Texas Agricultural Extension Service
The Texas A&M University System

Operating Practices Can Improve Yield Maps

Stephen W. Searcy

Yield is an important aspect to any crop producer, as it ultimately determines the profitability of an enterprise. Yield mapping has become an important part of precision farming strategies. As more producers and custom harvesters have yield mapping systems installed on combines, the number of fields mapped is growing rapidly. However, the maps are only as good as the data recorded. Calibration and operating practices have a big impact on the accuracy of the data, and deserve attention on the part of the combine operator. It makes no sense to invest up to $10,000 on a system to collect yield data, and then ignore the practices necessary to ensure the quality of that data.

In order to understand good yield mapping practices, you need to know how the system calculates yield. A yield mapping system consists of several components. It must have sensors to calculate the amount of crop harvested, and a positioning system to determine the machine's location and the area harvested. The system must also include a data storage devise for recording the position and yield data, and an operator's console. ***Figure 1*** shows the different parts of the yield mapping system.
The components of the above yield mapping system are typical. An impact flow sensor (left, background) and a moisture sensor (foreground, with cable) determine the mass flow of grain. The GPS receiver (white antennas) determines position of the machine, while the operator console displays values and provides operator input.

Figure 1. A yield mapping system consists of several components, including the grain flow sensor, the GPS receiver and the operator display. Photograph courtesy of Case IH.

Most yield mapping systems today use impact sensors to measure the flow of grain through the machine (***figure 2***). The calibration of the sensor relates the force on the sensor to the mass flow rate of grain. A second sensor is placed in the clean grain path to measure moisture content. The measured data is sent to the data storage computer, where dry weight yield is calculated and stored.

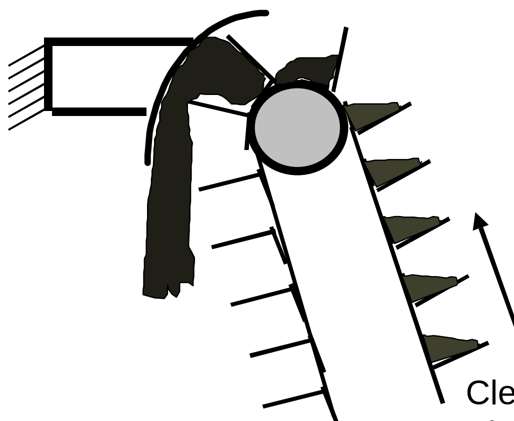

Figure 2. The grain carried to the top of the clean grain elevator is thrown against the impact sensor. The mass flow rate is related to the impact force of the grain.

During harvest, the operator console displays the current yield measured by the system. This display value is presented in the units selected by the operator (e.g., bushels per acre). In order for the system to calculate the area harvested by the machine, the operator must enter the normal operating width of the harvester into the console. For corn harvesting, this is the number of rows being harvested times the row spacing. For small grains, the operator enters the normal width of cut. Generally this is not the full width of the header, since it is difficult to keep the header full at all times. For a 24' header, the average cutting width may be only 23 or 23 ½ feet.

The yield data recorded is a calculated value that combines the mass of the grain and the area harvested to get pound per acre. The yield per acre is calculated with the following equation.

$$\frac{Pounds}{Acre} = \frac{Mass\ Flow}{Cutting\ Width\ x\ Distance\ Traveled}$$

For the yield to be accurate, the mass flow, cutting width and distance values must be correct. Inaccuracy of any value can cause significant error in the yield data. This is why it is important to calibrate both grain flow and distance traveled sensors, as well as accurately enter the cutting width.

When yield is recorded in volumetric terms (bushels, barrels, etc.) per acre, a standard grain test weight (user adjustable) is used to convert from pounds to the volumetric measure.

Figure 3 illustrates a combine operating with a partial header width of cut. Unless a change in cutting width is entered into the console, the system will calculate area from the width of cut and the distance traveled. In this situation, **W** is the cutting width entered into the monitor, and **w** is the actual cutting width. Since only half of the header is cutting grain, the yield calculated using **W** will resulting in an over-estimation of the area harvested. This will result in yield data that is one half of the actual yield. In many cases, partial cutting widths can not be avoided. The yield mapping systems allow for the operator to change the actual cutting width, but this is generally not feasible when the combine operator has many other tasks competing for attention.

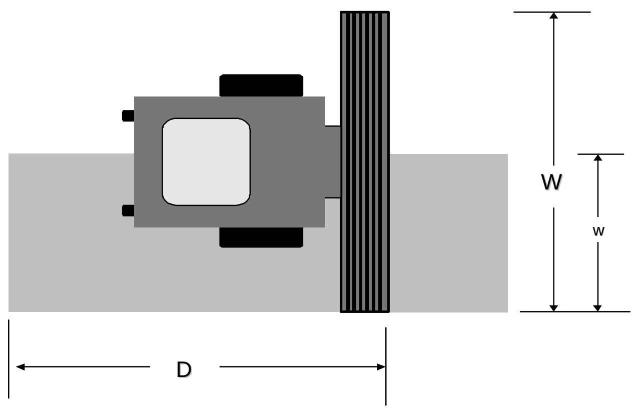

Figure 3 The area harvested is determined from the indicated cutting width and the distance traveled. Differences between indicated (**W)** and actual (**w**) result in errors.

