

## BACKGROUND

### Deoxynivalenol (DON)

- A type B trichothecene produced by *Fusarium* fungi and considered as one of the most significant mycotoxins in agriculture.
- CFIA has set a 1 ppm regulatory guidance limit for DON in swine diets.
- Existing decontamination strategies are limited in terms of binding efficiency, biosafety and cost-effectiveness.

### Magnetic graphene oxide (MGO) nanoparticle treatment

- Has been considered as an efficient and versatile tool for removing various environmental contaminants due to its unique physical and chemical properties.
- MGO, a compound of magnetic nanoparticles and graphene oxide, is synthesized mainly by physical and chemical methods.
- Most studies involving MGO treatment are in the early stage and conducted in aqueous solutions and not on real substrates (e.g., wheat grains).

## OBJECTIVES

### Investigate the application of MGO nanoparticles for the decontamination of DON in grains used in swine feed

- Establish optimum operational requirements and application conditions in in-vitro experiments;
- Evaluate the efficacy of MGO as a DON binder in swine feed, and;
- Assess the impact of MGO addition in swine diet on the overall performance of pigs.

## MATERIALS AND METHODS

### Optimization of MGO application conditions using Response Surface Methodology (RSM)

- A matrix of 20 experiments with 8 factorial points, 6 axial points and 6 central points.
- MGO was applied to three different substrates: wheat, barley and corn.
- DON levels were measured using liquid chromatography – mass spectrometry/ mass spectrometry (LC-MS/MS) techniques.

Table 1. Experimental variables and their levels.

| Variables                              | Levels      |          |             |           |             |
|--|-------------|----------|-------------|-----------|-------------|
|  | -alpha (-α) | Low (-1) | Central (0) | High (+1) | +alpha (+α) |
| Temperature, °C                        | 2.5         | 12       | 26          | 40        | 49.5        |
| Contact time, hours                    | 0.8         | 2.5      | 5           | 7.5       | 9.2         |
| MGO application rate, mg/ 5 g of grain | 32          | 100      | 200         | 300       | 368         |

### In-barn testing with pigs

- Aimed to investigate the effects of using MGO nanoparticles as a DON binder in wheat-barley based swine diet on nutrient digestibility and growth performance of pigs
- 12 nursery pigs with initial BW of 22 ± 2 kg
- 14-day experiment at the PSC metabolism room: 10 days for feeding and 4 days for data collection
- Three dietary treatments:
  - Negative control (NC): Pigs were fed a basal diet not contaminated with DON
  - Positive control (PC): Pigs were fed a basal diet that was contaminated with DON
  - Positive control + MGO (PC+MGO): Pigs were fed a DON-contaminated basal diet and added with MGO as a DON binder
- Monitored parameters:
  - Digestibility and retention of nutrients
  - Growth performance
  - DON and other mycotoxin levels in diet

