

NC-213 PROGRESS REPORT FOR 2025

Title

Utilization of the new ISU Kent Feed Mill and Grain Science Complex for Research, Education and Outreach

Investigators

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Outputs/Research Updates

The new ISU Kent Feed Mill and Grain Science Complex is a unique state-of-the-art facility that was commissioned and operationalized in 2023. It has a self-contained feed manufacturing tower, stand-alone pilot plant, ingredients warehouse, quality lab, classroom, and complete grain handling, drying and storage center. Its mission furthers ISU's research, teaching, service, Extension, and industry and international outreach in support of the global grain, feed, oilseeds, bioproducts, and animal industries. It is the headquarter of ISU's Feed Technology and Grain Science Extension and Outreach program. Capabilities, operationalization efforts, licenses, registrations, and first and second year operations were summarized in the 2021, 2022, 2023, and 2024 NC-213 progress reports.

Outcomes/Impacts/Deliverables and updates of studies continued in 2025

Nearly 1400 people from 26 countries visited the facility as part of 136 tours and trainings in 2025 including from Bangladesh, Brazil, Cameroon, Cambodia, Canada, Chile, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Ghana, Germany, Guatemala, Indonesia, Israel, Honduras Japan, Kenya, Malaysia, Mexico, Morocco, Nicaragua, Nigeria, Panama, Peru, Rwanda, Senegal, South Africa, South Korea, Taiwan, Thailand, Tunisia, Uganda, Ukraine, USA, Venezuela, and Vietnam. In-person, on-site trainings of domestic and international industry professionals focused on advanced feed manufacturing, mill operations management, grain and ingredient storage, co-products utilization, feed safety and quality management, regulatory compliance, and PCQI certification. The facility was also utilized for the industry-wide Stand Up 4 Grain Safety Week kick-off program in March. The latter focused on safety associated with traffic patterns around facilities, bin monitoring and preventative maintenance along with hearing protection. It was attended in person by 25 people and live broadcast to over 200. Under the umbrella of the International Grain & Feed Industry Academy, faculty, staff and industry experts utilized the feed mill tower, pilot plant and quality lab for six on-site trainings of 106 industry professionals from Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Indonesia, Malaysia, Mexico, Morocco, Panama, Peru, Philippines, Thailand, Tunisia, USA, and Vietnam attending offerings of the *Advanced Feed Manufacturing & Mill Management Short Course* in partnership with the U.S. Grains & BioProducts Council, Iowa Corn, U.S. Soybean Export Council, and

Iowa Soybean Association. The facility hosted two feed industry professionals from Colombia for 2-week long industry externships.

Four ISU courses held class onsite during the calendar year with nearly 120 students gaining knowledge and perspectives in feed technology, grain science, animal nutrition and bioproducts utilization including the 3-credit Feed Safety, Ingredient Quality and Analytics (TSM4570/5570) and Feed Processing and Technology (TSM4550/5550) courses required for completion of the ISU Feed Technology Minor. Both were taught entirely at the facility twice per week (4.5 h/week incl a 3-hour lab practical) with an enrollment of 16 and 18 students, respectively. One M.S. student from Purdue University participated remotely and spent 1-week on-site to complete the hands-on learning modules as part of a USDA NIFA HEC grant focused on the Grain Value Chain. The facility was the subject of two TSM4150/4160 Senior capstone projects involving 8 undergraduate students focused on installation of bin vibrators and capturing safety data. Two student organizations spent time touring the facilities with 51 students taking advantage of learning more about Complex and Academy offerings as well as the *Feed Technology & Mill Management Traineeship Program*. This industry-sponsored program connects companies with students interested in internships and employment. In 2025 12 students were sponsored by eight companies in key majors including mechanical, industrial and electrical engineering, ag systems and industrial technology, ag business, ag studies, ag communications, animal science, and industrial design. The facility was also used in support of eight graduate research projects, six are described in separate reports, i.e., (1) *Standard Method for Assessment and Digital Twin-Enabled Optimization of Hammer Mill Performance*, (2) *Integration of Cable-free Grain-Sensor Networks with Computational Fluid Dynamics to Predict Stored Bulk Ingredient Conditions*, (3) *Discrete Element Modeling (DEM) of Grain-to-Screw Conveyor Interaction for Predicting Effects of Inclination Angle and Moisture Content on Mass Flow Rate and Power Requirement*, (4) *Developing and Operationalizing a Quality and Food Safety Management System for the Iowa State University Kent Feed Mill and Grain Science Complex*, (5) *Development and Testing of Inline Temperature and Moisture Content Measurement of Feed Mash for Thermal Processing Control*, and (6) *Assessment and Approaches for Achieving Net-Zero Carbon Emissions for Grain Drying, Handling and Storage Operations* (funded by an NC-213/Andersons Research Grant). Two Ph.D. students from Ghana and Brazil were hosted to conduct research in support of their respective dissertations which they will complete at their home institutions.