This problem with inaccurate yield data is greatest at corners and point rows. However, inaccuracy will also occur when the operator does not maintain a constant cutting width. In many situations, the number of questionable data points may be so small that they don't have a big impact on the yield map. However, some crops and field shapes do have more of a problem with bad data. For example, rice yield mapping generates a large number of questionable data points because levees in the fields often prevent maintaining a full header. Table I shows data from rice yield mapping in 1996. While the actual mass of grain measured was reasonably close for most fields, the harvested area was significantly over-estimated. Most of the error in average yield for the field can be attributed to the errors in harvested area.

Yield maps can be useful tools for crop managers, if the data is reliable. Understanding how grain yield mapping systems work, and taking care in the operation of the system will insure that you have more than just a pretty picture. A little effort to follow good operating practices can be rewarded with highly accurate data. The following suggested practices will help maintain data reliability.

TABLE I
Errors in yield mapping in rice fields under wet conditions

Field	Total Weight (% error)	Area Harvested (% error)	Average Yield (% error)
1	-1.9	23.1	-22.3
2	-7.1	24.4	-27.2
3	-3.2	28.5	-26.5
4	-2.5	23.6	-25.1
5	-3.7	19.3	-23.4

Suggested Practices

Understanding how the yield mapping system works will go a long way toward improving data accuracy. Training your combine operator to follow these practices will also help ensure that you have useful information at the end of the harvest season.

Enter field names before beginning harvest
Descriptive names for each field harvested are very helpful, and should be entered into the console prior to the start of harvest for that field. While the operator consoles will allow the entry of field information on the combine, the urgency of harvesting often causes incomplete or erroneous information to be entered. It is better to set up all fields in advance. If the field contains more than one variety or management practice, you may also want to label the loads so that these situations can be examined separately. For custom harvesters, entering descriptions for that day's fields should be considered part of the routine for maintaining the combines.

Sensor Calibration
Grain flow sensors must be calibrated since each installation can be slightly different. The calibration process involves harvesting an area and comparing the measured weights of the harvested grain with actual weights as determined by scales. The calibration procedures vary by manufacturer and the suggested practices in the owners' manual should be followed. Some systems require only a single calibration load while others require multiple loads at different flow rates. The suggested practice is to harvest a full grain tank at a constant speed in an area where the yield is reasonably uniform. For systems which require multiple calibration loads, it's important to remember that the sensor should be calibrated at several different flow rates. This means that the flow rate of grain through the machine must vary. This is done by harvesting at different speeds or by harvesting at a constant speed with partial cutting widths. If partial swaths are used, the operator must accurately enter the cutting width. For example; if the combine has a 24 ft. header, the operator may choose to use cutting widths of 24 ft., 18 ft., 12 ft., and 6 ft. Manufacturer's suggestions for calibrating the system should be followed in order to ensure the maximum accuracy. Calibration is easiest when a weigh wagon is available. Although it may be inconvenient to drive partially loaded trucks to a scale, it is

important to have an accurate calibration of the yield mapping system. During the harvest season, you should periodically compare the measured grain weight with weigh tickets. If there is a discrepancy of more that four to five percent, then recalibration and examination of the system may be necessary. If a yield mapping system has been used for some time, the mass flow sensors may have become worn or fallen out of adjustment.

Calibrate speed sensor

Accurate distance measurements are critical for accurate data. Depending on the manufacturer, the distance the combine travels may be measured with the GPS receiver, a radar sensor or wheel rotation. Check your operators manual to determine which method your system uses, and calibrate it under harvest conditions if possible. Only radar and wheel rotation systems will need calibration.

Don't record data over previously harvested areas

Data on grain flow rate and position is recorded whenever the header is in the normal cutting position. When the platform is raised for transport or for cornering, data recording should be disabled. The operator must remember to raise the platform whenever grain is not being harvested. If the operator turns corners while leaving the platform in the cutting position, data will be recorded as if grain were being harvested. This will result in adding zero yield data to the file. The header height at which data logging is turned off is adjustable. See your operator's manual for the adjustment procedure.

Avoid recording data during partial swath widths

It is often better to avoid recording data in situations where the calculated yield will be incorrect. The operator should try to avoid creating partial swath widths, and can disable data recording when partial widths are unavoidable. In most cases, there will be plenty of yield data available, and the loss of a little data is better than including incorrect data. The disadvantage of disabling recording is that the operator must remember to turn it back on when cutting a full header width.

Alternate mapping and non-mapping combines

Fields are often harvested with multiple combines, not all of which may be equipped with yield mapping systems. This a perfectly acceptable situation, provided that the operators recognize the need for the instrumented combine to cover all areas of the field. The machines should alternate swaths rather than harvesting different portions of the field. If one of four combines has yield mapping, data will be available from only 25 percent of the field. That data should be as uniformly distributed as possible, in order to have the most useful yield map.