Linseed harvests parameters depending on the state of cutting mechanism

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Abstract

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The operating and economical parameters of agricultural products harvesting are important aspects from production costs point of view. Profitability of the crops depends on quantity and quality of end products and efficiency of growing and harvesting operations. In case of linseeds harvesting by combine harvester statistically important impact of cutting mechanisms state on energy, exploitation and economical parameters was determined.

Keywords: flax; combine harvesting; energy consumption; GPS

Conventional utilization of combine harvesters dates back in the 1950's in the Czechoslovakia. Trend of the combines design development is aimed to increase efficiency and improve ergonomics. For example 2 decades ago the standard values were approx. 4–12 kg/s for material flow and approx. 1.5 to 3 ha/h for specific performance (Neubauer et al. 1989). Today the material flow can be even 90 kg/s.

Working conditions in agriculture are relatively difficult due to the influence of dust, stones and water content in processed materials and environment. Cutting mechanism is the first functional part of the combine harvester which comes into contact with harvested crops. The result is an increase of foreign particles abrasive incidence on the cutting mechanism. Issues of cutter wear parts are dealt by Šimůnek et al. (2003).

Evaluation of combine harvester cutting table mechanisms according to the quality work was performed by Jech and Sloboda (2000) at harvest of seed clover crops. Standard harvest losses increased from 10 to 20%. Measurement was performed on 20 m distance. The performance of harvesting was not monitored in dependence on cutting mechanisms condition.

The quality of used materials and maintenance requirements are increasing in dependence of performances. Water content has a significant impact on raw material processing performance, including harvesting operations Souček (2005). Low performance of harvesting operations results into higher specific costs and worse economy of crops growing.

Problems of harvesting operations parameters are taking effect on specific cost especially in case of tough stems and low crop yield. The typical example is linseed growing in conditions of the Czech Republic. Parameters of linseeds harvesting are systematically monitored in the framework of the Ministry of Agriculture of the Czech Republic research project Linseed for dual utilization.

Part of this project is a comparison of two combine harvesters with different conditions of cutting

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mechanism. Performance and energetic parameters were monitored and processed during the research.

MATERIAL AND METHODS

Harvesting parameters monitoring was realized in North Moravia near Bludov, Czech Republic. Experiment was realized in cooperation with Agricultural Marketing Cooperative Bludov and Agritec Šumperk, Ltd., during the harvest season of 2010. Heavy rains, especially in August and first half of September, resulted in low quality of harvested linseed, high water content and soil waterlogging in a scale, which made harvesting impossible. It resulted in harvesting terms postponing to second half of September.

Harvested crop was the Biltstar linseed variety. Seed yield level was 1.0 t/ha and the average crop height was 56 cm. The harvesting was realized by CLAAS Lexion 560 and CLAAS Lexion 460 (CLAAS GmbH, Harsewinkel, Germany) Evolution combine harvesters.

Basic technical parameters of used combine harvesters are provided in Table 1.

The properties of used combine harvesters are comparable. The only exception is the installed engine power. Impact of this parameter is important, but only at the installed power level, it means max. 12%. In case the combine harvesters do not use the full power, then the impact of installed power on harvesting parameters is decreasing.

A new scythe and new cutting mechanism fingers were installed to CLAAS Lexion 560 combine harvester. All replaced parts were made by the original manufacturer. The reason of replacement was excessive wear of the cutting mechanism, which was not allowed during realization of crops harvesting.

Table 1. Basic technical parameters of monitored combine harvesters

Type	CLAAS Lexion 560	CLAAS Lexion 460 Evolution
Working width (m)	7.6	7.6
Engine power (kW)	283	249
Weight (t)	14.5	14
Drum diameter (mm)	600	600
Drum width (mm)	1,700	1,700
Drum speed (1/s)	6.5–19.2	6.5–19.2

Diagnostic signals of wear were bluntness of edges and clearance of the scythe in mowers fingers.

The cutting mechanism of CLAAS Lexion 460 Evolution combine harvester was remanufactured (revitalized) in the framework of regular maintenance. The cutting mechanism scythe was also replaced, but with a non-original one. Fingers of mower were not changed. Both monitored combine harvesters operated at the same field during the monitoring.

Movement of machinery on the land was monitored online by continuous recording of coordinates by the GPSMAP 76Cs devices (Garmin Ltd., Kansas, USA). The advantage of this method is the ability to construct the exact time frame, determine the travel speeds, altitudes and subsequent data processing in digital form.

The next measured parameter was energy consumption. It was calculated from the measured value of diesel consumption:

$$W_{sp} = m_{pal} \times Q^{t}_{i\ pal} \qquad \text{(MJ)} \qquad (1)$$

where:

m_{pal} – weight of consumed fuel (kg)

$Q^{t}_{i\ pal}$ – fuel value (MJ/kg)

Specific energy consumption is energy, which was consumed by harvesting of given quantity of linseeds:

$$W_e = \frac{W_{sp}}{m_s} \qquad \text{(MJ/t)} \qquad (2)$$

where:

m_s – weight of harvested linseeds (t)

The measuring and next processing of given data were realized on 10 sections of the field. Statistical evaluation was focused on comparison of the data measured in each section and finding a statistically significant difference between monitored operating parameters. Specific costs were calculated in the AGROTEKIS program (available free at www.vuzt.cz). Processing and statistical evaluation of the measured data were realized in MS Excel 2003.

