

## NC-213 PROGRESS REPORT FOR 2023

### **Title**

Advanced Modeling of Stored Grain Ecosystems for Cables-Free Grain Storage Management.

### **By**

*Maier, D.E.*, Professor, Agricultural & Biosystems Engineering

*Wright, J.J.*, Graduate Research Assistant, Agricultural & Biosystems Engineering

*Brumm, T.*, Professor, Agricultural & Biosystems Engineering

*Rosentrater, K.*, Professor, Agricultural & Biosystems Engineering

IOWA STATE UNIVERSITY

### **Research Updates/Outputs**

Monitoring the quality of stored bulk grain is generally done using temperature cables hung from silo roofs. This poses several challenges such as costs, interference with stir-drying, and lack of rapid spoilage detection. New wireless monitoring systems aim to solve these problems by replacing temperature cables with headspace and plenum sensors that monitor temperature, relative humidity, and CO<sub>2</sub> concentration. The new system needs to monitor grain conditions, make aeration decisions, and provide warnings of grain spoilage in time to take action. A previously developed non-aeration model was modified and coupled with a new aeration model from Amber Ag. The non-aeration model is a pseudo-3D finite volume method computational model with boundary conditions based on local weather data. The temperature and moisture diffusion in the non-aeration model accounts for variable diffusivity, evaporative cooling, conduction, and natural convection. The boundary conditions model accounts for solar radiation, heat lost to the grain mass and forced convection due to wind. CFD modelling was utilized to update and improve the aeration model by quantifying the non-uniformity of aeration due to a core of fines and peaked grain mass. Early grain spoilage detection was derived from the analysis of CO<sub>2</sub> sensor readings. This model will next be implemented in the bins at the new ISU Kent Feed Mill and Grain Science Complex where all necessary sensors for future studies have been installed. Once the model is completely validated, it will be used commercially by Amber Ag and academically by ISU for teaching and research.

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### **Publications**

- Wright, J.J. 2023. Predictive modeling for cable free grain storage management. Unpublished M.S. Thesis, Iowa State University.