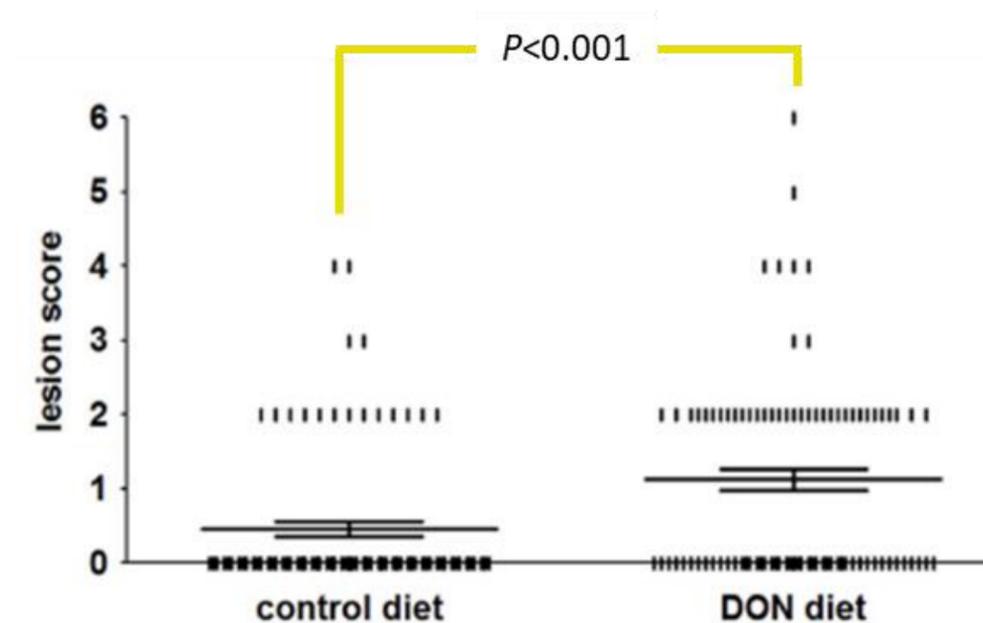


Figure 1. Lesion scores of individual broiler chickens challenged with *C. perfringens* strain 56. Chickens were fed either a control or DON-contaminated diet and subsequently challenged with *C. perfringens* strain 56. The solid bars represent the average lesion score in each group. Error bars represent SEM. Intestinal lesions in the small intestine

Interaction between mycotoxins and vaccination

T-2 toxin halved the response to **ND vaccination** in broiler chickens.

Table 3. Mean (\pm SE) haemagglutination inhibition titres to Newcastle disease virus of broilers fed cyclopiazonic acid and T-2 toxin

| CPA (ppm) | T ₂ (ppm) | HI titres-log2 (n = 8) |
|-----------|----------------------|-------------------------------|
| 0 | 0 | 6.50 ^a \pm 0.96 |
| 10 | 0 | 4.00 ^b \pm 0.58 |
| 0 | 1 | 2.70 ^b \pm 0.75 |
| 10 | 1 | 3.50 ^{bl} \pm 0.96 |

Means with same superscripts within a column do not differ significantly ($p < 0.01$).

1: Represents significant ($p < 0.01$) cyclopiazonic acid and T-2 toxin interaction.

AFB1 and OTA reduce the response to **IBD vaccine** in broiler chickens.

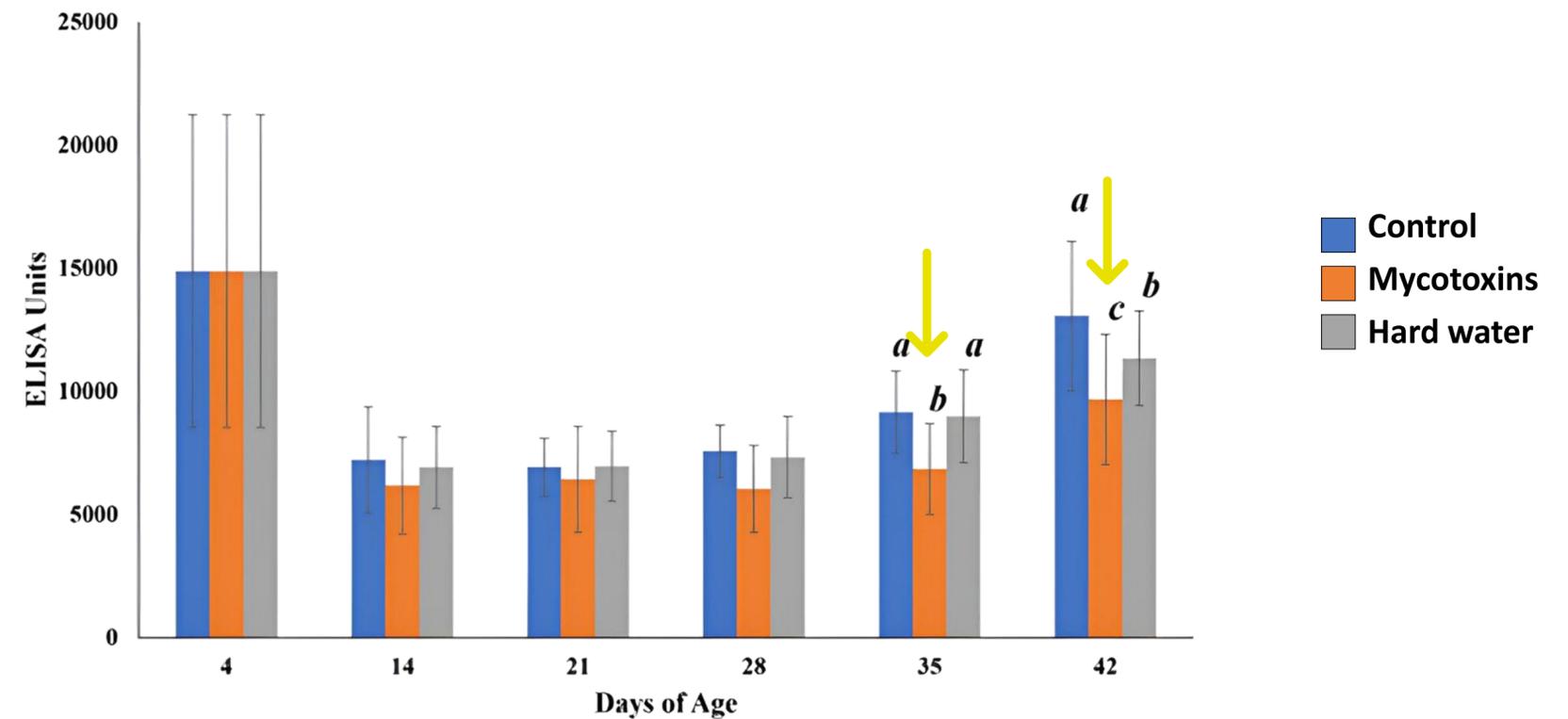
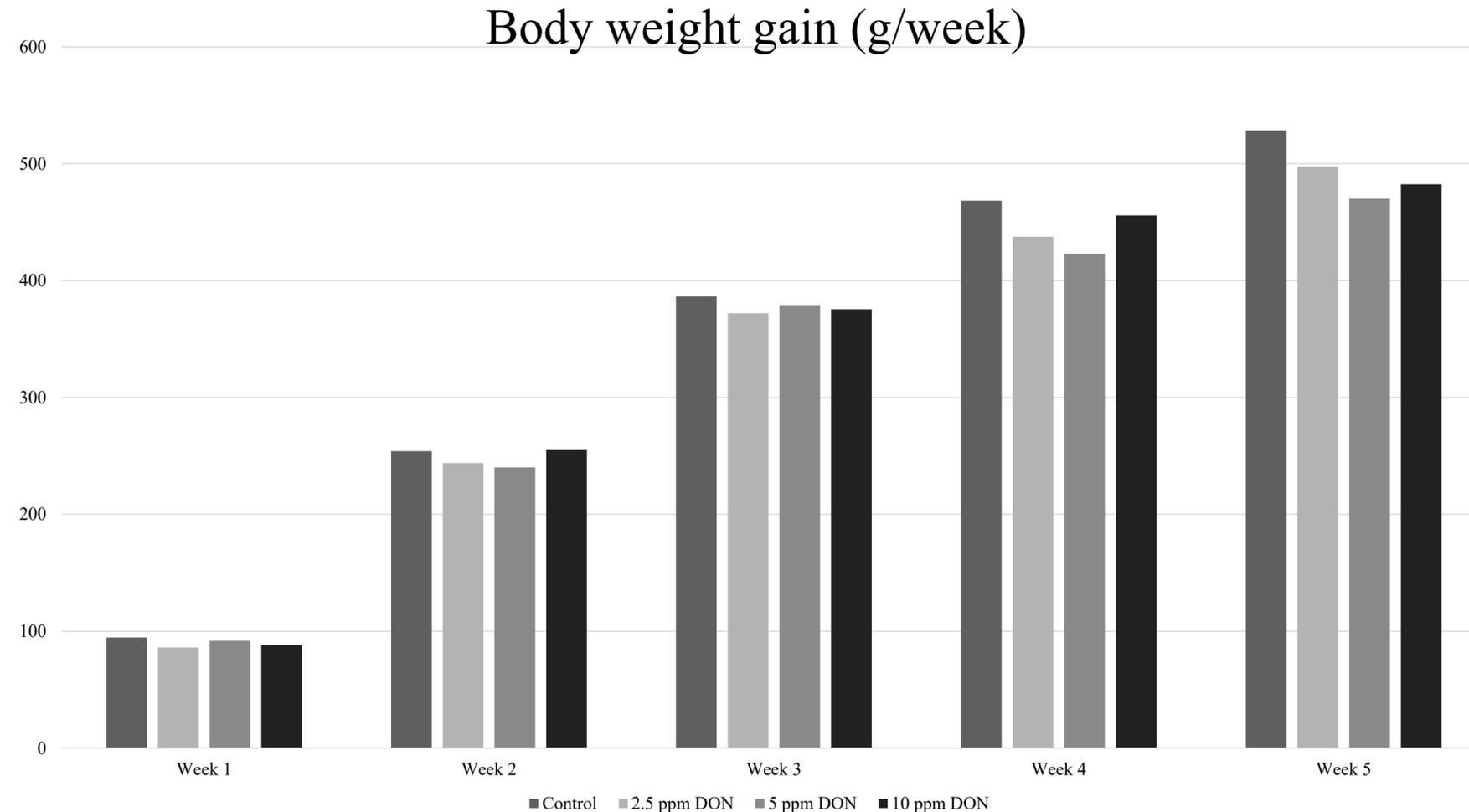


Figure 2: Mean \pm SD ELISA titers against IBD vaccine in broiler chicken (4-42 days of age). Means with a different letter within the same column are significantly different at $p < 0.05$. G2: +(ve) control, G3: received the mycotoxins ration, G4: received the hard water.