Grain stored since fall 2024 was utilized for the manufacture of approximately 10,000 tons of pathogen-free poultry layer feed. All corn transferred from storage to feed mill is screen-cleaned. Aggregated screenings and corn samples are tested on a weekly basis. Corn screenings that test above limits are diverted to feed for other species such as beef. Corn screenings are also analyzed for particle size and BCFM content as part of a graduate research project. Aggregated corn and corn screenings samples were tested for six mycotoxins (aflatoxins, fumonisin, Deoxynivalenol (DON), T2/HT2, ochratoxin A, zearalenone (ZER)) using Neogen Reveal® Q+ MAX lateral flow test strips quantified with the Raptor® Integrated Analysis Platform lateral flow test strip reader with built-in incubation. All samples tested well below the aflatoxin action level of 20 ppb. All samples tested below 5.0 ppb, the European Commission's established maximum level for ochratoxin A. Neither screened nor unscreened corn samples were above either the U.S. FDA advisory limit of 20 ppm or the client's limit for fumonisin. Twenty-eight

(28) out of 101 samples of screenings tested were above the client's maximum limit but below the U.S. FDA guidance level. Screened corn analyzed for DON remained below the client's limit. However, 12 out of 101 samples were above the U.S. FDA advisory limit (5 ppm) and the client's limit. For unscreened corn, 3 out of 29 samples were above the client's limit. For T2/HT2, 6/100 samples of corn screenings tested above the EU suggested limit of 200 ppb for poultry feed. For unscreened corn, one sample was above the client's maximum limit. All screened corn samples tested below the respective limits. One corn screenings sample tested above the U.S. FDA suggested limit for ZEA of 500 ppb. However, 19/80 tested above the client's limit in poultry feed. For screened corn, 6/29, and for unscreened corn, 5/29, were above the client's limit. No feed samples tested above the respective FDA maximum allowable or advisory or EU guidance or maximum levels for poultry feed.

During the fall harvest of 2025, a total of 182,977 bushels of corn were received in 186 truck deliveries from nearby fields of ISU research and demonstration farms. Average corn moisture content was 16.1% with a standard deviation of 3.0 percentage points and a range of 12.5% to 28.1%. A total of 71,739 bu were dried from an average moisture content of 18.9% to 15.0% in a Sukup TM2410 mixed-flow dryer. Corn was graded according to USDA-FGIS procedures. Broken corn and foreign material (BCFM) averaged 0.86% with a standard deviation of 0.55 percentage points and a range of 0.08-3.12%. Test weight averaged 56.0 lb/bu with 1.51 lb/bu s.d. and a range of 52.4-67.2 lb/bu. All new corn samples tested below the respective FDA maximum allowable or advisory or EU guidance or maximum levels for poultry feed. One aggregated sample tested 1.8 ppm for DON which was above the limit specified by the client for their poultry layer feed. For ZEA, two aggregated samples (68.1 ppb and 394.4 ppb) were above the maximum 50 ppb limit specified by the client. So far, no feed samples manufactured with 2025 harvested corn has tested above the respective maximum DON and ZEA client limits. Aeration cooling front movement and static pressure readings are also being quantified in four identical 54-foot diameter bins as a function of corn that was screen-cleaned before storage versus not. All bins were cored soon after filling and are unloaded based on a rotation schedule of weekly corn transfers to the feed mill.