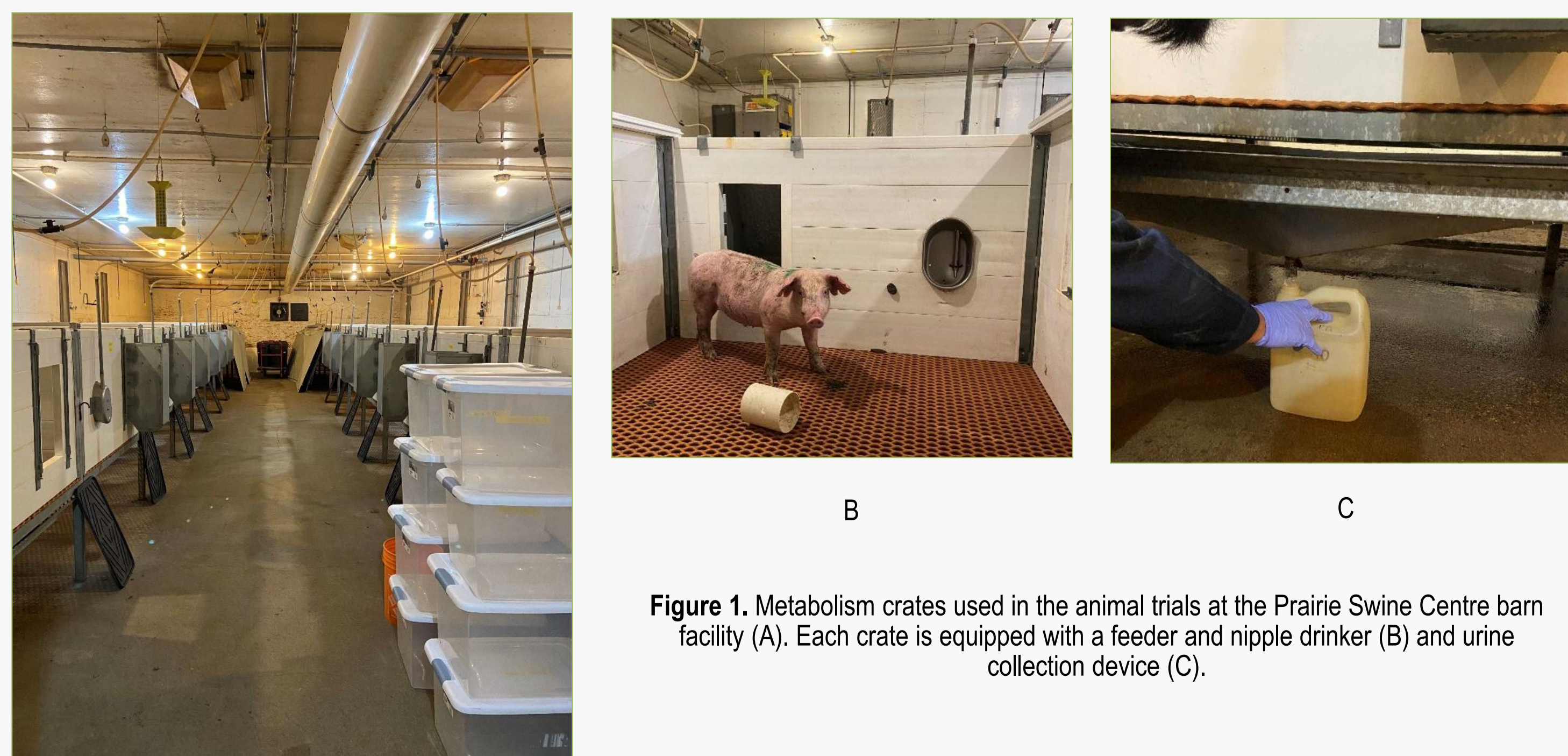


Figure 1. Metabolism crates used in the animal trials at the Prairie Swine Centre barn facility (A). Each crate is equipped with a feeder and nipple drinker (B) and urine collection device (C).

## RESULTS

### Optimization of MGO application conditions

Table 2. Optimum levels of the operating parameters for mitigating DON contamination in wheat, barley and corn grains.

| Operating parameters                   | Wheat | Barley | Corn |
|--|-------|--------|------|
| Temperature, °C                        | 49.5  | 2.5    | 29   |
| Contact time, hr                       | 4.6   | 9.2    | 5.4  |
| MGO application rate, mg per 5 g wheat | 368   | 368    | 365  |
| Predicted adsorption efficiency, %     | 33.8  | 53.2   | 32.3 |

