

Crop Yield Monitors



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Crop yield monitors are electronic devices designed to measure crop yield in the field while harvesting. Yield monitors can be offered as standard equipment on new combines or they can be installed as third-party components on existing combines (after market). Yield monitors make use of electronic sensors to calculate crop productivity, usually in pounds (or bushels) per acre. Sensors used are:

- **Mass flow sensors** – A mass flow sensor measures how fast product (grain or lint) is entering the combine. Since this is a flow rate sensor, the results usually are expressed in units of mass per time (pounds per minute, for example). There are different types of sensors that can be used to measure mass flow. For example:
 - **Impact sensor** – Impact sensors typically are used in grain combines. Grain entering the combine hits an impact plate. The recorded force on the plate is proportional to the incoming grain mass.
 - **Optical sensor** – Optical sensors can be used to detect how often the clean grain elevator is loaded. When grain is present, a light source would not be able to reach the photo sensor. The quantification of total dark time versus total light time can be calibrated to mass flow of grain. In cotton yield monitors, optical sensors are used to detect the flow of cotton lint in the cotton conveyer pipe. Optical sensors also are used in prototype sugarcane yield monitors.
 - **Load cell** – A load cell can be used to weigh a section of the clean grain crossing the auger floor. Grain flow is calculated by measuring the auger speed.
 - **Radiation sensor** – A radiation sensor can be used to measure grain flow. The

intensity of a radiation source is detected by a sensor. The flow of grain blocks radiation from reaching the sensor. Higher radiation intensity detected by the sensor indicates lower grain flow.

- **Moisture sensor** – Grain crops such as corn, soybeans and wheat usually are harvested in different moisture conditions. Since grains are composed of dry matter and water, it is



Photo courtesy of USDA Natural Resources Conservation Service

necessary to correct the mass of grain that is being harvested to a standard moisture to express a yield value that is not affected by the variable moisture content of the grain. For corn, the standard value is 15.5 percent wet basis. One bushel of corn at 15.5 percent moisture weighs 56 pounds. Corn being harvested at 18 percent moisture weighs 57.7 pounds per bushel. The 2.5 extra points in moisture represent 1.7 pounds of water. Moisture sensors usually are capacitance-based; they measure the ability of the material to conduct electricity. A calibration describes how moisture in grain affects the transmission of electricity.

- **Speed sensor** – The combine’s speed is needed to calculate the area covered by the combine each minute and the consequent yield. There are different types of speed sensors such as the radar or hall effect sensors, but the majority of yield monitors today will access speed information through the Global Positioning System or GPS.

- **Cutting width** – The last missing piece of information is the cutting width, which, along with the combine’s speed, will be used to calculate area harvested. Most yield monitors allow the operator to indicate whether the combine is operating at full capacity (100 percent cutting width) or if a fraction of the header is being used (50 percent, for example). That allows errors to be minimized.

- **Combine’s positional information** – When equipped with a GPS receiver, a yield monitor can store yield information and GPS coordinates that can be used later to create a yield map. Yield maps can be valuable tools in documenting and understanding differences in yield performance.

- **Other components** – Along with sensors to measure mass flow, combine speed, combine position and other factors, a yield monitor has to have a display or console. The display is the primary interface between the user (farmer) and the monitor. The user can customize field names, input information and follow displayed information in real time during the harvesting process. The display

also is where most of the computing power or the “brains” of the equipment is located. Most yield monitors also use a portable storage card to store yield and positional data. Electronic files on this card can be transferred easily to a personal computer for yield map creation.

Potential Benefits of Yield Monitors

- Yield monitors measure crop yield and the location in the field in real time. This information can be applied to a map and used as documentation of varying yield throughout the field (low- and high-yielding areas). The map can be used in a variable fertilization program or contract negotiations or to address the causes of yield variations.
- Yield monitors on grain combines also will measure moisture content of the incoming grain. This information is valuable for combine adjustment while harvesting.
- Yield monitors can keep track of how much crop was harvested (area and weight). Farmers may use this information to accurately fill trucks without overloading them or to charge third parties for harvesting costs.
- Yield monitors can help farmers on farm trials, documenting yield differences of side-by-side varieties, varying levels of fertilizer, etc.

