Development of an Overhead Optical Yield Monitor for a Sugarcane Harvester in Louisiana

Randy R. Price[1], Richard M. Johnson[2] and Ryan P. Viator[3]

Louisiana State University, AgCenter, Alexandria, LA[1], USDA/ARS, Sugarcane Research Unit, Houma, LA[2], Viator Consulting & Research, Houma, LA[3]

A paper from the Proceedings of the
14th International Conference on Precision Agriculture
June 24 – June 27, 2018
Montreal, Quebec, Canada

Abstract. *A yield monitor is a device used to measure harvested crop weight per unit area for a specific location within a field. The device documents yield variability in harvested fields and ultimately can be used to create a geographical-referenced yield map. Yield maps can be used to identify low yielding areas where poor soil fertility, disease, or pests may adversely affect yield. Management practices can then be adjusted to correct these issues, resulting in an increase in yields and production efficiency. Although yield monitors are well established in small grain crops, a consistent, functional yield monitor has yet to be developed for the sugarcane chopper harvester. The objective of this research was to develop a yield monitoring system that could be used in the Louisiana sugarcane industry. A yield monitor was constructed for a billet-type sugarcane harvester that uses two laser distance sensors mounted above the loading elevator to measure the height and length of the billet piles per slat. By using this method, a volume to mass relationship can be established for the weight flow of sugarcane through the combine. Testing of the system indicated that the cumulative billet pile length had the best relationship to harvested weight and exhibited a linear relationship with coefficients of determinations ranging from 0.93 and 0.97. Estimated yields matched actual yields with a 0.99 slope and a coefficient of determination of 0.87. Yields were predicted to be within 7.3 metric tons per hectare of actual values. Material height did not perform as well as material length and had a relationship to harvested weight with coefficients of determination ranging from 0.66 to 0.93. Estimated yields matched actual yields with a coefficient of determination of 0.46. The product of material height to material length also returned a power curve relationship to harvested weight with coefficients of determination ranging from 0.74 to 0.96. Yield comparisons exhibited a coefficient of determination of 0.74, which was better than the material height alone, but not as good as material length by itself. Statistical testing indicated that variances in material length were strongly correlated to material flow, but not to sugarcane variety, direction of cut, or day of testing. Sample analysis indicated that the monitor should be able to predict yields to within 2.2 metric tons per ha of actual values on 0.4 ha or larger precision farming blocks. The yield monitoring system developed in this research project is easily installed and would allow sugarcane farmers to produce yield maps that could be used to optimize their farming practices and potentially increase yields and profits.*

Keywords. *GPS, Harvesting, Precision agriculture, Sugarcane, Yield monitor*

Introduction

A yield monitor is a device used to measure harvested crop weight per unit area for a specific location within a field. The device documents yield variability in harvested fields and ultimately can be used to create a geographical-referenced yield map. Yield maps can be used to identify low yielding areas where poor soil fertility, disease, or pests may adversely affect the crop yield. Management practices can then be adjusted to correct these issues, resulting in an increase in yields and production efficiency. In addition, an accurate yield monitor would help Louisiana sugarcane farmers by allowing them to more accurately fill trucks and maximize the loads and therefore minimize truck transportation costs (this strategy can be especially important in wet or muddy years where truck weights can vary significantly). Although yield monitors are well established in small grain crops, a consistent, functional yield monitor has yet to be developed for the sugarcane chopper harvester. The objective of this research was to develop a yield monitoring system that could be used in the Louisiana sugarcane industry.

Materials and Methods

A yield monitor was constructed for a billet-type sugarcane harvester that uses two laser distance sensors (Model LT3, Banner Engineering Minneapolis, MN, USA) mounted above the loading elevator to measure the height and length of the billet piles per slat (Figure 1). By using this method, a volume to mass relationship was established for the weight flow of sugarcane through the combine. Data was sent to a collection box located in the cab with all the functions of a yield monitor (GPS, storage location, etc.).

Data was collected from three locations in Louisiana: 1) the USDA/ARS, Sugarcane Research Unit's Ardoyne Research Farm in Schriever, LA, 2) Naquin Farms, Schriever, LA, and 3) Allain Farms, Jeanerette, LA. At each location yield data was collected with a single-row, chopper harvester (John Deere, Thibodaux, LA, USA) and the total plot weight determined using a modified single-axle high-dump billet wagon (John Deere, Thibodaux, LA) equipped with load sensors mounted on the spindles at the end of the axle and on the wagon's tongue where it connects to the tractor.

