NC-213 PROGRESS REPORT FOR 2025

Title
Developing and Operationalizing Quality and Food Safety Management System at FMGSC to Address the Challenges Faced at US Feed Mills.

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Outputs/Research Updates
Achieving a high standard of food safety in animal food manufacturing facilities is needed by government regulations, international certifications, customer requirements, and companies' obligations to protect public health. In the United States, the Food and Drug Administration (FDA) requires feed mills to meet the Food Safety and Modernization Act (FSMA) rules based on the Code of Federal Regulations (CFR) 21 parts 507 and 225. Some feed mills implement multiple food safety management systems to achieve the feed safety standards different stakeholders require. These call for activities such as feed equipment cleaning to control micro-ingredients and/or medication carryover in finished feed, which can be challenging to implement.

Outcomes/Impacts/Deliverables and updates of studies continued in 2025
Study 1: Identify and understand the challenges faced by some U.S. feed mills when implementing multiple food safety management systems (MFSMS). [see 2024 NC-213 Annual Report]
Study 2: Develop the Quality and Food Safety Management System at the ISU Kent Feed Mill and Grain Science Complex. [see 2024 NC-213 Annual Report]
Study 3: Implement the Quality and Food Safety Management System at the ISU Kent Feed Mill and Grain Science Complex. [see 2024 NC-213 Annual Report]

Study 4: Determine the recovery of magnetic iron tracer in feed mill bucket elevators, and to investigate the effect of feed composition and physical properties on the recovery
Incidences of carryover of veterinary drugs and feed additives in non-target animal feed have resulted in regulatory guidance of control measures such as flushing, cleanout and sequencing (Martinez et al., 2018; U.S. FDA, 2023). The U.S. FDA recommends flush size of 5 to 10% mixer capacity. However, it is unrealistic to achieve zero tolerance of carryover, and no two feed mills are alike regarding cleaning out equipment. At the ISU Kent FMGSC, discussions are ongoing to address possibility of carryover of feed ingredients such as Distillers' Dried Grains with Solubles (DDGs) from swine feed into genetic poultry layer feed. Thus, DDGs could not be used to conduct carryover studies. Instead, a tracer was identified for the experiment. The study focused on quantifying residual in the boot of two 'self-cleaning' bucket elevators and to determine the effect of run days and feed tonnage on the accumulation of feed residue in the boots. Secondly, Microtracer F-blue recovery was studied as a step to adopt it as a tracer for on-

site screening of carryover in feed manufacturing equipment. There was a significant difference in residual amounts between the two legs which was not influenced by the number of days run and tons of feed mixed. Mixer uniformity tests with the tracer indicated complete mix for three of the four trials. The recovery percentage in the first two trials were similar but differed significantly in trials 3 and 4. The significant variation in the recovery percentage was influenced by particle size of the feed as well as some ingredients. A manuscript has been drafted and is in preparation for submission to a peer reviewed journal.

Study 5: Quantify carryover (cross-contamination) in feed mill bucket elevators using magnetic iron tracers, and to determine the effect of feed composition and physical properties on carryover.

Considering the incidences of cross-contamination and the need to have a rapid screening method on-site, this project focused on quantifying carryover in two 'self-cleaning' bucket elevators at the ISU Kent FMGSC using magnetic iron tracers, and to determine the effect of feed composition and physical properties on carryover. Three trials were conducted by adding Tracer F-blue to the carrier feed. Two ton of feed was used for equipment flushing and subsequent feed batches (1, 3, and 5) were sampled. The samples were analyzed by quantifying carryover using a developed equation. An actual feed ingredient, "Calsporin (*Bacillus subtilis*) was used to validate the results from Tracer F-blue and the developed equation. There was no significant difference in carryover between the two bucket elevators. But there was a significant difference as a result of feed tonnage as well as the type of feed used as a flush material. This observation led to an additional question, 'how does the percentage carryover apply to actual veterinary drugs practically?' A manuscript is in preparation and will be submitted to a peer-reviewed journal for publication.

Study 6: Establish "actual" carryover limits with the iron tracer using the Average Daily Intake (ADI)-derived carryover method and the maximum residual limit carryover method.

Toxicological limit values are established for compounds if they can be isolated and tested, e.g., Chloramphenicol in shrimps with 0.1 to 1.0 µg/kg (Hanekamp et al., 2015). The process to test veterinary drugs can be laborious and take much time. Considering that iron tracer was used to determine cross-contamination, and expressed as a percentage, there is a need to express toxicological limit in the same unit (%) as a baseline for comparison. The ADI-derived carryover method (ADCL) and the maximum residual limit (MRL) methods were used (Nestmann and Lynch, 2007; European Medical Agency, 2014). ADCL was calculated as a ratio of maximum approved level of veterinary drug to a calculated safety factor (the product of 3-10-fold extrapolation sensitivity factor times 3-to-10-fold contraindication time factor and withdrawal time factor). The % carryover based on ADCL was expressed as a ratio of the ADCL to the maximum approved level of the active ingredient multiplied by 100. The MRL-based carryover was expressed as a ratio of maximum residual limit based on the target species to a maximum approved level of the drug and expressed as a percentage. By comparing the percentage carryover of the tracer experiment to the ADCL and MRL-based method, the carryover level based on the tracer does not exceed the carryover limit. There is the need to validate the MRL-

based and ADCL based carryover limits by other commercial feed mills as a step to using on-site tracer screening method for rapid decision making.

Publications

Oral/Poster Presentation

- Animal Industry Committee Meeting, Iowa State University Kent Feed Mill and Grain Science Complex (U.S.), Agri-Business Association of Iowa, June 25, 2024 (Akoto: 1 lecture)
- IGFIA Advanced Feed Manufacturing & Mill Management Short Course – Southeast Asia Feed Industry Team. USGBC and USSEC South East Asia Region, Iowa Corn Promotion Board and Iowa Soybean Association, July 7-11, 2025 (Akoto: 1 lecture, 2 hands-on training).
- IGFIA Advanced Feed Manufacturing & Mill Management Short Course – Tunisia Feed Industry Train-the-Trainer Team. USGBC Middle East & Africa Region, August 18-23, 2025 (Akoto: 1 lecture, 6 hands-on training).
- Sectional Meeting, GRI GEAPS, Iowa State University Kent Feed Mill and Grain Science Complex (U.S.), December 3, 2025 (Akoto: 1 lecture)

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