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Use of Fortschritt E-281C Self-Propelled Harvester in Grass Ensiling

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Abstract: Investigations were carried out in 2006 on sown meadows of the Agricultural Complex "Zlatibor", Plc. The Fortschritt E-281C self-propelled harvester at two operating speeds of 2.16 km/h and 2.83 km/h was examined. Silage yield was 17.6-22.4 t-ha. At speeds lower than 2.16 km/h the harvester achieved the capacity of 6.61 t/h and surface area performance of 0.76 ha/h. At increased operating speeds of 2.83 km/h and at an improved working regime the harvester productivity increased to 9.02 t/h and 0.95 ha/h. Low harvester productivity, which was only 8.26-11.27% of the projected productivity, caused specific power consumption of 18.94 and 13.85 kWh/t in the first and second variant, respectively. The harvester had a quality performance, producing uniform chopped material, 74.46% of which was shorter than 5 cm. Maximum cutting height was 11 cm.

Better grass ensiling organisation may increase daily performance of the harvester.

Key words: Fortschritt E-281C harvester, grass silage, operating speed

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Introduction

Grass ensiling is a method of preserving and storing green forage with a low nutrient loss being produced and the fodder quality obtained being good and similar to the green matter quality. Ensiling can be carried out even in such weather conditions – frequent rains, when green matter cannot be prepared in an alternative traditional way – dried as hay. In these conditions, the first cut often gets rain-soaked, cannot dry out and low-quality or decayed hay is obtained, resulting in a loss of substantial green matter protein amounts which should be compensated by expensive concentrated feed. During grass ensiling, the harvested silage is being readily taken off the plot, resulting in more rapid regeneration and obtainment of yet one more cutting during the year.

The process of green matter production by ensiling and silage distribution to animals is completely mechanised. Different domestic- or foreign-made self-propelled harvesters are used for grass ensiling on large farms. The Fortschritt E-281C is an example of the grass-ensiling harvesters mentioned, and was the subject matter of our research aimed at determining its productivity, performance and operating quality.

Material and Method

The investigations were carried out over 2006 on sown meadows of the Agricultural Complex “Zlatibor”, Plc. Examinations were made of the Fortschritt E-281 C self-propelled harvester at two operating speeds of 2.16 km/h and 2.83 km/h.

During the investigation, an average green matter yield, grass height and silage moisture were determined. In order to identify the harvester performance characteristics, the operating speed, basic operation time, standstills, trailer weight, trailer loading time and capacity of the harvester were calculated. Engine operation regime and harvester performance expressed through chopped matter length, cutting height and cutting width were also monitored.

All of the measurements were made following standard methods used for examination of technical technological and performance characteristics of machines. All the data obtained were statistically analysed.

Results and Discussion

The grass silage was harvested from artificial meadows where orchard grass and timothy grass predominated with, however, a considerable weed distribution. Plant height ranged from 46-112 cm, and its yield varied from 17.6-22.4 t/ha, with 71.46-76.80% of moisture.

Table 1. gives basic specifications of the 125 kW diesel Fortschritt E-281C self-propelled forage harvester. The harvester could be mounted with a maize harvesting device, direct grass cutting device and a pick-up device for collecting the cut grass from cuttings for grass and hay ensiling. The research

covered the direct grass cutting device in the ensiling process. During the investigation, the harvester operating speed was gained at the first transmission level with top gas used and 0 driving variator for lowest speeds.

According to the Table 2 operation results obtained, there was an observable dependence between the operating speed and the capacity of the harvester. In variant 1, at lower operating speeds ranging from 2.0-2.25 km/h the harvester capacity achieved varied from 5.77-6.99 t/h. With improved harvester operation regime, increased cutting width and higher operating speed of 2.5-3 km/h the harvester capacity was raised to 7.33-10.79 t/h. The productive capacity achieved was only 11.29% compared to the projected capacity.