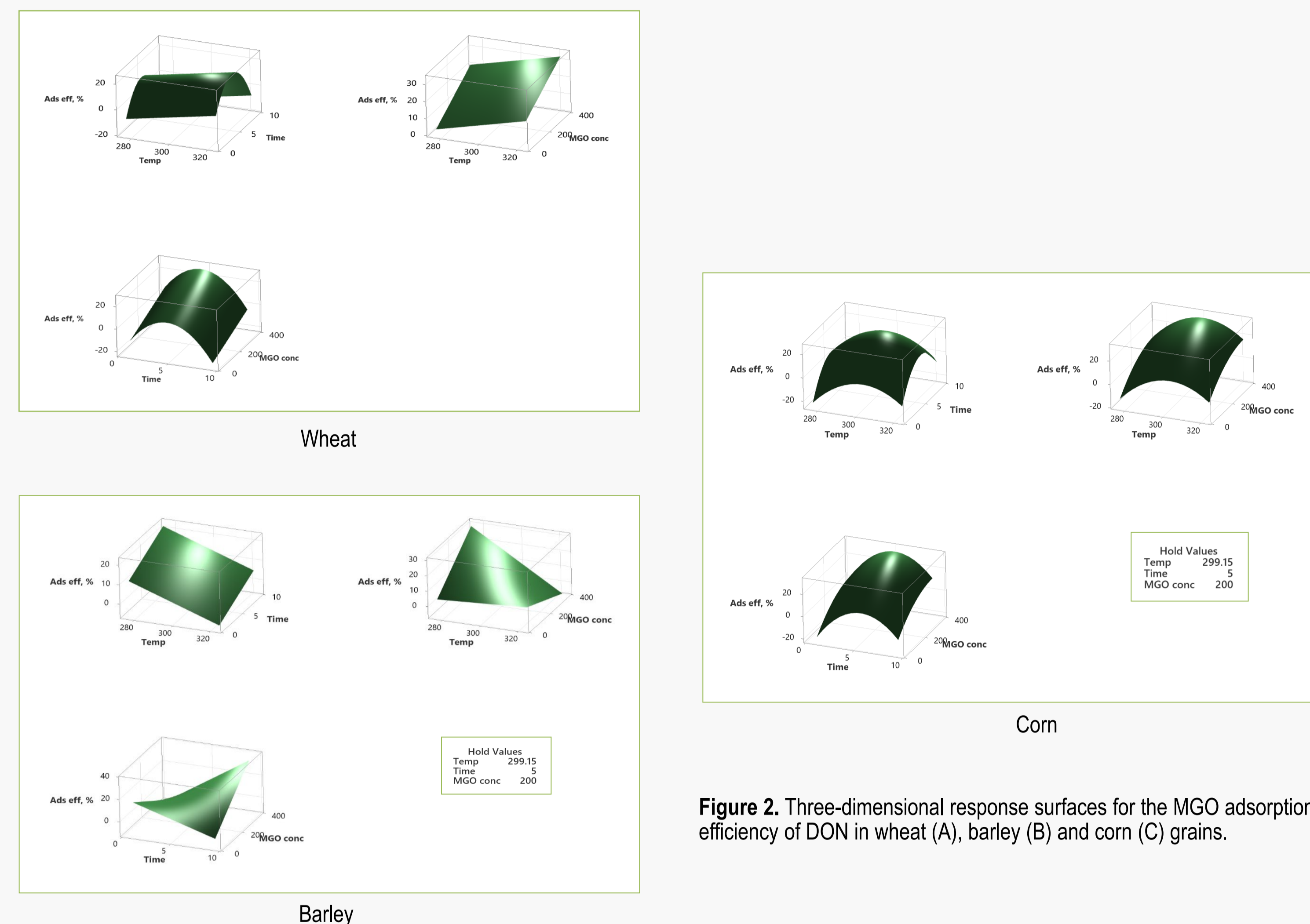


Figure 2. Three-dimensional response surfaces for the MGO adsorption efficiency of DON in wheat (A), barley (B) and corn (C) grains.

### Impact of MGO nanoparticles as a DON binder on nutrient digestibility, nitrogen balance and growth performance of pigs

Table 3. Effect of MGO inclusion on nutrient digestibility in nursery pigs.

| Treatments | Calculated nutrient digestibility <sup>1</sup> (%) |                    |                    |                    |                    |
|------------|--|--------------------|--------------------|--------------------|--------------------|
|            | GE   | DM                 | TDN                | Fat                | CP                 |
| NC         | 86.75 <sup>a</sup>                                 | 96.03 <sup>a</sup> | 92.76 <sup>a</sup> | 65.61 <sup>a</sup> | 86.93 <sup>a</sup> |
| PC         | 83.25 <sup>b</sup>                                 | 95.10 <sup>b</sup> | 91.11 <sup>b</sup> | 56.80 <sup>b</sup> | 82.25 <sup>b</sup> |
| PC+MGO     | 82.96 <sup>b</sup>                                 | 94.61 <sup>b</sup> | 90.44 <sup>b</sup> | 55.37 <sup>b</sup> | 82.23 <sup>b</sup> |

<sup>1</sup>GE, gross energy; DM, dry matter; TDN, total digestible nutrients; CP, crude protein  
<sup>a,b</sup> Means without a common superscript within a column are significantly different ( $p < 0.05$ ).

Table 4. Nitrogen balance results for nursery pigs fed DON-contaminated diets with MGO binder.

| Treatments | N <sup>1</sup> intake, g/d | Urinary N output, g/d | Fecal N output, g/d | N retained, g/d | Protein deposition, g/d |
|------------|----------------------------|-----------------------|---------------------|-----------------|-------------------------|
| NC         | 52.77                      | 12.00                 | 6.89 <sup>b</sup>   | 33.87           | 211.67                  |
| PC         | 51.75                      | 11.10                 | 9.13 <sup>a</sup>   | 31.52           | 197.01                  |
| PC+MGO     | 55.29                      | 11.04                 | 9.87 <sup>a</sup>   | 34.38           | 214.90                  |

<sup>1</sup>N, nitrogen; <sup>2</sup>Protein deposition = N retained x 6.25  
<sup>a,b</sup> Means without a common superscript within a column are significantly different ( $p < 0.05$ ).

Table 5. Growth performance of nursery pigs fed diets contaminated with DON and added with MGO as a DON binder.

| Treatments | ADG <sup>1</sup> | ADFI       | G:F         |
|------------|------------------|------------|-------------|
| NC         | 0.99 ± 0.2       | 1.37 ± 0.1 | 0.72 ± 0.1  |
| PC         | 1.04 ± 0.1       | 1.35 ± 0.1 | 0.77 ± 0.04 |
| PC + MGO   | 1.04 ± 0.03      | 1.40 ± 0.1 | 0.74 ± 0.04 |

<sup>1</sup>ADG, average daily gain; ADFI, average daily feed intake; G:F, gain to feed ratio

## CONCLUSIONS

- Using RSM, graphical and numerical optimization results revealed that the optimum levels for temperature, contact time and MGO application rate vary depending on the type of feed grains used.
- The inclusion of MGO in the diet had no apparent effect on nutrient digestibility and nitrogen retention, and no adverse impact on growth performance.
- Follow up research involving long-term feeding of MGO-treated diets to nursery and grower-finisher pigs with higher DON levels (more than 3 – 5 ppm) is recommended to fully assess the overall impact of this technology in mitigating mycotoxin contamination in swine diets as well as on the environment.

## ACKNOWLEDGMENTS