Impact of mycotoxins on broilers' performance

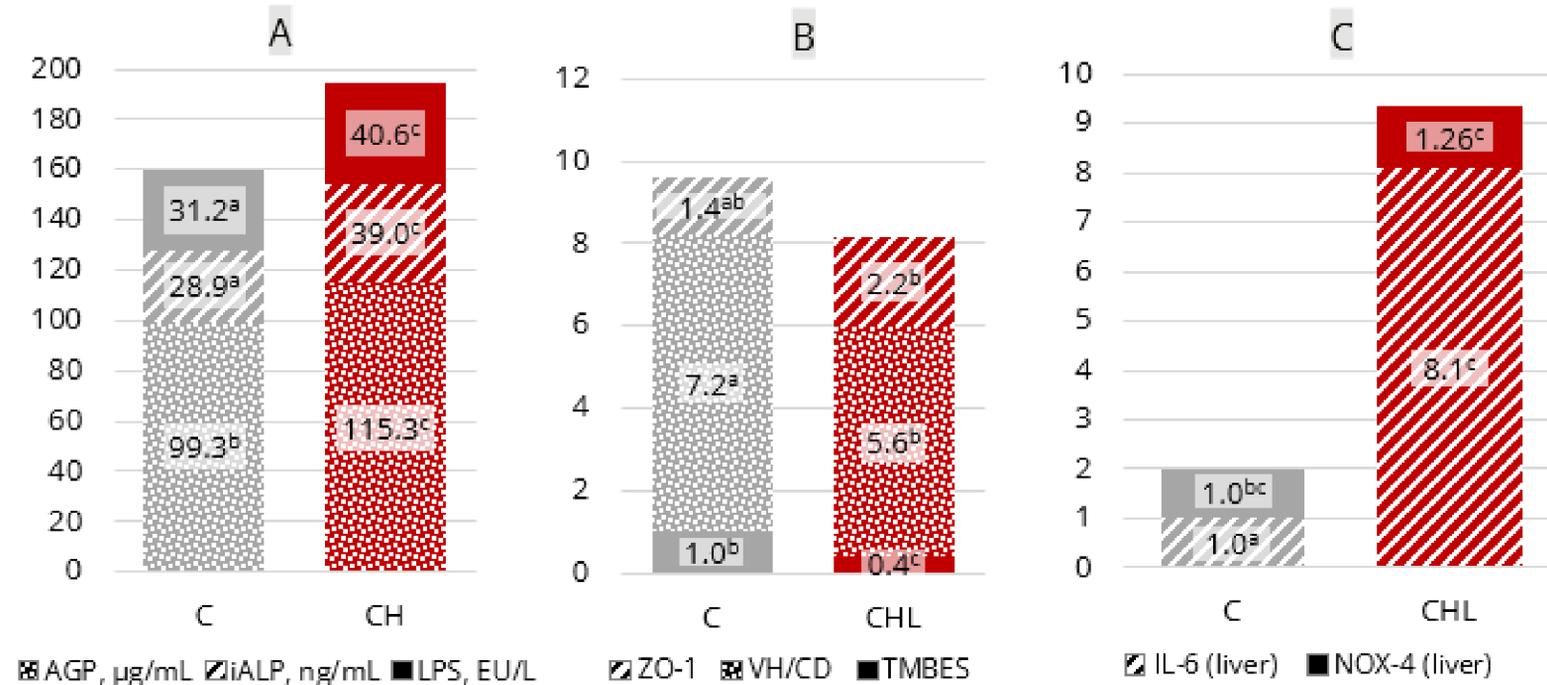
DON reduces weight gain of broiler chickens, particularly at levels below the EU guidelines.



| | Body weight (g) ^c | Body weight gain (g/week) |
|------------------------------|------------------------------|----------------------------|
| Overall | | |
| Control | 729.8 ^a ± 19.5 | 346.5 ^a ± 12.1 |
| 2.5 mg/kg | 692.5 ^b ± 19.6 | 327.5 ^{ab} ± 12.1 |
| 5 mg/kg | 686.6 ^b ± 19.5 | 320.8 ^b ± 12.1 |
| 10 mg/kg | 706.0 ^{ab} ± 19.6 | 331.5 ^{ab} ± 12.2 |
| <i>P</i> values ^c | | |
| Week | <0.001 | <0.001 |
| DON treatment | 0.001 | 0.005 |
| DON treatment × week | <0.001 | 0.152 |

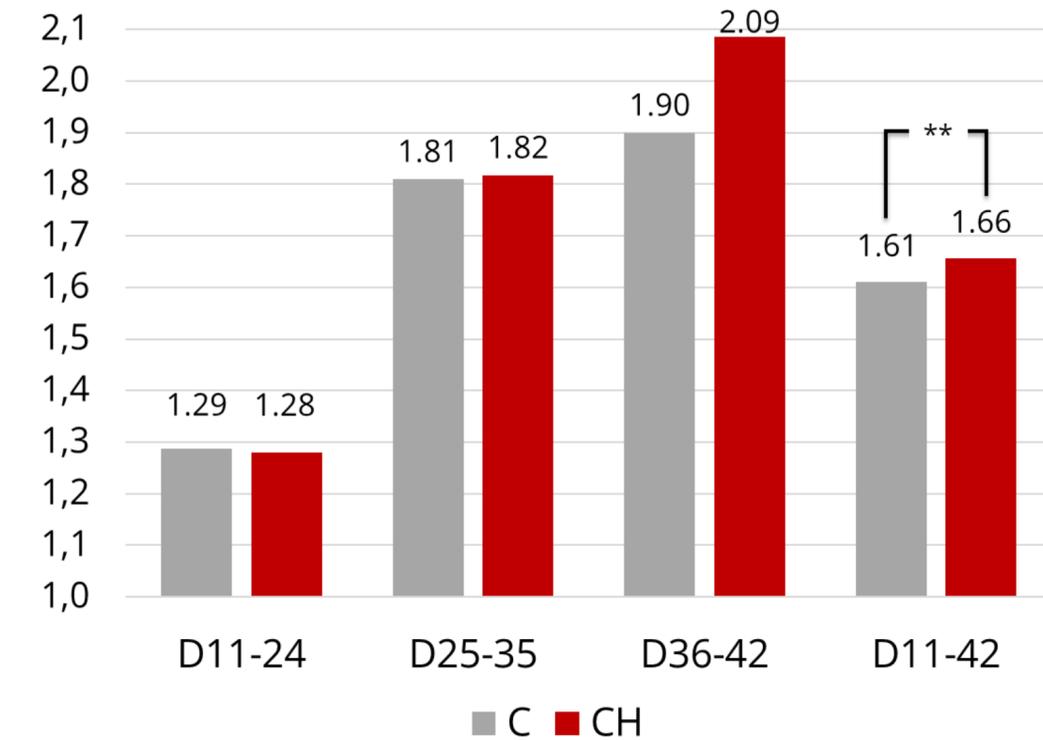
Impact of mycotoxins on broilers' performance

DON and FUM trigger intestinal inflammation (A), and affect gut integrity (B) and liver function (C)



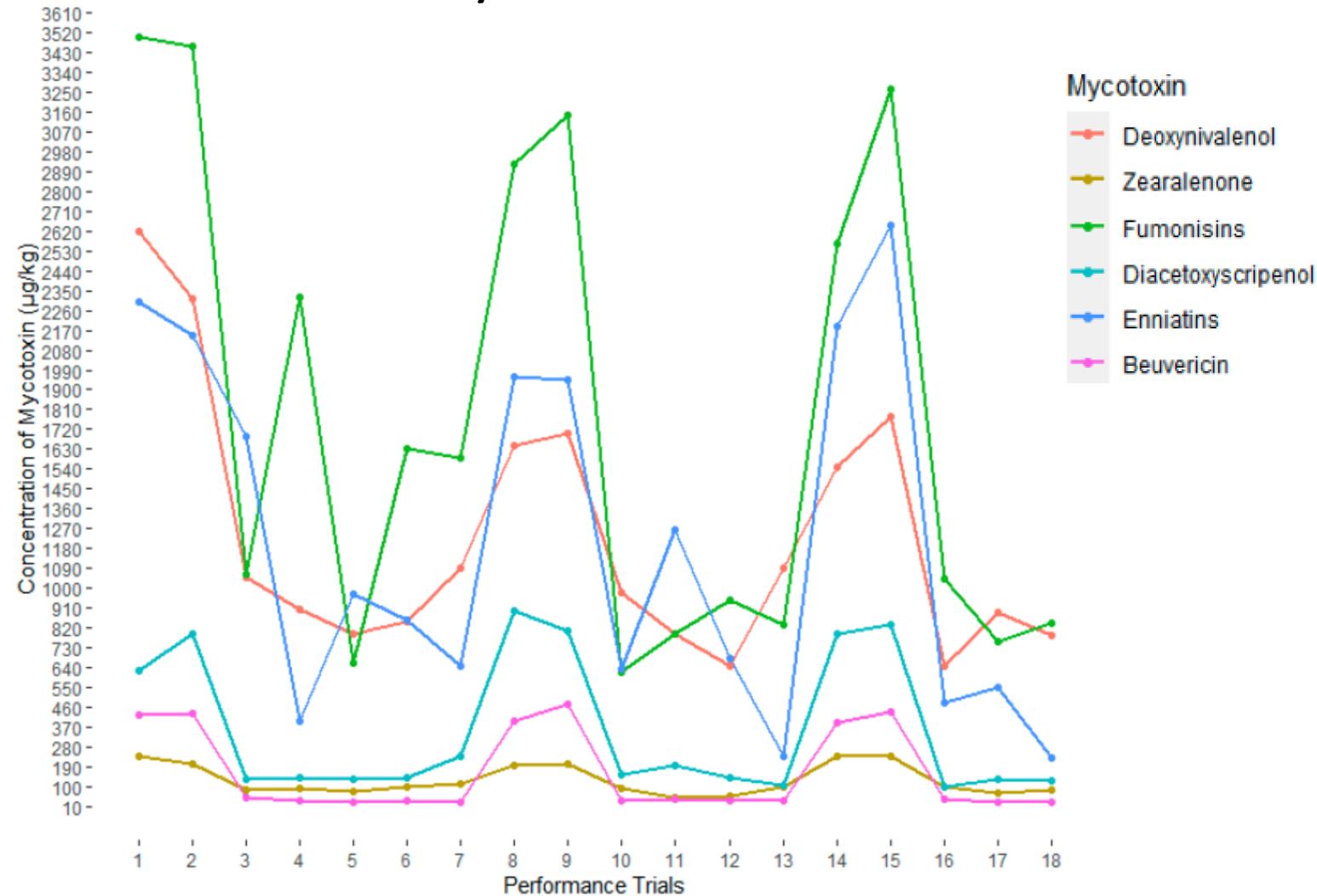
Means of 10 samples per treatment (1 bird/replicate), measured on d30. A: iALP – intestinal alkaline phosphatase (small intestine scrapping); AGP – alpha-1-acid glycoprotein (small intestine scrapping); *E. coli* LPS (serum). B: TMBES: Total Mean Bacterial Enteritis Scoring (according to de Gussem, 2010); VH/CD: villus height to crypt depth ratio (duodenum); ZO-1: relative mRNA expression of zonula occludens-1. C: IL-6 – Interleukin 6 and NOX-4 – NADPH oxidase 4 in the liver (relatively to control).