Tab. 1 Basic specifications of the Fortschritt E-281 C forage harvester

Engine power	125 kW
Header length	640 cm
Cutting width	427 cm
Cutting device speed	2 m/sec
Height	395 cm
Weight	5260 kg
Chopping device type	Cylinder with knives
Cylinder diameter	800 mm
Cylinder revolution number	914 r/min
Peripheral cylinder speed	38.27 m/sec
Number of cylinder knives (at one's own choice)	8, 4, 2
Chopping length	5-90 mm
Tank capacity	185 l
Transmission level number	3 1
Operating speed	1.58-8.7 km/h
Transport speed	20 km/h
Capacity	80 t/h

In his investigations on the Toron SPS-35 self-propelled forage harvester equipped with a low silage adapter, Gasparac (1984) achieved the performance of 27.3-48.6 t/h or 2.1-3.7 ha/h at an alfalfa cutting height of 5.6-8.2 cm. The same author (1985) examined four self-propelled alfalfa-ensiling harvesters. The highest performance of 56 t/h at an operating speed of 11.6 km/h and an operating width of 2.2 m was registered with the Orkan 300 harvester. The chopping length averaged 1.3 cm. The lowest capacity of 35 t/h and performance of 2.5 ha/h was attained by the Fortschritt E-281 harvester at a 6.2 km/h operating speed and a 4 m cutting width. An average chopping length was 4 cm.

Similar results were also obtained by Milojevic (1980) in his investigations of 5 self-propelled ensiling harvesters of which the Fortschritt had the highest operating width but, due to low operating speeds of 2.3 km/h, achieved the capacity of 14.69 t/h or daily performance of 117.58 t, which was only 53.53% of the theoretical performance.

In ensiling the first alfalfa cutting with an average yield of 22. 22 t/ha using the Dania 5500 self-propelled harvester, Stanojevic (1984) produced the daily performance of 6.27 ha or 81-139 t of harvested matter.

In grass ensiling by direct Fortschritt E-281 cutting, the capacity of 27 t/h at an operating speed of 4 km/h and chopping length of 30-50 mm was achieved by Novakovic (1984). Using a device for collecting the cut matter from cuttings, the harvester achieved the capacity of 25.2 t/h and performance of 0.8 ha/h at an operating speed of 4.5-5 km/h and chopping length of 50-80 mm.

In grass ensiling, Radivojevic (1995) compared two harvesters and a self-loading trailer. The capacity of 7.15 kg/sec and performance of 5.88 ha for 8 hours of work were achieved by the self-propelled Fortschritt E-281-C forage harvester at an operating speed of 6.07 km/h. The losses produced by the harvester at trailer loading were 1.35 t/ha or 5.80 % of the average yield achieved.

Komarcevic (1981) and Jacinac (2006) examined the Fortschritt E-280 harvester in whole maize ensiling. At an average operating speed of 4.55 km/h, the performance achieved was 27.50 t/h of effective work time or 24.8 t/h of the total time.

Tab. 2. Performance characteristics of the Fortschritt E-281C self-propelled harvester at two operating speeds

Basic parameters	Variant 1					Variant 2				
	$\overline{X}$	min	max	Sd	Cv	$\overline{X}$	min	max	Sd	Cv
Op. speed km/h	2.16	2.00	2.26	0.109	5.03	2.83	2.57	3.00	0.18	6.26
Basic oper. Time, s	1152	995	1270	127	11.02	891.8	727	1124	154.3	17.31
Standstills, s	1396	90	200	47.70	34.17	121.2	85.0	150	25.58	21.10
Total time	1291	1085	1435	165.3	12.80	1013	868	1209	136.9	13.52
Coefficient	0.89	0.86	0.92	0.25	2.84	0.88	0.84	0.93	0.36	0.40
Trailer weight, kg	2110	1870	2420	227.1	10.76	2202	1920	2510	234.5	10.65
Capacity, t/h	6.61	5.77	6.99	0.48	7.33	9.02	7.53	10.79	1.27	14.07
Performance, ha/h	0.76	0.68	0.82	0.05	7.03	0.95	0.92	1.00	0.031	3.28
Power consumption, kWh/t	18.9	21.7	17.9		7.33	13.85	16.61	1.58		14.07

The harvester performance in the first and second variants averaged 0.76 ha/h and 0.95 ha/h of effective work time, respectively. The working time utilisation coefficient was 0.89 at lower speed and 0.84 at higher operating speed. The high coefficient was due to the harvester being operated in a twisting spiral pattern with no time loss recorded for the harvester to turn on furrow-edges. Harvester operation standstills covered the time consumption for trailer change only and not for their awaiting. There were no or there were very few standstills due to breakdown and blockage and they did not have any significant effect on the harvester productivity.

