

NC-213 PROGRESS REPORT FOR 2025

Title

Assessment and Approaches for Achieving Net-Zero Carbon Emissions for Grain Drying, Handling and Storage Operations

Investigators

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Outputs/Research Updates

Grain drying, handling, and storage operations utilize significant amounts of energy which releases greenhouse gases into the environment. The development of energy efficient operations systems, as well as the identification and implementation of net-zero carbon emission technology, could make a positive impact on the environment. Quantifying current greenhouse gas emissions from post-harvest operations is important to assess possible mitigation solutions. The specific objectives of this project are:

1. Quantify the scale and assess the challenge for achieving net-zero carbon emissions for on- and off-farm grain handling, drying and storage operations.
2. Identify approaches and evaluate their potential for achieving net-zero carbon emissions for on- and off-farm grain handling, drying and storage operations.

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

Building upon prior analysis of commercial grain elevators, this project evaluated energy use and greenhouse gas (GHG) emissions associated with grain handling, drying, and storage operations across multiple facility scales. Previous Life Cycle Assessment (LCA) of two commercial grain elevators with storage capacities of approximately 7.1 million and 2.85 million bushels (2700 HP and 1250 HP of connected loads, respectively) determined energy use intensities of 0.39 and 0.31 kWh per bushel and baseline GHG emissions of 138 and 109 g CO₂eq per bushel, respectively, when supplied by regional grid electricity. Scenario analysis suggested that renewable electricity sources, particularly wind and solar, could reduce electricity-related emissions by 86–96%.

During 2025, a comparable analysis was conducted utilizing the grain center at the Iowa State University Kent Feed Mill & Grain Science Complex (FMGSC) to extend this work to a research-scale, controlled environment. The FMGSC Grain Center has a total storage capacity of approximately 220,000 bushels and an installed electric motor capacity of approximately 670 HP. Electricity consumption was monitored during drying, handling, and storage operations from the beginning of the 2024 fall harvest through the start of the 2025 fall harvest. Total electricity consumption was approximately 158,000 kWh resulting in an energy utilization intensity of 0.72 kWh per bushel and GHG intensity of 254 g CO₂eq per bushel. This higher value compared with commercial elevators reflects research-scale operations, where smaller batch sizes, higher airflow in bin aeration, and intensive experimental monitoring reduce equipment efficiency. Higher aeration rates (0.5–1.0 cfm/bu versus 0.1–0.2 cfm/bu typical in commercial bins) require disproportionately larger fan motor

power plus routine grain screening during transfers further contributed to higher fan and conveying energy per bushel.

Total GHG emissions for the FMGSC Grain Center were estimated by combining electricity and natural gas use. Natural gas consumption for grain drying was quantified separately for a high-temperature mixed-flow dryer (180.6 g CO₂eq per bushel) and a medium-temperature in-bin stir-dryer (69.3 g CO₂eq per bushel) contributing a weighted average of approximately 160 g CO₂eq per bushel. Combined with electricity-related emissions, the total facility-level GHG intensity under conventional energy sources is approximately 414 g CO₂eq per bushel.

Scenario analysis indicates that supplying 40% of the facility's electricity demand with solar panels would reduce electricity-related emissions to 166 g CO₂-eq per bushel, a 34.6% reduction. Total GHG intensity would reduce to 326 g CO₂-eq per bushel, a 21% reduction. This demonstrates that even partial adoption of renewable energy can significantly reduce emissions in grain operations, highlighting the real climate impact of smart energy choices.

Publications

Article/News briefs/Reports

- 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 (Sabbir: 1 lecture; 1 hands-on session)
- 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 (Sabbir: 1 lecture; 1 hands-on session)
- IGFIA Advanced Feed Manufacturing & Mill Management Short Course – Tunisia Feed Industry Train-the-Trainer Team. USGBC Middle East & Africa Region, August 18-23, 2025 (Sabbir: 1 lecture; 2 hands-on sessions)

Oral/Poster Presentations:

- Sabbir, A.S.M.Y.B., Maier, D.E., Assessment and Approaches for Achieving Net-Zero Carbon Emissions for Grain Drying, Handling and Storage Operations. NC-213 Annual Meeting 2025, Kansas City, Missouri, February 27-28, 2025. (Sabbir: Oral presentation, Poster presentation)
- Sabbir, A.S.M.Y.B., Maier, D.E., Benefit of Coring on moving cooling front. GRI GEAPS Chapter meeting, December 3rd, 2025. (Sabbir: Presenter)

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