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STRAW AND HEY YIELD MAPPING BY HARVEST

ŠIAUDŲ DERLIAUS ŽEMĖLAPIŲ SUDARYMAS

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Yield mapping is one of the basic elements of precision agriculture system. Different sensors and systems which are placed directly on harvesters are commonly used for yield mapping nowadays. The technical solution for straw and forage crops yield measurement consists of a simple arrangement of a position sensor – potentiometer mounted on the belt tension roller on a chosen round pick-up baler with variable chamber. Rotary press with variable chamber VICON RV1601 Opticut was used for measurement. Wheat straw, barley straw and hay was pressed during trial measurement. Position of the belt tension roller was monitored by the potentiometer. Numbers of pulses from the potentiometer corresponded with the position of measuring belt tension roller during the chamber filling. Calibration of the measuring system showed a strong dependence of the tension roller position on the amount of pressed straw or hay (R = 0.99). Finally, yield map of straw and hay was created..

Precision agriculture, yield mapping, harvest, round bale.

Introduction

Mapping of crop yields is one of the fundamental elements of precision agriculture. For forage yield mapping is used sensors and systems that are placed directly on mowers or cutters. Mapping method yields suitable for various crops is proving to be a haul weighing devices or pick presses. The idea behind the principle of work of these methods is based, is relatively simple. There is lot of problems in practical applications.

Wheeler et al (1997) described the basic requirements for the mapping system of crop yield based on continuous weighing of wagons. Goodwin et al (1999) continued research on the apparatus based on continuous weighing of trailer. Overall, the semi-continuous weighting in combination with the adoption of GPS (Global Positioning System) signal can be used for yield mapping. The same principle is founded the idea of mapping forage yield at harvest using the round baler. Measuring system developed by Behme et al (1997) and Wild and Aurenhammer (1997, 1999) - the system was based on load sensing axis wheels gauge sensors.

The whole system can be supplemented with a GPS receiver to create yield maps. Weighing during movement of machine can achieve measurement errors greater than 20%. The negative effect on measurement accuracy has impacts resulting from irregularities in the terrain crossing. The main content of the article is an introduction of measuring forage yield and straw by harvest by press with variable chamber, which is based on the measurement current location tension pulley bands of the variable pressing chamber (Kroulík et al., 2010, Mašek et al., 2011).

Materials and methods

The technical solution consists in the arrangement of the tensioning mechanism for tracking a variable compression chamber of the press VICON RV1601 OPTICUT during molding of forage or straw into the bale. Location tensioning mechanism was monitored with the potentiometer (Fig. 1). The outputs from the potentiometer are pulses. A specially designed electrical circuit was connected with the potentiometer and DGPS receiver. The recording interval was set to 2s.

The system must be also calibrated. Before calibration line was created punctuated with 10 m line of straw with 10m break without straw (Fig. 2). Ten lines were considered. Thus was gradually developed bale. For each line were pulse reading, which corresponded to position the tensioning mechanism for the gradual implementation of the bale chamber.

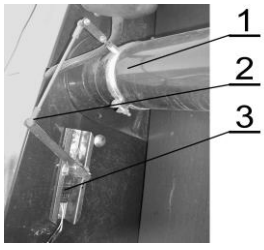

Fig. 1. Location potentiometer on the belt tensioning mechanism: 1 – belt tension roller mechanism, 2 – connecting rod, 3 – potentiometer

1 pav. Potenciometro padėtis ant diržo tempimo mechanizmo: 1 – diržo tempimo ritininis mechanizmas, 2 – jungiamoji traukė, 3 – potenciometras

Fig. 2. Calibration line – 10 m row + 5 m space

2 pav. Kalibravimo linija – 10 m eilė + 5 m tarpai

By measuring these parameters can be determine the immediate throughput of material and create yield maps of harvested material. To obtain spatially-related data throughput of material were recorded in data logger. Pulses of a potentiometer

and machine position from DGPS receiver were at the same time recording to the data logger too. For measurements we used hay, barley straw, wheat straw and chopped wheat straw.

Results and discussion

Based on the results of calibration potentiometer the calibration curve was obtained. Depending on the number of pulses during the potentiometer and net weight of the package best fit exponential calibration curves for different materials was counted (Tab. 1).

Tab.1. Equals of calibration curves for hay and straw
Lentelė 1. Kalibravimo kreivių lygtys šienui ir šiaudams

Wheat straw	Barley straw	Hay	Chopped wheat straw
y = -4.4148x + 2715.5	y = -4.1445x + 2752.2	y = -2.941x + 2732.5	y = -2.7721x + 2752.9
R^2=0.99	R^2=0.99	R^2=0.99	R^2=0.99

After calibration was evaluated yield by hand. There was sampling network on the field and in each sampling point was evaluated the yield. Fig. 3 shows the hay field with sampling point and yield map (hand waging).

