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Calibrate Your Yield Monitor for Greater Accuracy During Harvest

In a precision agriculture system, accurate yield monitor data is key for making informed crop management decisions throughout the year. Often the harvest-time rush is overwhelming and limits the time available to carefully calibrate grain yield monitors. The time you spend to calibrate your yield monitor is critical to making a precision agriculture system work for you, and the investment in time and effort can pay dividends. Calibration of your combine's yield monitor will ensure the data you collect is accurate. The up-front investment in calibration also helps minimize the time spent on future post-processing of data.

Accurate yield monitor data is key for making informed crop management decisions throughout the year.

Why calibrate?

Most yield monitors work by measuring the force that moving grain imparts on an impact plate as the grain moves from the combine's clean grain elevator to the loading auger, on its way to the tank. The amount of clean grain flowing into the tank will cause the force to vary as the combine travels through the field—the greater the measured force, the higher the yield. Like any other sensor, a grain yield impact plate requires measurement and calibration of its response under varying conditions as the combine travels through the field to provide accurate sensing performance.

A current technology trend in production agriculture is using "Big Data," or very large data sets, to glean information that can be used for decision making. Assessment of measured responses (such as yield data) on a farm from data collected over multiple years can provide insight into the behavior of the production environment. This insight can help the farmer to improve management decisions.

While the notion of managing and analyzing big data sets is still in its infancy stages, farmers should be cognizant of its current and future importance. As a farmer collects yield and other types of data from a field, the farmer is measuring the response of that field to the inputs applied during the growing season. If done over several years, uncontrollable variations, such as weather, begin to average out. This longer-term analysis of data sets helps growers start to see the response to inputs more clearly.

This is where the accuracy of yield measurement becomes critical. If yield measurements are poor, any potential insight tying yield response to the inputs used to produce the crop will be incorrect (i.e., junk in equals junk out). So it is important that the collected yield data is as accurate as possible. Stated another way, solid, accurate yield data is foundational to a production agriculture system.

This concept led to a study of yield monitor accuracy on combines to assess the error in yield measurement. In 2015, four combines harvesting corn in southern Wisconsin (both dry and high moisture) were randomly spot-checked for yield monitor accuracy. A Meridian 240 Series seed

tender equipped with a DigiStar weight-bar scale system was used to collect grain weight data as the grain was being unloaded from the combines (figure 1). Samples of the grain were collected and later oven-dried to get an accurate measurement of moisture content. The assessment compared the predicted yield from the yield monitor over a full combine grain tank to that measured using the seed tender's scale. This was done so that spot-checking the yield monitors did not impede the progress of the harvest operation. Three replicate measurements were collected for each of the four combines.

FIGURE 1. Meridian seed tender equipped with DigiStar scales for weighing harvested grain from four combines across southern Wisconsin during the 2015 harvest.

The combine yield monitor data were corrected to the standard moisture content of 15.5% based on the reading of the moisture sensor installed on the combine. The measured yield weights from the seed tender were also corrected to 15.5% moisture based on the oven-dried samples. The complete data set (table 1) shows that the yield sensors were consistent in either overestimating or underestimating the actual yield between replications. None of the machines evaluated produced yield values that were low at one point and high the next. This is an indication of proper functionality of the sensors and that calibration would be effective at minimizing the errors.

When considering the entire data set (i.e., all combine yield values vs. actual values from the seed tender) the Root Mean Squared Error (RMSE) is the metric used to describe the difference between the measured values (combine) and actual values (seed tender) (see table 2). This statistic represents the amount of variation in the combine data at a given seed tender value. The RMSE error for all machines was 384.5 lb (6.9 bushel (bu)), which tells us that in total the yield estimation of all the machines was about 7 bushels off. All data analysis was done at a 95% confidence interval. Considering each combine individually and comparing the yield value to the seed tender across three loads, one combine showed a statistically significant difference between its estimated yield from the yield monitor and that measured with the seed tender. That machine had an RMSE of 86.7 lb (1.6 bu). The other machines did not have significant differences between yields estimated with the yield monitor and measured with the seed tender.

TABLE 1. Yield data collected on four combines to assess yield monitor accuracy in 2015.

Machine	Load	Combine yield (bu)	Tender yield (bu)	Difference (bu)	Yield error (%)	Combine moisture (%)	Actual moisture (%)	Moisture error (%)
1	1	118.2	110.6	7.6	7	16	17	5
	2	119.7	111.2	8.5	8	16	17	8
	3	118.8	111.6	7.2	6	16	17	6
2	1	69.3	67.9	1.5	2	20	21	7
	2	66.8	66.1	0.7	1	20	22	8
	3	65.4	63.9	1.5	2	20	21	4
3	1	147.9	162.1	-14.2	9	25	23	6
	2	83.6	92.2	-8.6	9	25	24	5
	3	107.4	116.0	-8.6	7	25	23	6
4	1	109.7	107.5	2.2	2	25	26	5
	2	104.0	101.4	2.7	3	24	27	9
	3	109.8	108.7	1.1	1	24	27	11

A key point this data shows is that most of the errors were relatively small and these four combines were relatively well calibrated, with only one combine having a significant difference between its yield monitor reading and that measured by the seed tender. A difference of 1.6 bushels for Combine 3 is a small error, but enough difference to suggest the need to recalibrate the yield monitor for more accurate data. Considering the complete data set in table 1, Combine 3 showed a reading of approximately 14 bu difference to that of the seed tender and percent error readings as high as 9%. These individual measurements indicate a higher error than that shown in the statistical analysis due to error dilution in averaging the data.