What Are Common Issues Associated With Yield Monitors?

- **Calibration** – To accurately measure yield, the yield monitors have to perform calculations, since an electronic sensor is being used to measure a physical activity (for example, a force exerted on a plate) and translate that into a measurement of mass. The relationship between the measured observation and crop yield is called a calibration curve. Calibration curves most often are linear – an increase in force measurement means an increase in yield. Figure 1 show an example of linear relationship between two variables.

To obtain the most accurate description of the relationship between the measured observation and crop yield, it is necessary to calibrate the

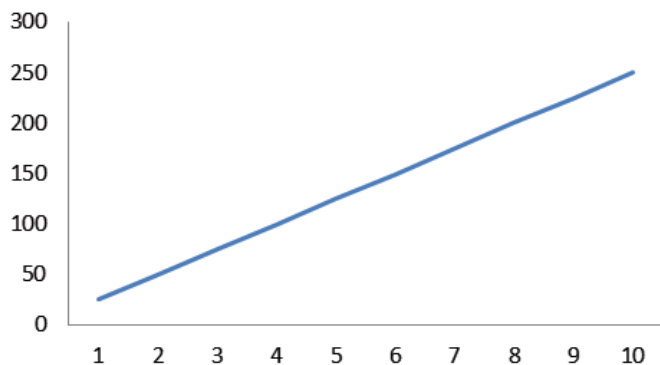


Figure 1. A linear relationship.

yield monitor several times throughout the season. Calibration is the process of using a “weigh wagon” to measure the crop output of an area and then informing the yield monitor the amount of crop that actually was harvested. Manufacturers usually ask that farmers calibrate yield monitors using grain at different moisture content levels and different varieties. Calibration will help yield monitors become more accurate, but it has to be done often. In systems where there are moisture sensors (grain combines), calibration of these sensors is required, as well. Usually, to calibrate a moisture sensor, the farmer has to harvest some grain and update the moisture measurement with the value obtained using a reliable moisture meter.

- **Cleaning and maintenance** – Sensors have to be kept clean. Moisture sensors are especially sensitive to dirt (plant sap or soil) that can accumulate over the plate. If a sensor overestimates crop moisture, yield will be underestimated.
- **Swath width** – When calculating area, yield monitors use length (distance traveled) and cutting width information. Since yield is calculated as weight per area (bushels per acre), an accurate area measurement is needed. If the combine is harvesting an irregular field using less than the full cutting width, the yield measurement will be underestimated. Some yield monitors will allow operators to enter the number of rows being harvested or a percentage of the width that is being used so the monitor can correctly calculate crop yield.

- **Instantaneous versus average yield** – The position of the mass-flow sensor in the combine is important in understanding how yield information is derived. In the case of grain crop yield monitors, the mass-flow sensor is positioned at a place on the combine that is away from the entry point of the grain. This means grain entering the combine will be slightly delayed before being measured by the sensor. This delay may be of 5 to 20 seconds. If the combine is moving at 5 miles per hour, for example, it will travel up to 145 feet before the grain actually is measured. Most software used today to build yield maps can account for this delay. A second problem, however, is that not all grain entering the combine at the same time will reach the mass-flow sensor at the same time. Grain entering the combine at the center of the header is conveyed through the threshing process more quickly than grain entering at the ends of the header. Therefore, measurements at any given point may have been based on some grain that had just entered the combine and some that had already been there for a few seconds. When interpreting yield maps, it is important to realize individual yield points may not represent the exact situation at a point in the field but might be the measurement that resulted after the combine traveled several feet.

- **Combine speed** – It is important for the operator to maintain a constant speed while harvesting. Variations in combine speed eventually will introduce errors into the yield measurements.

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Pub. 3234 Online only 3/12

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