RESULTS AND DISCUSSION

The monitoring was realized at sections of the field, which had comparable parameters for harvest. Downtimes and turning on the headland were selected and excluded. The calculated performance

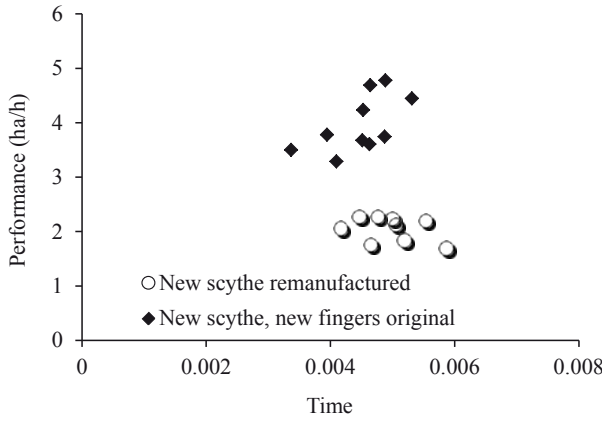

Fig. 1. Dependence of performance on cutting mechanism condition

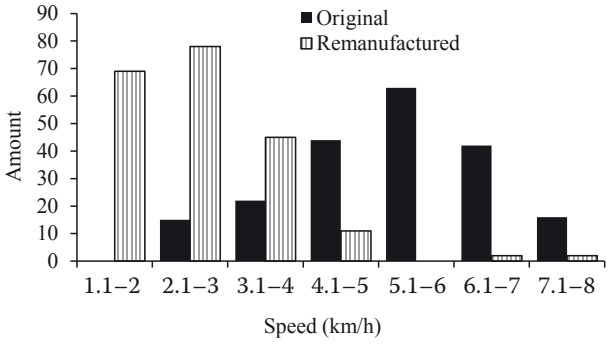

Fig. 2. Working speeds histogram

of both combine harvesters showed statistical significant differences on all measured sections. The observed performance is shown in Fig. 1. The histogram of measured working speeds for both harvesters is displayed in Fig. 2.

The average performances, specific energy consumptions and specific costs are presented in Fig. 3.

The summary of measured conditions and average calculated values are provided in Table 2.

The obtained data were analyzed by using appropriate statistical methods. Statistically significant differences in measurement of conditions represented by gradient and landform were not found. It is logical when considering the fact that combines harvested the same fields.

Statistical significant differences were found in values which were used in calculation of result parameters (working speed and fuel consumption).

The combine harvester CLAAS Lexion 560, where original parts were used for renovation, achieved better results in monitored parameters.

Flax growing areas are decreasing in the Czech Republic. In 1993, the flax crops area was more than 10,000 ha. According to the Ministry of Agriculture of the Czech Republic (2010) this area was reduced to 3,400 ha in 2010. One hundred percent of this was linseed only. Flax stem was not used except for research purposes. The whole flax crops area was harvested by combine harvesters. The significant impact of cutting mechanisms condition on economic and technical harvest parameters is evident from the presented comparison of two monitored combine harvesters. This can affect farm's total costs of linseed productions.

The performance of combine harvester with the non-original cutting mechanisms scythe was for about 2.4 ha/h lower, which means 60%. Considering the 12% difference in installed engine power, 48% difference remains for machine's performance. The calculated specific harvested costs were reduced by 35 % (15.2 €/t) [1€ = 24.80 CZK in 2010] in case of renovation with the original cutting mechanism parts.

The total specific costs of linseed harvesting were 27.8–43 (€/ha). Mitáš and Červinka (2000) present flax harvesting specific costs of 192 €/ha including harvesting of stem.

The flax is a traditional crop in the Czech Republic. The importance of flax is the economic benefits

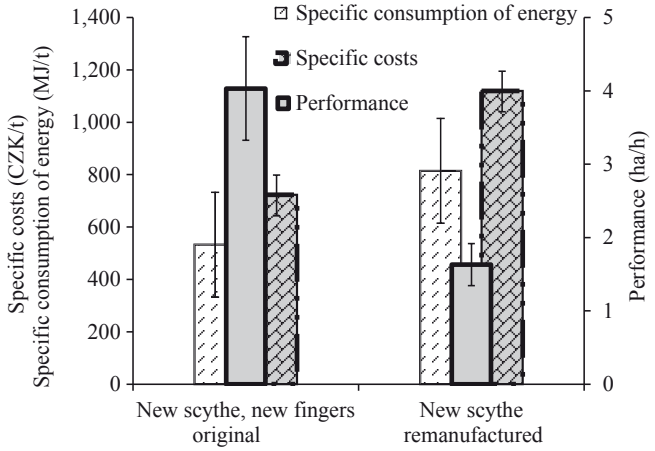

Fig. 3. Dependence of performance, specific energy consumption and specific costs of linseeds harvesting on cutting mechanism condition

Table 2. The conditions and results of measured harvest parameters

	Type		CLAAS Lexion 560	CLAAS Lexion 460 Evolution
Used machine	type of repair	q_m	new scythe, new fingers original	new scythe remanufactured
	performance (ha/h)		4.03	1.63
Characteristics of harvested material	crop		linseed, variety Biltstar	
	water content (%)	$W^t_{r\,vst}$	15.2	
	seed yield (t/ha)	m_{seed}	1.00	
	stem yield (t/ha)	m_{stem}	2.76	
	average crop height (mm)	x_{1i}	56.0	
Specific consumption of energy	(MJ/ha)	We	532.43	814.54
	(MJ/t)		532.43	814.54
Specific costs	(€/t)	n_j	27.8	43

(food, textiles and cosmetics) and environmental importance (expansion of crop diversity, production of biodegradable materials and composites). The new styles of utilization of flax materials for energetic and technical purposes are researched in the framework of national and EU projects.

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