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Performance Evaluation of Hay Yield Monitoring System in Large Rectangular Baler

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Abstract: Yield monitoring is one of the most important operations for efficient management of agricultural fields. One of the common methods used to monitor hay yield variability is to monitor the hay mass flow rate inside the baler chamber during hay baling process.Therefore, this study on a 10 ha field was conducted to investigate the performance of a hay mass flow monitoring system mounted on a large rectangular baler in estimating alfalfa hay yield. The monitoring system was used to monitor alfalfa hay yield at different baler settings (baler chamber pressure values of 5000, 6000 and 7000 kPa and forward speed values of 4, 8 and 12 km/h) that affected bale density, hence, yield monitor data accuracy. Data from the monitoring system was utilized to generate a georeferenced yield data points that were compared, for calibration purposes, to an actual georeferenced alfalfa hay yield data points. The actual hay yield was obtained by physically weighing the hay bales out of the study area. Results revealed that bale density was mostly affected by baler chamber pressure and high levels of forward speed. Alfalfa hay bale density was found to be correlated to the chamber pressure. On the average, bale densities of 181.3, 171.6 and 168.9 kg/m^3 were obtained at baler chamber pressure of 7000, 6000 and 5000 kPa, respectively. The monitoring system exhibited a good performance in hay yield estimation at different baler working conditions with an average R^2 value of 0.87 for the relation between monitor-estimated and actual yield.

Key words: Hay yield monitoring · Baling · Large rectangular baler · Precision agriculture

INTRODUCTION

Alfalfa (*Medicago sativa*) is considered as one of the most important forage crops to the farmers, as well as, to the dairy and livestock producers due to its high yields of high quality forage. Alfalfa is cultivated in every continent in more than 80 countries in an area exceeding 35 million ha. Because of its low rate of dry matter, low level of suger and high buffer capacity, alfalfa is commonly used as hay, as it is not suitable for ensilage [1].

Hay baling is characterized as one of most essential hay production operations, as it facilitates hay handling, transporting and storing. In addition, hay baling is a high-capacity one man operation with low harvest losses [2]. Hay balers are designed for gathering the cut hay from windrows and compressing it in round or square-shaped bales. Baling process is accomplished after three operations, namely: (i) forage cutting using mowing machines, which cut forage and discharge it in rows, (ii) windrowing process using a windrower, which gathers the cut forage into larger windrows of 1.0 to 1.5 m width and (iii) raking process using a rake machine that stirs the hay and turns it over for hay drying [3].

Hay Bale Density: Hay bale density formed by round balers ranged from 80 to 200 kg/m^3, while large square balers provided bales with densities ranging from 130 to 180 kg/m^3[4]. In silage baling, increasing baler forward speed from 6.4 to 8.8 km/h tended to decrease silage bale density, however, differences were not significant [5,6].

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