If the research results obtained and the available and cited literature data are compared, it can be noticed that the harvester in performance research conditions achieved a much higher capacity – productivity in other authors

(Gasparac, Tanevski, Radivojevic). It was only the results by Novakovic under harvester performance conditions that were similar to the ones obtained by our research.

The surface area performance of the forage harvester depended on the following: harvester capacity, grass matter chopping length, operating speed, operating width, yield, plot size and shape, etc. Furthermore, nonconformity between the collection and transport of the plant matter harvested had a high effect on the overall performance due to standstills caused by transport device waiting. If these organisational weakness were eliminated, irrespective of the harvester age over 20 years, daily performance would be increased and ensiling period reduced.

Grass silage chopping length is a highly important technological factor affecting the silage quality. The fine-chopped matter can be better compressed during ensiling, it occupies less space in a silo facility, better silage quality is obtained, silage is more easily taken out of a silo, transported and distributed within a rack. Under our research conditions, 74.46 % the matter of less than 5 cm had the highest distribution, followed by 17.85% of 5-8 cm and 7.69% of over 8 cm length. According to Dinic (2005), the chopping length was dependent on the ensiling method and moisture content in the grass matter. The chopping length for ensiling the grass matter from a cutting with 65-70% of moisture was 2-3 cm. When ensiling grass by direct cutting, the chopping length should be 3-5 cm, which was achieved in major part of the cut matter in our research. The chopping length of 10-20 mm in 74.7% in alfalfa ensiling was achieved by the said harvester in the research by Tanevski (1990).

The cutting height averaged 8.50 cm, ranging from 5-11 cm. Basic factors affecting the cutting height were operating speed, construction features of the cutting device – great operating width, micro relief of the plot and crop state – lodging. According to Tanevski, an increase in operating speed to 4.5 km/h resulted in increases in both cutting height and non-cutting losses to 11 cm and under 1 % of the yield, respectively. In hilly regions with a pronounced micro relief, the operating width should be smaller.

As seen from table 2, there was a high specific power consumption of the harvester. It averaged 18.94 kWh/t and 13.85 kWh/t in the first and second variants, respectively, resulting also in increased fuel consumption. This was due to low productivity and age of the harvester. According to Potkonjak (1995), the projected specific engine power in self-propelled harvesters ranged from 1.20-2.0 kWh/t depending on the producer and engine design specificities. The projected power in this harvester was 1.50 kWh/t.

Conclusion

Grass ensiling is a method of preserving livestock feed being similar in protein content and overall quality to the green matter. Grass silage is used as a compensation for substantial amounts of expensive concentrated feed.

Based on the performance examinations in production conditions, the harvester productivity achieved was very low, 6.61 t/h on an average at lower speeds and 9.023 t/h at higher speeds, which was only 8.26% and 11.27%, respectively, of the capacity projected. The low productivity of the self-propelled harvester caused high specific power consumption of 18.94 kWh/t and 13.85 kWh/t and increased fuel consumption.

The harvester cutting quality was satisfactory since 74.46 % of the silage was less than 5cm and the cutting height did not exceed 11 cm.

Better grass ensiling organisation may result in an increase of performance which was 0.76 ha/h of effective work and in an ensiling period reduction.

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PRIMENA SAMOHODNOG KOMBAJNA FORTSCHRITT E-281C U PRIPREMI TRAVNE SILAŽE

- originalni naučni rad -

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Rezime

Istraživanja su obavljena u toku 2006. godine na sejanim livadama PK „Zlatibor" AD. Ispitivan je samohodni kombajn Fortschritt E-281C pri dve brzine rada od 2,16 km/h i 2,83 km/h. Prinos silomase je bio 17,6-22,4 t/ha. Kombajn je pri manjim brzinama od 2,16 km/h ostvario propusnu moć od 6,61 t/h i površinski učinak 0,76 ha/h. Pri povećenju brzine rada na 2,83 km/h i poboljšanju režima rada kombajna produktivnost je povećana na 9,0 2t/h i 0,95 ha/h. Mala proizvodnost kombajna svega 8,26-11,27% od projektovane prouzrokovala je utrošak specifične snage od 18,94 i 13,85 kWh/t. Kombajn je kvalitetno radio, davao je ujedačenu iseckanu masu i to 74,46% manju od 5 cm dužine. Maksimalna visina košenja je bila 11 cm.

Boljom organizacijom rada u spremanju travne silaže dnevni učinci kombajna bi mogli da se povećaju.