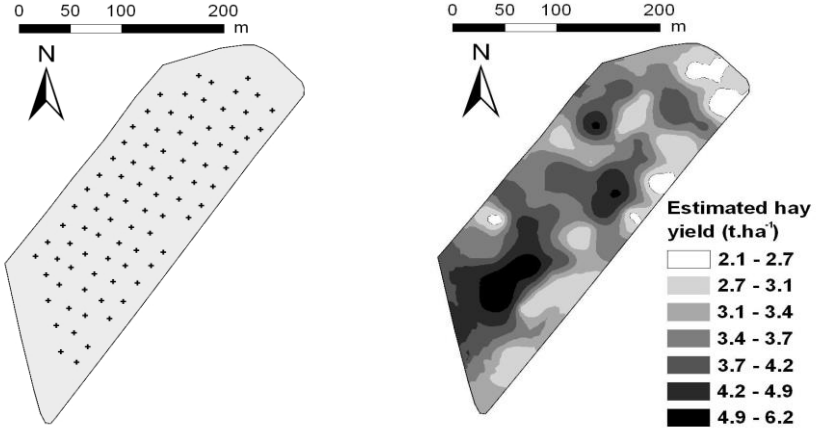

Fig. 3. Sampling point and estimated hay yield (hand evaluation)
3 pav. Pavyzdžių ėmimo vietos ir apskaičiuotas šieno derlius (rankinis skaičiavimas)

By pressing of hay and straw with variable press chamber machine is achieved uniform compressibility of bale with the increased volume (diameter) of bale. For the subsequent processing of each set increases gradually yield $t \bullet ha^{-1}$. Prior to the processing of the data set was necessary to exclude values that were recorded during the tensioning mechanism for returning a package to the starting position and the value recorded on headlands. Also a point where the package is bound to be

excluded from the data set. After processing, the record has been found in hay yield values ranging from 1.9 to 6.9 t·ha^{-1} with an average of 4.4 t•ha^{-1} .

The adjusted data were then used for processing of geostatistical methods which demonstrate the spatial relationships between the measured data. The final graphic output straw yield map was created by kriging interpolation method (Fig.3 and Fig. 4).

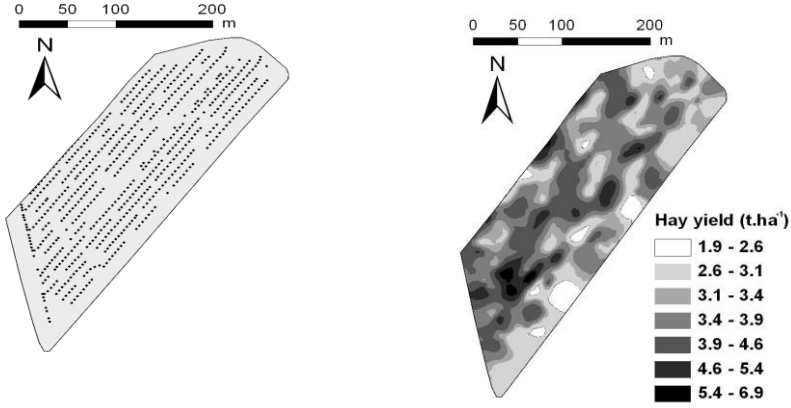

Fig. 4. Sampling point and hay yield (sensor)
4 pav. Pavyzdžių ėmimo vietos ir šieno derlius (gautas jutikliu)

Both methods are evaluated by statistical analysis ANOVA. There is no statistical difference on confidence interval level (α=0.05) between yield evaluation method (hand x sensor). A correlation analysis shows strong dependence between values of yield achieved by different methods of evaluation (Fig. 5).

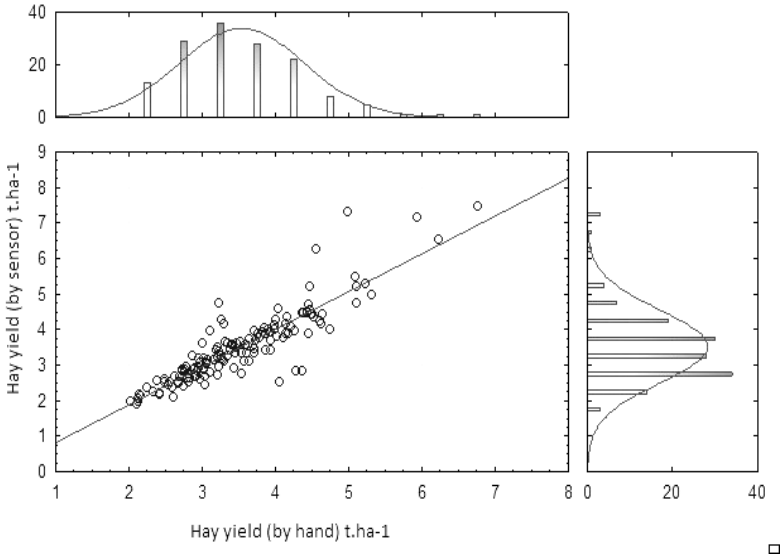

Fig.5. Results of correlation analysis
5 pav. Koreliacinės analizės rezultatai

Measurement was done for different plant material. The course of calibration curves shown in figure 6 was proved according to our hypotheses that behaviour of calibration curves would be dependent on harvested material. Differences in bales density and material specific weight influenced angular coefficient of the curves. On the other hand, the value range of sensor output signal remained the same for different materials, because of the constant final volume of the bale press chamber.