Costly consequences on FCR in growing-finishing stages



Impact of mycotoxins on broilers' performance

Mycotoxin contamination of the feed in 18 successive performance trials

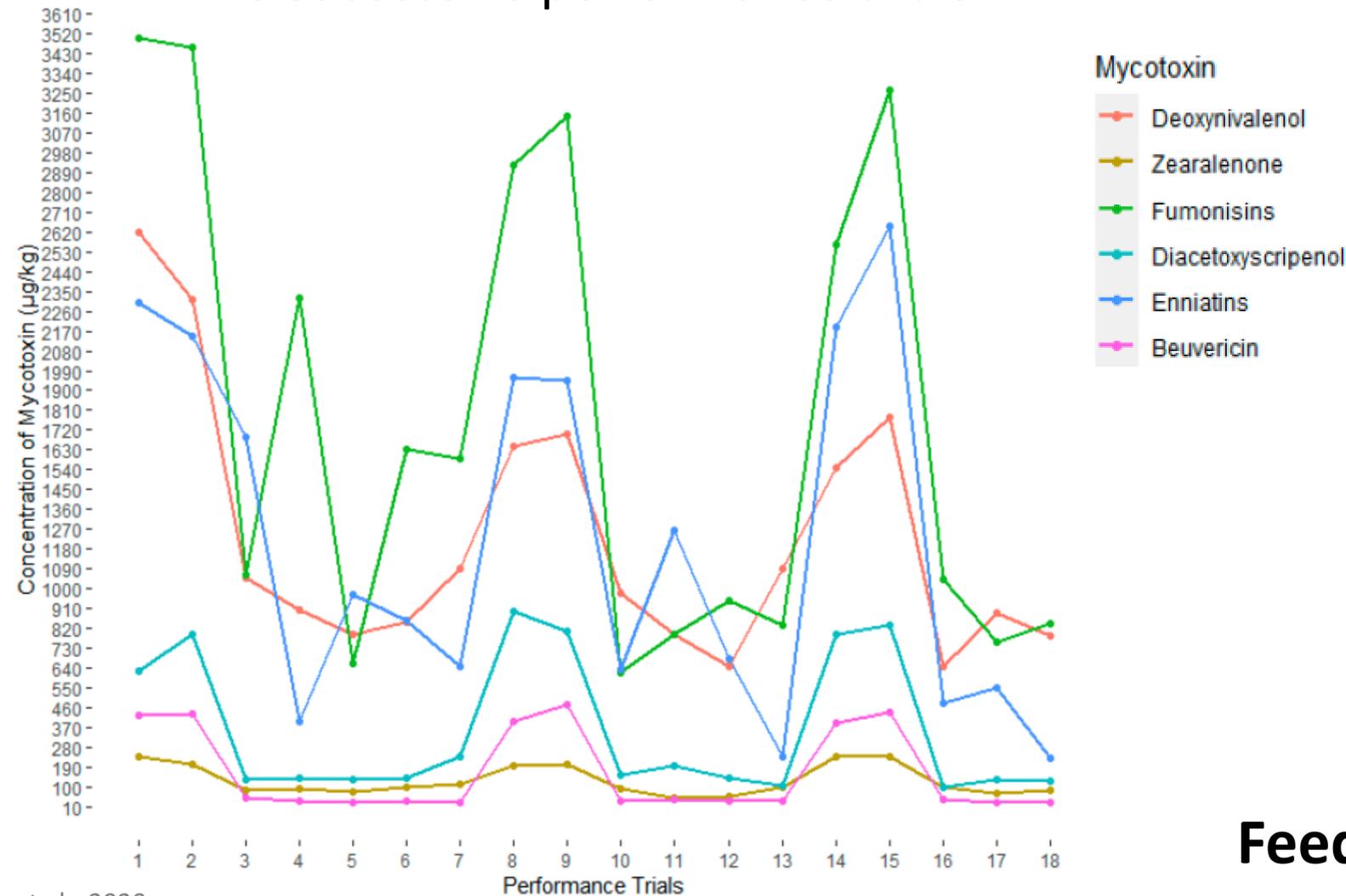


| Mycotoxin (ppb) | Med. | Max. | EU guidance |
|-----------------|------|------|-------------|
| DON | 898 | 2621 | 5000 |
| ZEA | 78 | 241 | NA |
| FB1 + FB2 | 815 | 4260 | 20000 |

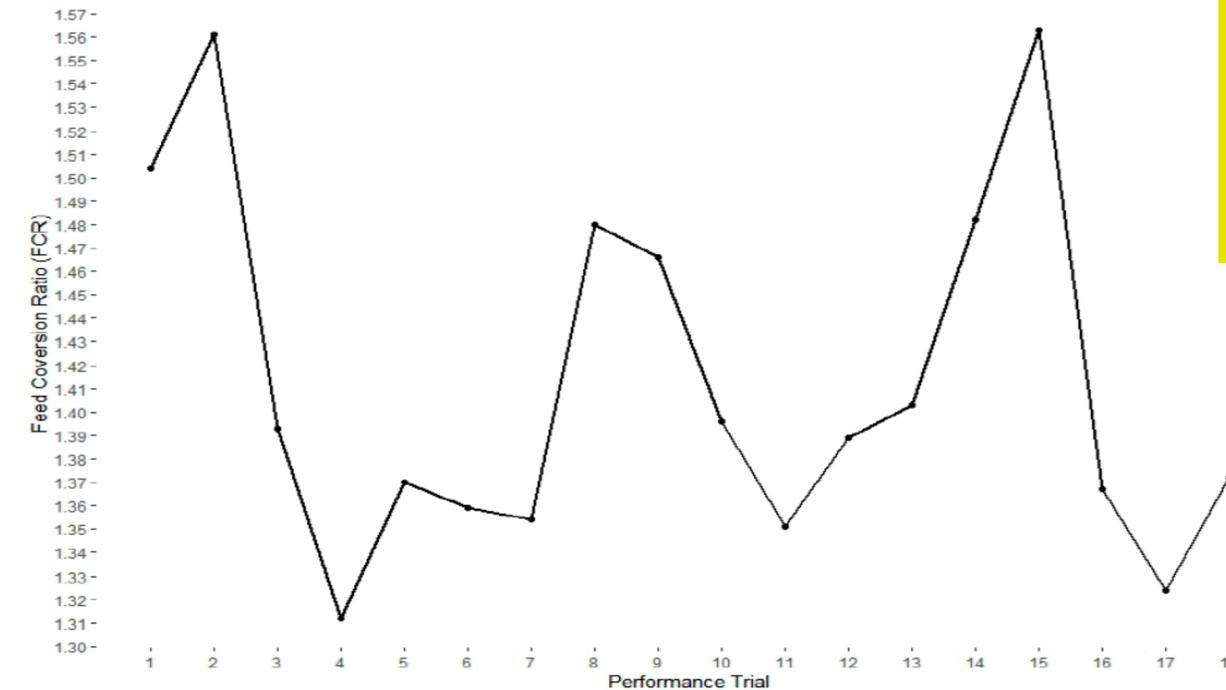
- Variable, natural, poly-contamination with mycotoxins
- Much below the EU guidance levels in all trials

Impact of mycotoxins on broilers' performance

Mycotoxin contamination of the feed in 18 successive performance trials



FCR of broilers in the 18 successive performance trials



Correlations (r^2):

- FCR* DON: 0.85
- FCR* FBs: 0.53
- FCR* DAS: 0.86
- FCR* ZEA: 0.92
- FCR* ENNs: 0.60
- FCR* BEA: 0.73

Feed efficiency is degraded in proportion to the mycotoxin level.

Impact on laying and breeding hens' performance

FUM and DON strongly reduce the **hatching rate** and further affect **progeny health** and performance.