TABLE 2. Summary of spot-check yield data on four combines in southern Wisconsin during corn harvest in 2015.

Machine	Average yield combine (bu)	Average yield seed tender (bu)	RMSE (bu)	Significant difference?
1	118.9	111.1	0.9	no
2	67.2	65.9	0.6	no
3	113.0	123.4	1.6	yes
4	107.9	105.9	0.07	no
Average of all machines	**101.7**	**101.6**	**6.9**	**yes**

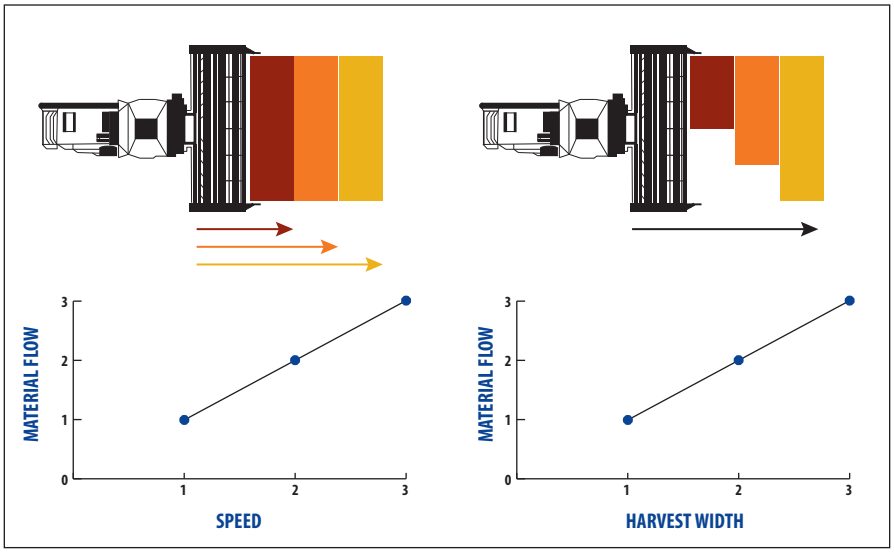
How to calibrate your yield monitor

Calibration of yield monitors should be done at varying rates of material flow into the machine. These rates should be representative of the different conditions that the combine will encounter while harvesting a crop. There are two ways to achieve this:

- Harvest the crop at full width of cut of the header and vary the speed of the machine (figure 2, left).
- Keep the machine at full harvest speed and vary the width of cut of the header (figure 2, right).

Either method will vary the amount of material entering the machine and provide multiple material flow rates for the sensor to read. However, this only works if your yield monitor accepts multiple calibration points. If your yield monitor accepts only a single calibration point, then the only option is to calibrate using the full header width at harvest speed. Recommendations for yield monitor calibration are as follows:

FIGURE 2. Varying the material flowrate through the machine for multi-point yield monitor calibration via full header width and multiple speeds (left) or constant speed and varying header width (right).



- Recalibrate *at least* once every harvest season. If possible, spot-check your yield monitor multiple times during a harvest season to ensure accuracy.
- Recalibrate as you move from one crop to another or as you encounter significant changes in moisture content or test weight.
- Check your combine's owner's manual for specifics on proper yield monitor calibration procedures (figure 3).

Another sensor on the machine that affects yield monitor accuracy is the crop moisture sensor. Most machines

FIGURE 3. Calibration of the yield monitor is accomplished through the field computer in the combine. Refer to the machine's owner's manual for specific details on completing the calibration process.

allow for offset calibration of this sensor, further improving moisture sensing accuracy and yield monitor performance. Recommendations for maintaining moisture sensor accuracy are as follows:

- Check moisture sensor accuracy with a handheld moisture meter, oven-dry a sample of grain, or compare the reading with the certified moisture tester at your local elevator or co-op.
- To check moisture sensor accuracy using an oven-dried sample of grain, place a grain sample in a paper bag and weigh the bag with the sample inside. This is the wet weight of the sample. Then place the bag in a regular household oven set to 217°F for 24 hours. Weigh the bag again to obtain the dry weight of the sample. To calculate the moisture content, subtract the dry weight from the wet weight, divide by the wet weight, and multiply by 100.
- Using an oven-dried sample is more time intensive than using a handheld moisture meter, but it will provide accurate results. Oven-drying grain is also a good way to check the accuracy of a handheld moisture meter. Several samples can be placed in an oven together and analyzed using this method.
- Again, be sure to refer to the machine's owner's manual for details on how to set the offset or calibrate the on-board moisture sensor.

Accurate yield data is a valuable piece of information for current and future management decisions. Taking time to ensure your yield data is as accurate as possible will help you to have confidence in making decisions based on the data collected. As previously discussed, accurate moisture sensing also significantly affects yield monitor accuracy. Be certain to calibrate both your yield and moisture monitors and check the calibration often for the most accurate data. Have a safe harvest!

Additional resources

Precision Farming Tools: Yield Monitor (Publication 442-502), by R. Grisso, M. Alley, and P. McClellan. 2009.Virginia Cooperative Extension. https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/442/442-502/442-502_pdf.pdf

Best Management Practices for Collecting Accurate Yield Data and Avoiding Errors During Harvest (EC20014), by J. D. Luck and J. P. Fulton. 2014. University of Nebraska–Lincoln Extension. http://extensionpublications.unl.edu/assets/pdf/ec2004.pdf.

Yield Monitor Calibration: Garbage In, Garbage Out, by R. L. Nielsen. 2010. Purdue University. https://www.agry.purdue.edu/ext/corn/news/timeless/yldmoncalibr.html.

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