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Performance Story

This study investigated the feasibility of converting a combine's grain loss signal into a grain loss rate. More specifically, this was investigated by comparing the loss sensor signal to the actual grain loss rate to determine if a correlation exists or could exist using other technologies. Since the implementation of combine loss monitoring systems around 1975, few improvements have been made to the grain loss technology and feedback to the operator. Current loss monitoring technology displays bar graphs or numerical values without a unit of measurement. Therefore, it is difficult for the operator to know if the monitor indication is 1 bu/ac or 5 bu/ac. There is a need to improve the presentation of the grain loss sensor signal generated by combine harvesters from unit-less numbers or graphs to absolute grain loss in bushels/acre, dollars/acre, or other meaningful units. In doing so, the operator and/or farm manager can make improved economic decisions and better manage grain loss during harvest.

The main objective of this project was to determine the correlation between existing harvester loss sensor output with actual grain loss by putting the harvester loss signal and the actual grain loss rate in relation. Further project objectives were to determine if existing technology is adequate to support a grain loss rate, optimize the harvest loss sensor, and to decrease harvest losses across all Saskatchewan crops through improved harvest loss feedback.

The project methodology included lab testing of the combine loss sensors as well as field tests with full-scale harvest and test equipment. Lab testing involved dropping grain kernels of varying size (peas, wheat, and canola) and frequency (simulating high and low loss scenarios) onto combine loss sensors to determine the loss signal characteristics such as amplitude, impact signal frequency (time of single seed impact to signal stabilization), and signal resolution. In knowing these characteristics, the loss signal could then be properly recorded during field testing. To collect the loss sensor signal data and actual grain loss rate data, field tests were performed using a test combine and the Prairie Agricultural Machinery Institute's (PAMI's) combine test equipment. The test equipment included a collector that was pulled behind the combine to capture all the material (straw, chaff, and grain) discharged from the rear of the combine over a set distance and a processor used to clean the grain from the captured material to determine the actual grain loss. Multiple test collections were taken at varying feed rates to create a grain loss curve. The grain loss sensor signals were recorded (cleaning shoe and separator) during each of these tests so the two sets of data could be subsequently compared. The loss signal was recorded using two methods:

1) The signal was recorded directly from the loss sensors using a data acquisition system (raw signal), and
2) The signal was recorded from the combine loss monitor (conditioned signal).

A number of tests were completed in three crop types (canola, wheat, and peas). This was done to determine how the loss signal and actual grain loss relationship changed with varying seed size.

The loss signal was then compared to the actual grain loss rate by plotting both curves and producing a relationship equation that could be used to correlate the two curves.
The results of the project showed there was a relatively strong correlation between the loss sensor signal and actual grain loss rate in large grain crops (peas) but a relatively poor correlation in small grain crops (canola and wheat), indicating a higher resolution would be required to

support a grain loss rate. The correlation was also found to be dependent on feed rate in all crop types and resulted in a non-linear relationship. This generally caused the combine loss signal to underestimate actual grain loss with increased feed rate for both loss signals recorded (raw loss sensor data and monitor data). Therefore, it can be concluded that the ability for existing loss sensing technology to provide an actual grain loss rate is limited. Though the correlation to actual loss was not consistent, for most conditions, the grain loss monitor system tested did provide a reliable indication of when actual loss was increasing or decreasing. In large grain crops, a grain loss rate could likely be determined through the use of relationship equations and correction factors. However, in small grain crops, design improvements would need to be made to the grain loss sensor system, to accurately indicate actual grain loss rate, especially on the cleaning shoe loss sensor.

A review of other sensing technologies was also completed to determine if any could be implemented to better support a grain loss rate. A variety of technologies were investigated including accelerometers, microphones, microwave, photoelectric, and ultrasonic sensors. Some of these technologies showed promise in their ability to detect grain loss but would require further research, development, and testing to determine their full capabilities.

The results from this project are significant to the agriculture community including producers, farm managers, and manufacturers through advancing loss monitoring technologies as well as raising awareness about the importance of managing grain loss during harvest. The results also showed promise in the correlation between the combine loss signal and actual grain loss rate and will drive further development in this area. If such technology becomes utilized in the future, it will help maximize producer profit by providing the operator with more meaningful feedback and information to make economic decisions.

Future research and development could be done to determine how the relationship equations between the loss sensor signal and actual loss rate change depending on combine make/model and/or crop type and condition. Another important area of investigation is real-time monitoring of feed rate during harvesting operations. As the relationship equations are dependent on feed rate, this rate must be known to accurately display a grain loss rate.