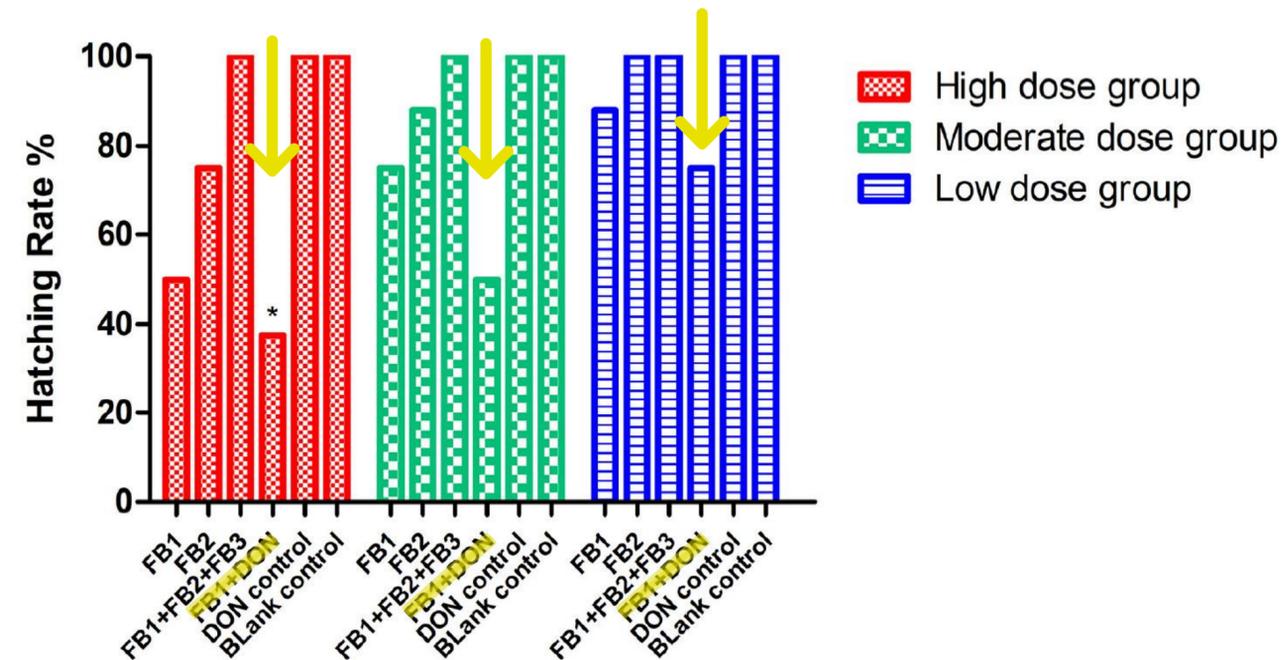


FIGURE 1 | Hatching rate post-inoculation with serial concentrations of FB or DON, or synergetic inoculation. *Indicates $p < 0.05$ when the high $FB_1 + DON$ group was compared to the high FB_1 group, the high $FB_1 + FB_2 + FB_3$ group, and the DON group ($p = 0.037$), while no significant difference was found when the moderate $FB_1 + DON$ group was compared to other moderate groups and the DON group ($p = 0.114$). Similarly, no statistical difference was found when the low $FB_1 + DON$ group was compared to other low groups ($p = 0.427$). The data were analyzed by Chi-square test with SPSS as the categorical variable.

Detection of mycotoxins in breeder eggs in 3 provinces of China (221 samples)

| Mycotoxin (ppb) | Albumen | Yolk |
|-----------------|------------|------------|
| FUM | 428 | 374 |
| DON | 449 | 394 |
| ZEA | 0.4 | 16.9 |
| OTA | 7.9 | 5.5 |
| AFLA | 5.0 | 2.4 |

Mycotoxins affect both laying rate and egg quality, causing problems of marketability, hatchability, and progeny health and performance.

Economic impact of mycotoxins in the poultry industry

Low mycotoxin contamination costs 0.30€/bird, only considering increased FCR

Table 2

Technical result and estimated feed cost breakdown for the broiler system under assessment, with potential additional costs required to purchase more feeds to maintain the weight of broilers exposed to mycotoxin-contaminated diet.

| | Non-contaminated Feed | Contaminated Feed | |
|--|--------------------------|----------------------|--------------------|
| Total number of birds | 100,000 | 100,000 | |
| Growing period (days) | 41 | 41 | |
| Number of cycles per year | 7 | 7 | |
| Estimated feed intake (kg/birds/ cycle) | 5.31 | 5.89 | |
| Total feed required (tonne/year) | 3929.4 | 4358.6 | |
| Feed cost per tonne | €500 | €500 | |
| Total feed cost per year | €1,964,700 | €2,179,300 | + 214,600 € |

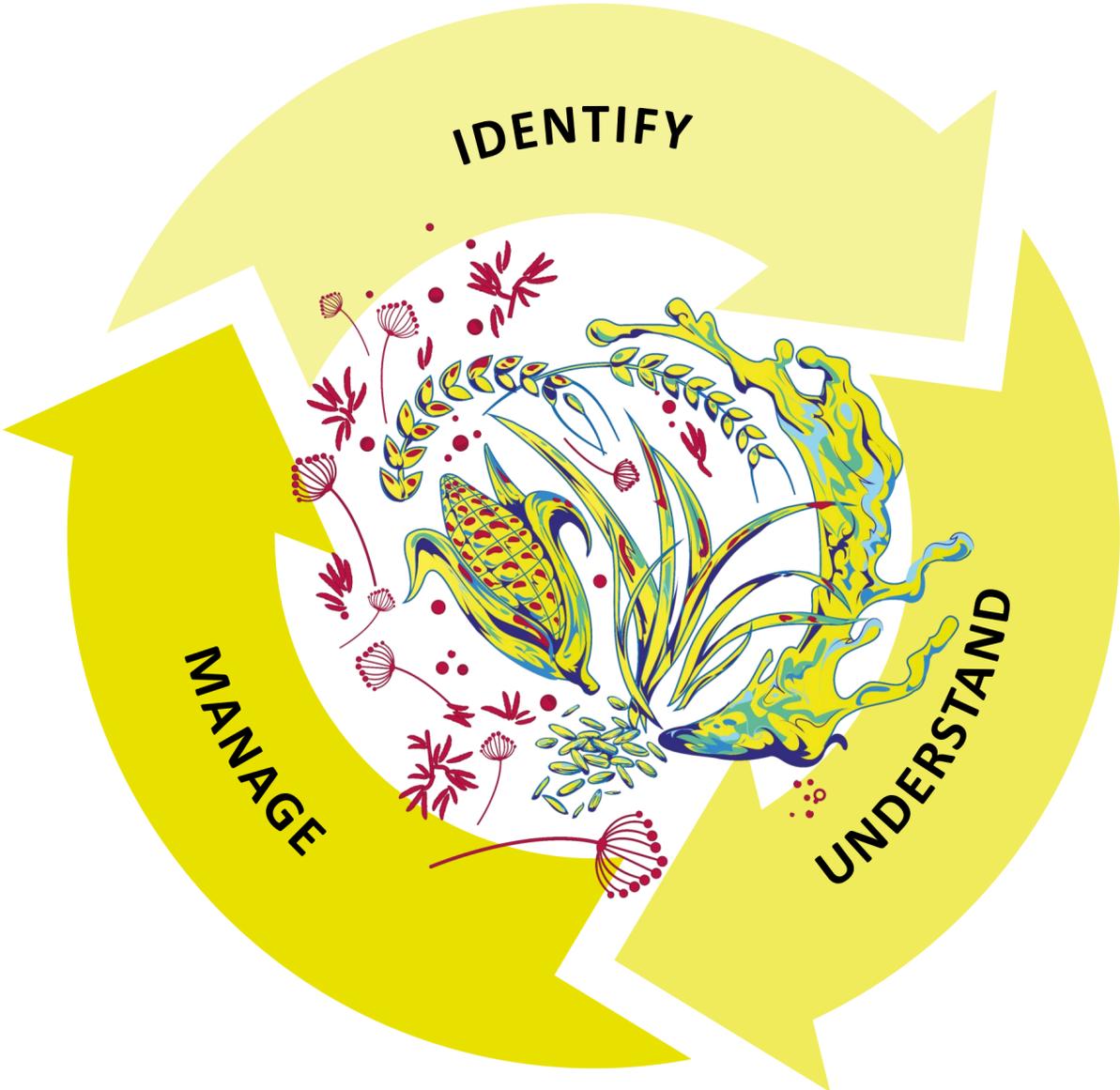
How do we make the camel's life easier?



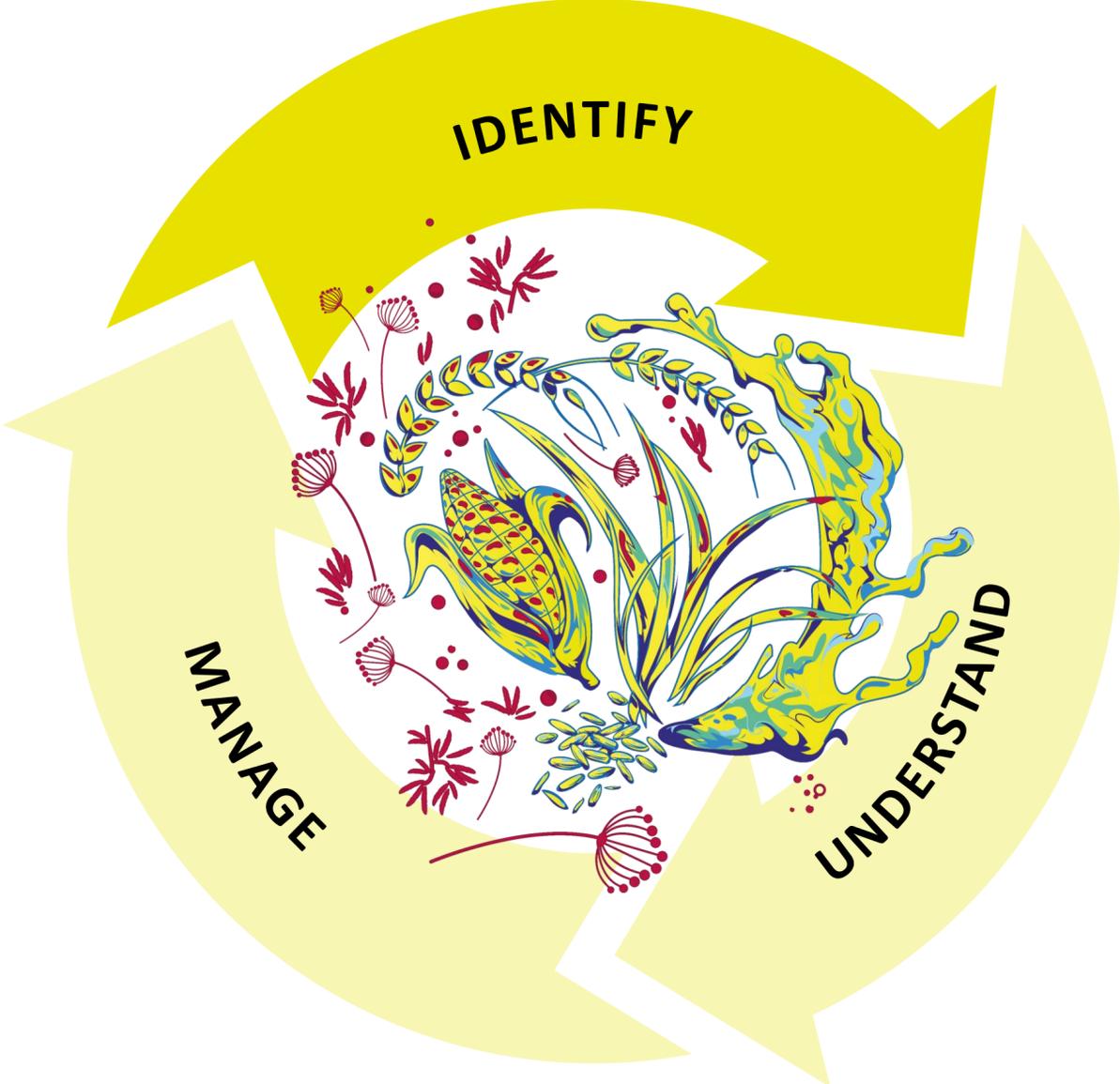
How to manage mycotoxin risk to secure animal performance?