The facility is managed by five full-time faculty and staff. In 2025 it was operated with assistance from five graduate students (one graduated in May'25 and was hired as a process research engineer by a major petfood company), three summer interns, and twelve hourly undergraduate student trainees (2 graduated in May'25 and 2 in December'25; one was hired by an engineering firm and 3 by feed manufacturing companies). The manufacture of heat-treated mash and crumbled feed for a commercial partner increased slightly to an average of 180 tons per week. Two to three 24-ton truck loads of pathogen-free finished feed are delivered each weekday to contracted genetic poultry layer producers in Iowa, Nebraska and Kansas.

Publications

Peer-reviewed publications

- Obeng-Akrofi, G., Maier, D.E., Rosentrater, K.A., Brumm, T.J., Akowuah, J.O. 2025. Evaluation of Moisture Sorption Isotherm for Shea Nuts, *Vitellaria Paradoxa*. *Applied Engineering in Agriculture* 41 (2), 169-178. <https://doi.org/10.13031/aea.16087>
- Nishimwe, K., Bowers, E., Maier, D.E. 2025. On-farm evaluation of aflatoxin binder inclusion in dairy feed as a strategy to reduce milk aflatoxin M1 contamination in the Rwandan context. *Mycotoxin Research* 41 (1), 207-214. <https://doi.org/10.1007/s12550-024-00576-9>

Article/News briefs/Reports

- Alexis Lambros, George Obeng-Akrofi and Dirk Maier. 2025. Feed Ops: Importance of steam conditioning. World Grain Magazine. <https://www.world-grain.com/articles/21814-feed-ops-importance-of-steam-conditioning>
- George Obeng-Akrofi, Younus Bhuiyan Sabbir and Dirk Maier. 2025. Grain Ops: Feed value of corn screenings. World Grain Magazine. <https://www.world-grain.com/articles/21962-grain-ops-feed-value-of-corn-screenings>
- Younus Bhuiyan Sabbir and Dirk Maier. 2025. Feed Ops: Feed value of corn screenings. World Grain Magazine. https://www.world-grain.com/articles/22214-feed-ops-coring-grain-mass-benefits-feed-mills?oly_enc_id=4236G1872612E8Y

Continuing Education Offerings

- Aqua Feed Manufacturing Training Program – Morocco Aqua Industry Team. U.S. Grains and BioProducts Council (USGBC), March 10-12, 2025 (3 lectures)
- Feed Manufacturing Training Program – Full-Fat Soybean Meal Team. U.S. Soybean Export Council (USSEC) and Iowa Soybean Association, March 25, 2025 (1 lecture; 1 tour)
- 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 (6 lectures)
- IGFIA Advanced Feed Manufacturing & Mill Management Short Course – Tunisia Feed Industry Train-the-Trainer Team. USGBC Middle East & Africa Region, August 18-23, 2025 (5 lectures)

Oral Presentations

- Advancing Feed Technology and Operational Efficiency with Artificial Intelligence and Data Analytics; Advanced Storage Practices for Preserving Grains and Feed Ingredients in Humid Climates. U.S. Grains Council Corn Quality Program, Istanbul, Turkiye, January 23-24, 2025 (2 lectures)
- Advanced Storage Practices for Preserving Grains and Feed Ingredients in Humid Climates. U.S. Grains Council Feed Mill Audits, Barranquilla and Buga, Colombia, February 18-20, 2025 (2 lectures)
- Advancing Feed Technology with Artificial Intelligence and Data Analytics; Best Practices for Ingredient Handling and Quality Preservation. U.S. Soybean Export Council 12th Maghreb Round Table for the Poultry and Feed Industry, Tunis, Tunisia, June 3-4, 2025 (Maier: 2 lectures)
- Innovation in Maintaining Quality and Quantity of Stored Corn and Co-Products; Best Practices for Ingredient Handling and Quality Preservation; Processing U.S. Sorghum for Feed. U.S. Grains & BioProducts Council Saudi Arabia Corn and Co-Products Promotion Workshop, Riyadh, Kingdom of Saudi Arabia, September 16, 2025 (3 lectures)

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