Results and Discussion

Testing of the system indicated that the cumulative billet pile length (the distance measured from the front of the slat to where the billets pile ceases to exist) had the best relationship to harvested weight and exhibited a linear relationship with coefficients of determinations ranging from 0.93 and 0.97. Estimated yields matched actual yields with a 0.99 slope and a coefficient of determination of 0.87. Yields were predicted to be within 7.3 metric tons per hectare of actual values. Material height had a linear relationship to harvested weight with coefficients of determination ranging from 0.66 to 0.93 and estimated yields matched actual yields with a coefficient of determination of 0.46. The product of material height to material length returned a power type curve relationship to harvested weight with coefficients of determination ranging from 0.74 to 0.96. Yield comparisons exhibited a coefficient of determination of 0.74, which was better than the material height alone, but not as good as material length by itself. Statistical testing indicated that variances in material length were strongly correlated to material flow, but not to sugarcane variety, direction of cut, or day of testing. Sample analysis indicated that the monitor should be able to predict yields to within 2.2 metric tons per ha of actual values on 0.4 ha or larger precision farming blocks. This accuracy is more than sufficient to produce yield maps to aid in management decisions, but not to optimize truck weights. An example yield map from Allain Farms is included in Figure 2.

Summary

The yield monitoring system developed in this research project is easily installed and would allow sugarcane farmers to produce yield maps that could be used to optimize their farming practices and potentially increase yields and profits.

Figure 1. Experimental yield monitor sensor bar mounted on harvester conveyor.

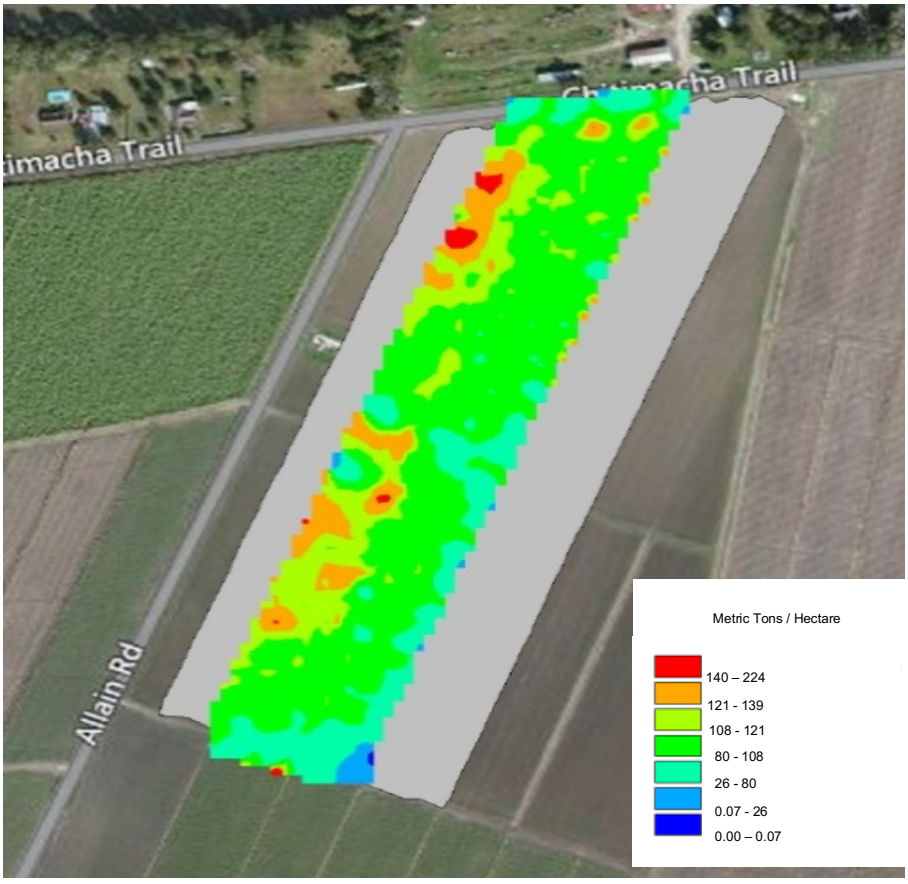

Figure 2. Material length yield map data from Allain farms, Jeanerette, LA.