EW Nutrition Toxin mitigation strategy



EW Nutrition Toxin mitigation strategy





Identify the risk



Mycotoxin **monitoring in the raw materials** and/or feed is the only way **to assess the risk** and then to manage it



Mycotoxin control plan

Check **most at-risk ingredients**, based on sensitivity and inclusion rate in the diet
Look for **most at-risk mycotoxins** in the region, or the region of origin of the cereals



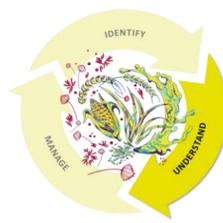
Mycotoxin detection

Quick tests (ELISA) help make **rapid decisions** upon reception of raw materials, or at new harvest
Chromatography (LC/MS-MS, HPLC...) can be necessary to make a **diagnosis** when problems occur on the farm



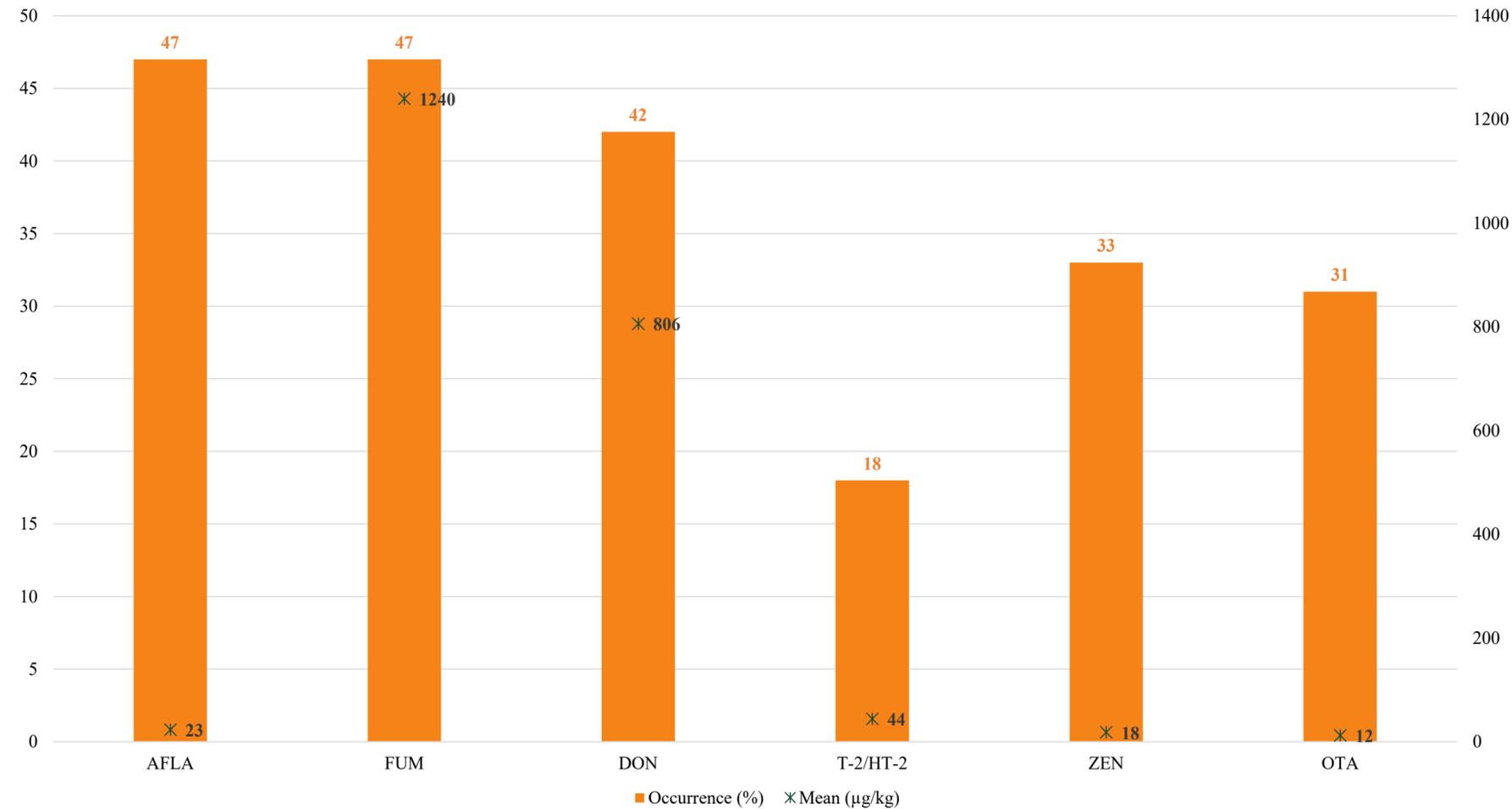
Importance of sampling

Independently of the chosen analytical method, great care should be paid to sampling
A good sampling ensures to analyze a **representative sample** from the batch and to **avoid a misestimation** of the mycotoxin contamination



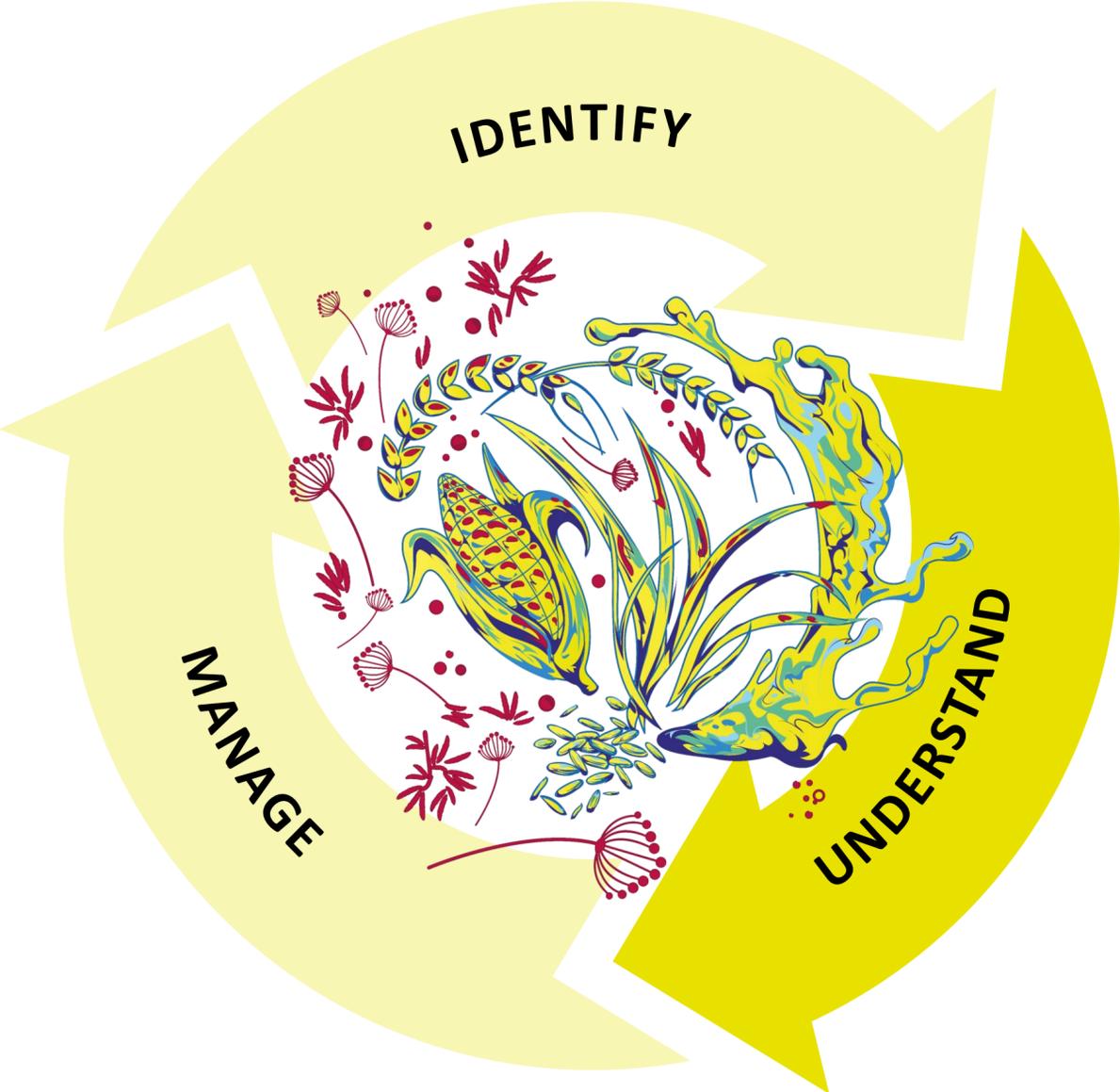
Identify the risk: mycotoxin occurrence trends