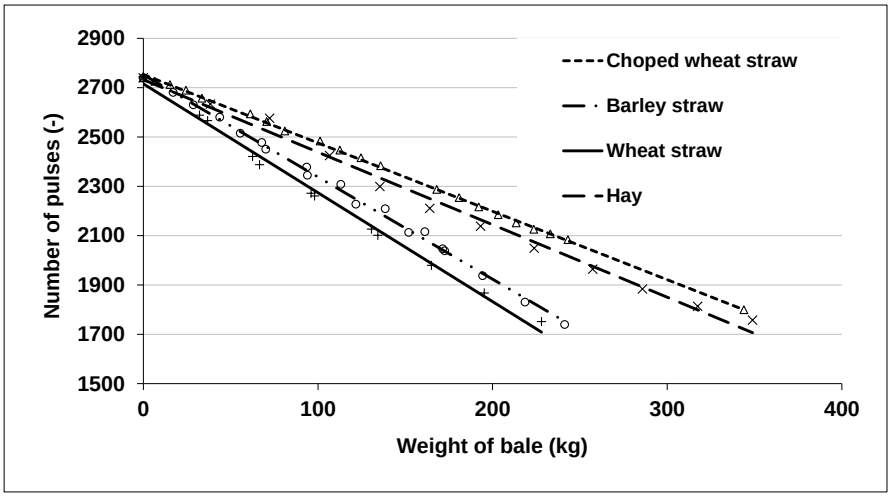

Fig. 6. Dependence of the number of pulses per bale weight for different materials
6 pav. Impulsų skaičiau ryšulio masei priklausomybė skirtingoms medžiagoms

Conclusion

Measurement of position belt tensioning pulley of bale press with variable chamber is shown as a possible method of evaluating the yield pressed material. Calibration of the measuring system showed that the principle of measuring the position of the belt tensioning pulley is not sensitive to shocks. Advantage of this solution is a simple construction but there is a limiting factor is the type of press, which is essential variable pressing chamber. The outcome will certainly affect the kind of pressed material and its compressibility, it needs calibration before harvesting.

Acknowledgement

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ŠIAUDŲ DERLIAUS ŽEMĖLAPIŲ SUDARYMAS

Santrauka

Derliaus kartografavimas yra vienas iš pagrindinių tiksliosios žemdirbystės sistemos elementų. Įvairios sistemos ir jutikliai, kurie yra uždėti ant kombaino, šiandien gali būti naudojami ir derliaus kartografavimui. Šiaudų ir pašarų ruošimo derlingumo matavimui pateikiamas paprastas techninis sprendimas su padėties jutikliu – ant ruloninio preso su kintamu kameros dydžiu diržo įtempimo ritinėlio sumontuotas potenciometras. Tyrimams naudotas ruloninis presas „VICON RV1601 Opticut“ su kintamo dydžio presavimo kamera. Per bandomuosius matavimus buvo presuojami kviečių šiaudai, miežių šiaudai ir šienas. Potenciometo pagalba buvo stebėta diržo įtempimo ritinėlio padėtis. Presavimo kameros užpildymo metu potenciometro impulsų skaičius atitiko su matuojamo diržo įtempimo ritinėlio padėtimi. Kalibravimo metu nustatyta, kad yra stiprus ryšys tarp įtempimo ritinėlio padėties ir presuojamų šiaudų arba šieno kiekio kameroje (R = 0,99). Darbo pabaigoje buvo sudarytas šiaudų ir šieno derlingumo žemėlapis

Tikslioji žemdirbystė, derlingumo žemėlapis, derliaus nuėmimas, rulonai.

И. Машек, М. Кроулик, З. Квиз

СОЗДАНИЕ КАРТЫ УРОЖАЙНОСТИ СОЛОМЫ ПРИ УБОРКЕ

Резюме

Картографированние является одним из основных элементов точного земледелия. Различных системы и датчики, которые размещены на комбайне, в настоящее время может быть использованы для картографированния урожайности. Для измерения урожайности соломы и кормовых культур предложено простое техническое решение с датчиком расположения - на натяжной ролик ремня выбранно пресса-подборщика с переменной камерой установлен потенциометр. Для исследований использованн рулонный пресс-подборщик “Vicon RV1601 OPTICUT“ с переменной камерой прессования. Во время испытаний были измерены сжатие соломы пшеницы, соломы ячменя и сена. С помощью потенциометра наблюдалось положение ролика натяжения ремня. При заполнении камеры прессования количество импульсов потенциометра соответствовало положению ролика натяжного ремня. Калибровка измерительной системы показала сильную зависимость положения натяжного ролика от количества прессованной соломы или сена в камере (R = 0,99). Наконец, были созданны карты урожайности соломы и сена.

Точное земледелие, карта урожайности, уборка урожая, рулоны.