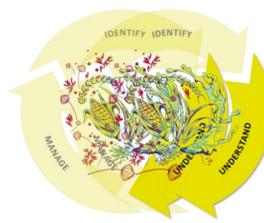
Meta-analysis of mycotoxin occurrence in animal feeds in Middle East and North Africa



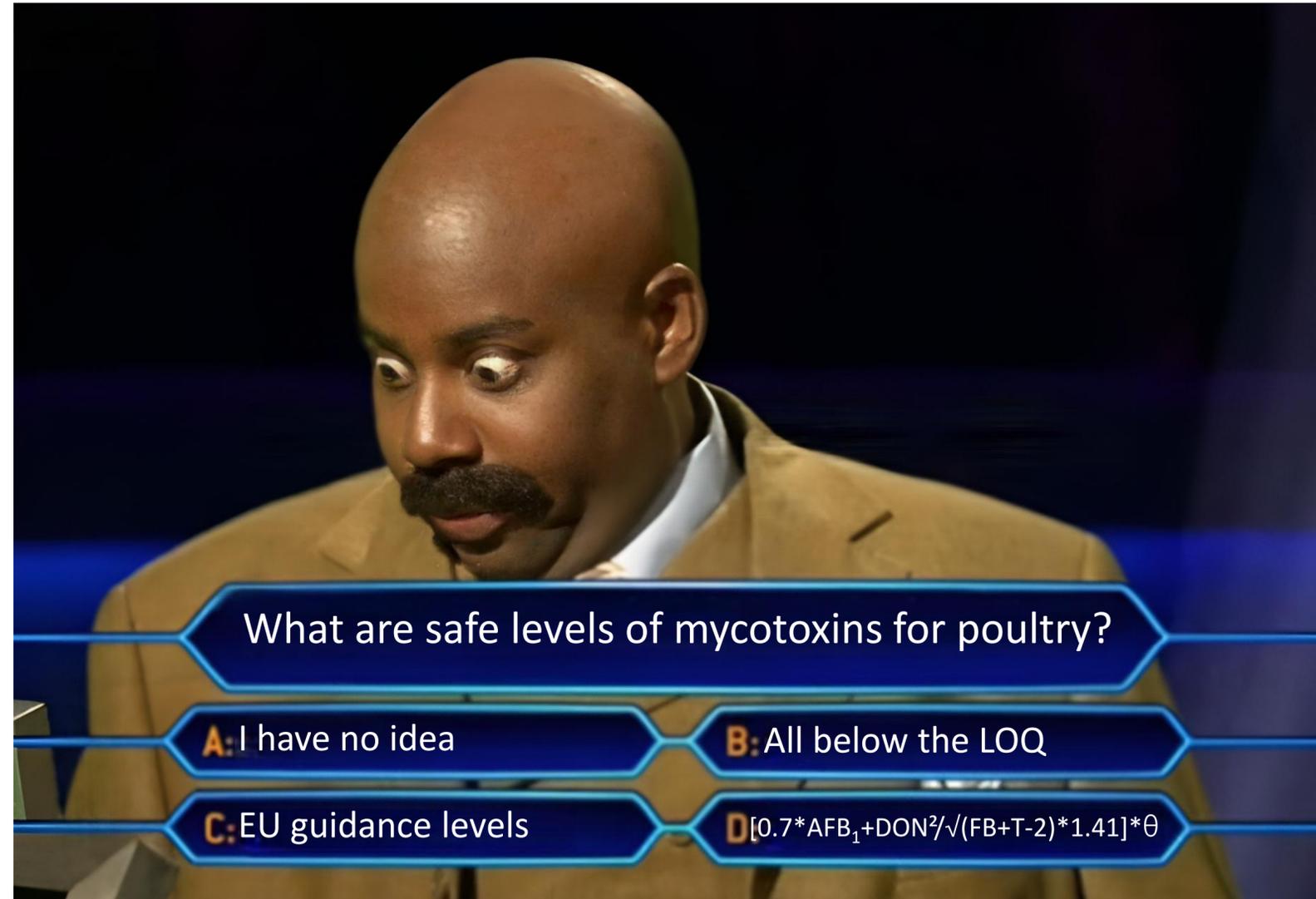
- Priority analyses in the region:
 - Aflatoxins
 - Deoxynivalenol
 - Fumonisin

EW Nutrition Toxin mitigation strategy

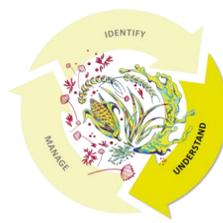




Understand the risk: what are safe levels?



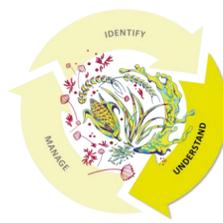
- Answer D is somehow the closest to reality, since defining “safe levels” is a multi-criteria equation:
 - About the mycotoxin: type, level and duration of exposure
 - About the cocktail: single mycotoxin or co-exposure (and which ones)
 - About the animal: species, breed, age, immune and health status
 - About the environment: biosecurity, stressors, feed composition...



Understand the risk: what are safe levels in the EU?

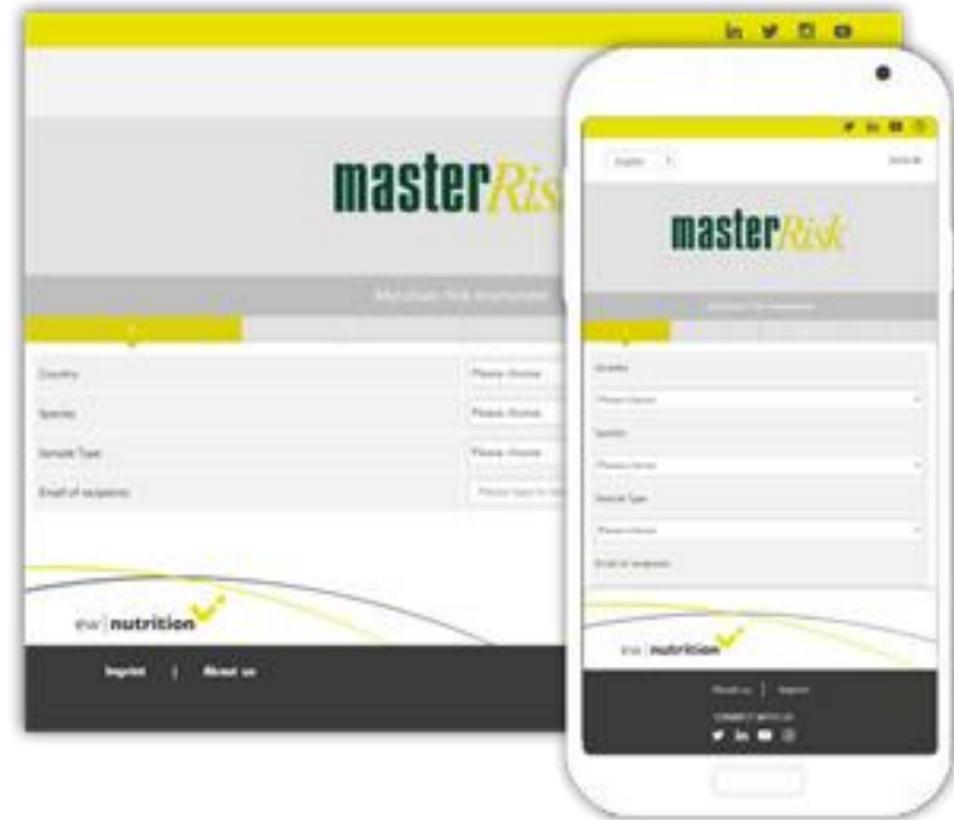
| Mycotoxin (ppb feed) | EFSA opinion Broilers | EFSA opinion Laying hens | EU recommendation (2006/576/EC) |
|---------------------------------|----------------------------------|-------------------------------------|--|
| DON | 600 | 5,000 | 5,000 |
| NIV | 3,000 | 1,000 | NA |
| T-2/HT-2 | 500 | 2,000 | NA |
| ZEN | 50,000 | 100,000 | NA |
| FUM | 1,000 | NA | 20,000 |
| OTA | 30 | 30 | 100 |
| EAs | 2,100 | 3,700 | NA |
| ENN B | 12,720 | 11,230 | NA |
| ENN B1 | 4,060 | 3,600 | NA |
| BEA | 12,600 | 8,930 | NA |

- 3 to 20 times difference between EU guidance and EFSA opinion!
- Lack of studies to update or provide recommendations in many cases.



Understand the risk: EW Nutrition dedicated tool

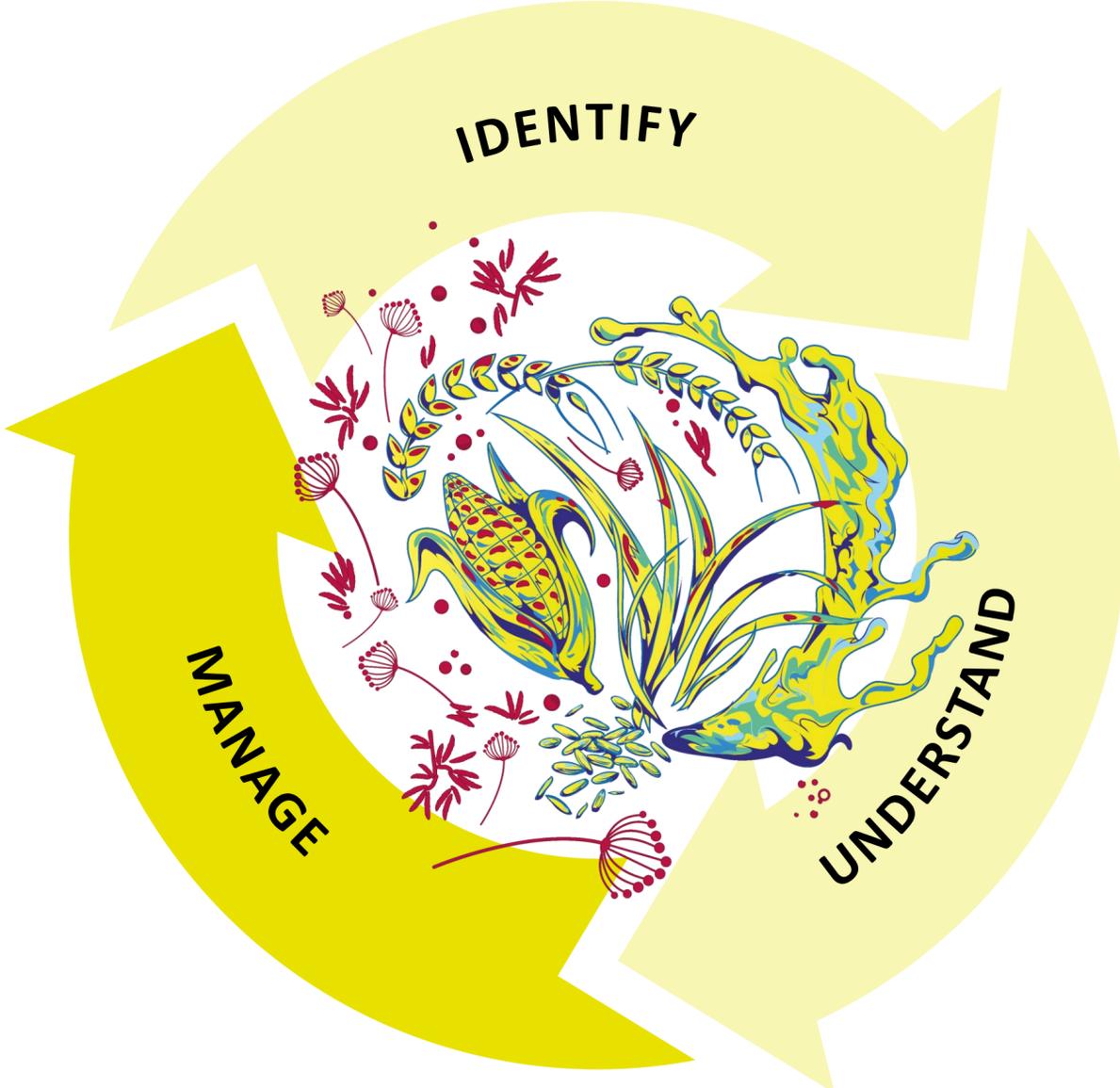
masterRisk

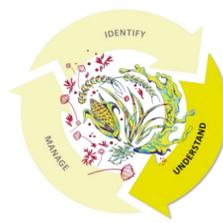


- MasterRisk helps understanding the risk associated with mycotoxins present in raw materials, finished feeds or complete diets.
- MasterRisk helps choosing the best strategy to successfully manage the risk considering:
 - Individual mycotoxins
 - Mycotoxin interactions
 - Species sensitivity

<https://masterrisk.ew-nutrition.com/>

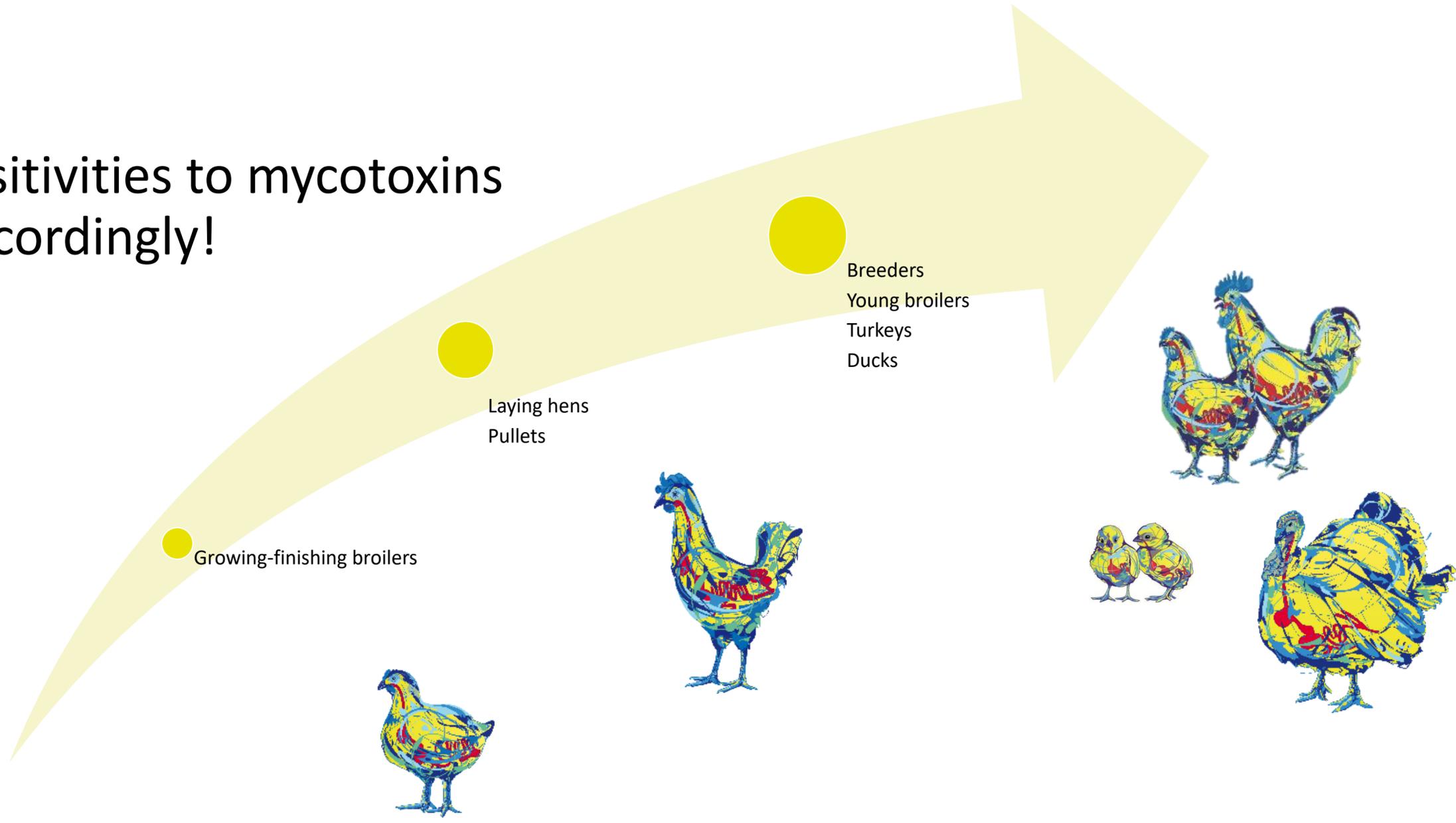
EW Nutrition Toxin mitigation strategy





Manage the risk: know the priorities

Animals show different sensitivities to mycotoxins and should be protected accordingly!

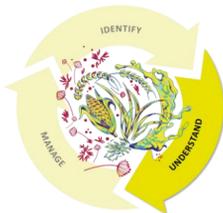




Manage the risk with adequate in-feed solutions

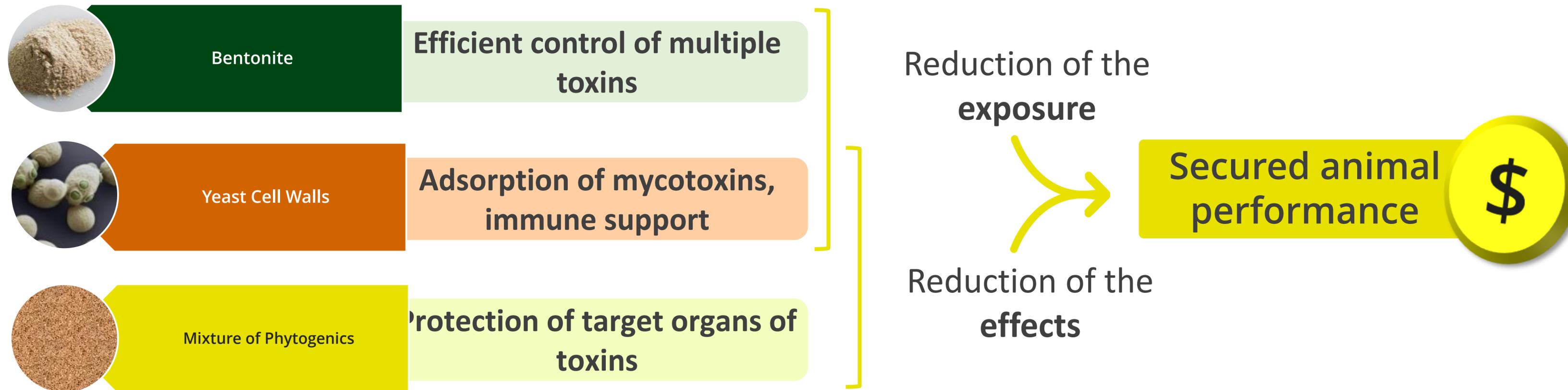
- 2 product lines dedicated to toxin risk management
- Comprehensive offer to address a variety of needs





How do Solis and Mastersorb products work?

→ Selected active ingredients, which work synergistically to ensure optimal animal performance and well-being under toxin challenges.



Benefits of Solis and Mastersorb: recent results

Physiological and zootechnical response of growing-finishing broilers to a multi-mycotoxin challenge with or without an in-feed intervention

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Introduction
Mycotoxins are found in cereals and proven to exert toxicity in animals. In-feed interventions that reduce their exposure and effects can be used to mitigate their impact on poultry. Young broilers are regarded as most sensitive to mycotoxins and their exposure is avoided; however, during later stages the exposure can increase, potentially hindering health and performance.

Objectives
» To evaluate the combined effects of deoxynivalenol (DON) and fumonisin B1 (FB1) on the intestinal and hepatic functions, as well as performance of growing-finishing broilers;
» To evaluate the capacity of an in-feed intervention (IFI – Solis Max 2.0, EW Nutrition GmbH) to mitigate these effects.

Trial design
» Animals: 480 one-day-old broiler chickens (Ross 308).
» Design: 4 groups (Table 1), with 10 replicates of 12 birds.
» Experimental period: control diet from day 1-10; experimental diets from day 11-42.

Results and discussion

Animal performance
The exposure to mycotoxins affected feed efficiency (-4.6 pt FCR from d11-42, $p < 0.01$; Fig. 1), as previously evidenced by Kolawole et al. (2020). Consequently, the chickens' growth tended to decrease (Fig. 2). Birds fed the IFI had similar performance as the CON group.

DON and FB1 exposure impacted performance of growing-finishing broilers, and this effect was avoided with the IFI.

Gut health parameters
On d30, the intestinal mucosa of CHL broilers showed higher inflammation (increased α -1-AGEP and IALP, $p < 0.01$) and permeability (elevated serum *E. coli* LPS, $p = 0.001$) (Fig. 3 A), accompanied by a reduced ZO-1 expression in the jejunum ($p < 0.001$), a poorer histomorphometry (reduced VH/CD, $p = 0.016$) and a higher lesion score (TMSES, $p < 0.05$) (Fig. 3 B), in accordance with the literature (Greiner and Applegate, 2013). These effects were all avoided in the T group. The IFI also improved some parameters in the absence of challenge, like the ZO-1 gene expression. This could be explained by the phytogetic blend used in the IFI (Li et al., 2015).

DON and FB1 confirmed to affect broilers' gut health in the growing-finishing period. The IFI mitigated these effects and improved the gut condition even in the absence of challenge.

Liver condition
The histopathology revealed hepatic fibrosis, cellular necrosis, bile duct proliferation and vacuolation of hepatocytes in the CHL group (data not shown). These changes were substantially reduced in the T group. Additionally, the expression of genes related to oxidative stress (NOX-4) and inflammation (IL-6) was upregulated with mycotoxins and this effect was avoided with the IFI ($p < 0.001$) (Fig. 4).

DON and FB1 adversely affected the liver function and integrity. The IFI significantly mitigated these effects.

Conclusions
DON and FB1 are known to impact intestinal and hepatic functions in poultry, even at levels below the EU guidance. This study shows that a co-exposure to DON and FB1 affects the metabolism of growing-finishing broilers, finally hindering their performance. The IFI (T) effectively prevented the mycotoxin-induced changes and performance loss, making it a relevant tool to manage mycotoxin risk in broiler production.

References
Dreiner B, Applegate TJ. Modulation of Intestinal Functions Following Mycotoxin Ingestion: Meta-Analysis of Published Experiments in Animals. *Toxins* 2013, 5, 398-423.
Kolawole O, Odeh R, Mwangi C, Omondi R, Akh W, Mwangi J, Akh W, Mwangi C, Odeh R, Odeh R. The Effect of Mycotoxin Exposure on the Growth Performance of Growing-Finishing Broilers. *Toxins* 2020, 12, 425.
Li H, Qiu F, Wang L, Xu H, Pan S. Effects of Compound Organic Blends on Intestinal Permeability in Rats with Alcohol-Induced Liver Injury. *Food Funct.* 2015, 6(2):470-8.

Table 1. Experimental design

| Treatment | 2,000 ppb DON 5,000 ppb FB1 | Solis Max 2.0 2 kg/T of feed |
|--------------------------------|--------------------------------|---------------------------------|
| Control (C) | | |
| C + In-feed intervention (IFI) | | X |
| Mycotoxin challenge (CH) | X | |
| CH + IFI (T) | X | X |

Figure 1. Feed Conversion Ratio

Figure 2. Body weight (g)

Figure 3. Markers of intestinal inflammation (A) and integrity (B)

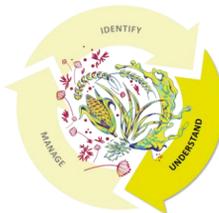


- Key information:
 - Broiler study
 - 2 ppm DON + 5 ppm FB1
 - Evaluation of performance, gut health and liver parameters

DON and FUM exposure impacted performance of growing-finishing broilers, and this effect was avoided with the IFI.

DON and FUM confirmed to affect broilers' gut health in the growing-finishing period. The IFI mitigated these effects and improved the gut condition even in the absence of challenge.

DON and FUM adversely affected the liver function and integrity. The IFI significantly mitigated these effects.



Secured animal performance with Solis and Mastersorb

- Efficacy of the products widely proven
 - In scientific *in vivo* studies
 - On various species
 - On the major mycotoxins, including the “difficult” ones
 - On endotoxins
 - On pesticides
 - ...



TRS308_BRO_SLX 2.0
Solis Max 2.0 diminished the effects of a high mycotoxin challenge in broilers

Trial indicates Solis Max 2.0 can reduce the effects of DON and Ochratoxin in broilers' performance.

Trial No. MS_12m17
Mastersorb Gold counteracts effects of DON and ZEA on broiler performance

... improves body weight, FCR, and EBI for broilers challenged with DON and ZEA in a dose-dependent way.

Trial No. kp221ia122
Mastersorb FM prevents low performance, preserves liver health, and improves broiler performance in broilers challenged with aflatoxin

Conclusion
Study shows that...

Trial No. H1032-m0812
Mastersorb Gold diminishes the toxic effects of fumonisin in broilers

Conclusion
Study shows lower weight loss and better liver health in broilers challenged with fumonisin at 3kg per ton of feed compared to control.

Trial No. H1032-m24
Mastersorb Gold significantly mitigates the negative effects of a *Clostridium perfringens* challenge in broilers

Conclusion
The study showed a reduction of anti-alpha toxin antibodies in broilers challenged with *Clostridium perfringens*, implying a reduction of the bacterial toxin challenge.

TRS316_PLL_SLX 2.0
Solis Max 2.0 diminishes effects of endotoxins in stressed pullets

Trial No. 304FF_410b1t
Mastersorb Gold prevents LPS-induced inflammation and improves gut health in broilers challenged with AFB₁ and OTA

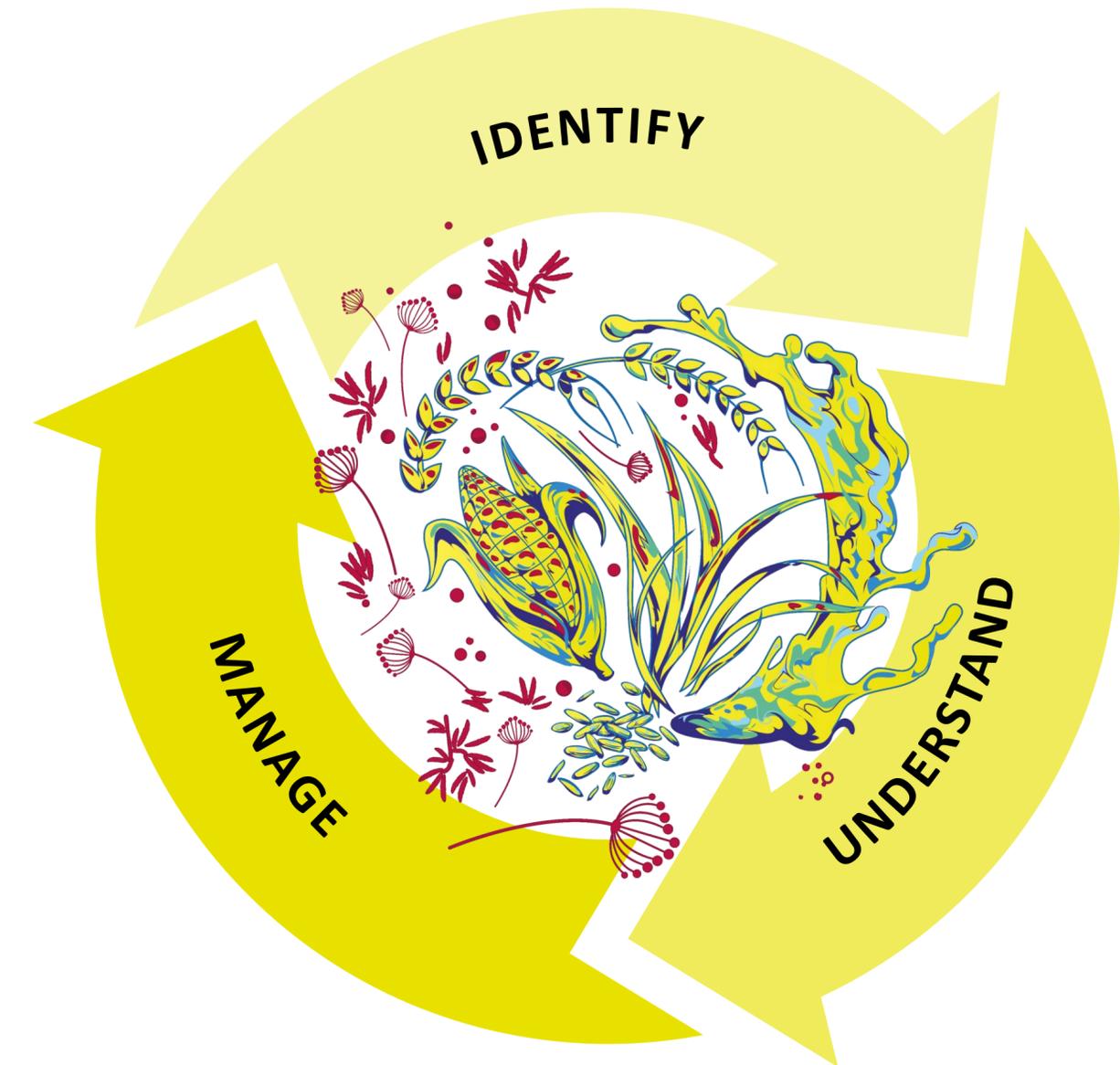
Conclusion
Study shows Mastersorb Gold can mitigate the effects of Aflatoxin and Ochratoxin on broiler gut health, gut integrity, and inflammation, delivering better performance results than AGP treatment.

TRS349_BRE_SLX 2.0
Solis Max 2.0 improved the reproduction performance of layer breeders exposed to an intermittent multi-mycotoxins challenge

Highlights
The co-exposure to aflatoxins and ochratoxins altered the fertility and incubation parameters of the breeding hens, as well as the DOC quality. Solis Max 2.0 successfully mitigated these effects.

Take home messages

- Mycotoxins are a threat to animal well-being, **performance and productivity**
- They primarily act on the **intestinal functions and immune system**, in synergy with other stressors
- A complete toxin mitigation strategy includes **monitoring, prevention and management** measures
- EW Nutrition can support you!





THANK
YOU!

