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Practical Testing of a Four-Row Potato Harvester

Structural changes in agriculture are leading to more and more harvesting and haulage cooperatives on arable farms. This also applies to potato harvesting, where efforts are being made to organise harvest and haulage cooperatively. The key machines are SP-potato harvesters, which are produced by two German manufacturers. During the harvest periods of 2002 and 2003 the Holmer potato harvester was tested in practice.

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Keywords

Potato harvest, potato harvester, electronic potato

The following reasons and advantages speak in favour of cooperative potato harvesting:

- Low workload and -peaks in autumn due to the harvest
- Little demand for hired help, which results in lower costs
- When a new machine is purchased, individual farm mechanisation is often too expensive
- It is becoming more and more difficult to find suitable personnel for this kind of work
- The harvest is very weather-dependent (limited number of field work days), which requires efficient harvesting machinery

These reasons speak in favour of self-propelled harvesters being used for the potato harvest like for the sugar beet harvest 20 years ago [1].

Machine Description of the Examined "Terra Melix"

- Three-axle chassis with articulated steering ("crab steer") on wheels (2•1050/50 R32 front axle and 4•1000/50 R25 tandem rear axles)
- Hydrostatic drive: 0 - 25 km/h stepless
- Automatic slope compensation up to 8°
- A front-mounted lifting unit with the possibility of share division allows for lifting from tilth and lifting of only two ridges (e.g. in tramlines)
- The potato harvester features a modular design, this allows single component groups (e.g. axial roller cleaner) to be exchanged or retrofit
- The cleaning unit consists of two chain webs, two haulm picking units and an axial roller unit which can be activated or bypassed as desired thanks to a by-pass option (depending on potato variety and use)
- Bunker capacity 16 t, which can be unloaded within 2 min. [2]

Examination of Harvesting Capacity

For the collection of harvest data in 2003, harvesting work was accompanied on several dates. In addition to the measurement and recording of the harvester's examplary data, such as lifting time per bunker, discharge time per trailer, etc. the harvested quantity was determined trailer-wise. After correction for the dirt tare, this information was correlated with the data collected on the harvester.

Field Capacity under Optimal Conditions

Under the optimal harvesting conditions on this recording day, an average harvesting performance of 1.1 ha/h was achieved (*Fig. 1*). This was mainly a result of the average harvesting speed of 4.6 km/h, which had particularly favourable effects due to the long field. One bunker filling consisted of two

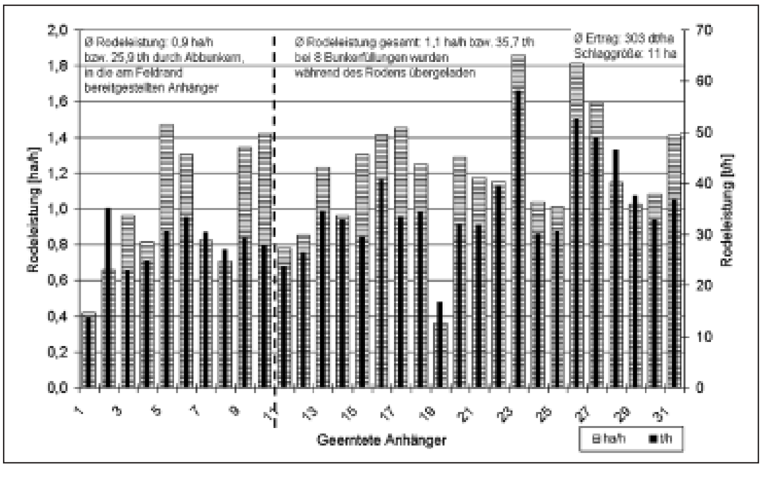

Fig. 1: Harvesting capacity of the potato harvester under ideal conditions

field lengths (a total of 860 m). Therefore, the bunker needed to be unloaded only at one end of the field. The bunker was filled 8 times, the potatoes were also side-loaded directly onto a tractor-trailer combination by the harvester, while the harvest was in progress. This enabled the field capacity to be increased again (*Fig. 1*). This increase results from the time saved for the ride to the field and back as well as bunker unloading (Ø 3,5 min./hopper) [3].

Quality Requirements for Harvested Potatoes

For cooperative harvesting, it is particularly important that the quality requirements of all marketing directions (food potatoes: little damage; starch potatoes: free of admixtures) can be fulfilled because this is a prerequisite for the profitable utilisation of the harvester's capacity in a potato cultivation region. For this reason, the tested harvester has been designed such that starch- and food potatoes can be harvested with different cleaning intensity depending on the processing direction. Therefore, a "by-pass" solution is integrated into the cleaning unit which provides a choice of intensive cleaning and gentle harvesting. A total of 10 stored programs are available, which can be adapted individually depending upon the harvesting situation.

Since the configuration of the year 2002 still had considerable shortcomings with regard to tuber damage, the cleaning unit was intensively redesigned for 2003.

Examination of Tuber Damage

For the measurement of the mechanical load on the tubers at different machine settings, an "electronic potato" was used. The "dummy" PTR 200 has a tuber-like shape. In its interior, a triaxial acceleration sensor is installed which radios the collected shock values to a hand-held computer, where they are stored [4]. After a measurement series comprising five repetitions, the measurement values are exported to Excel with the aid of a program and evaluated. The individual values are displayed as relative values (%). Initial results of comparative fall trials under laboratory conditions on different surfaces and from different falling heights with subsequent comparative assessment of a potato variety (Agria) have shown that shocks <30%, which act on the tuber just once do not result in quality-reducing damage. However, this is not yet a statistically significant value, which for the time being only serves for orientation. Potato damage very strongly depends on maturity, the DM content, the variety, the starch content, the weight of the individual tuber, and the temperature [5].

Table 1: Frequency of impacts ≥ 30 %

	configuration 2002	2003
	without cleaner	
shocks/impacts ≥ 30 %	28.3	5.6

The "electronic potato" was used to examine whether the technical improvements of the cleaning system led to gentler tuber treatment. For this purpose, two "Terra Melix" harvesters in the 2002 and 2003 version were tested parallel on the same potato field with largely identical setting and with the same harvesting speed.

With the 2002 configuration, 2 series of measurements were taken, while 3 measurement series were carried out with the 2003 version. The results shown in *Figure 2* are average values of the two measurement series of the 2002 configuration and the three series of measurements of the 2003 version. For the calculation of the average maximum and average shock intensity, only the shocks >20% were used, because it can be assumed that all values <20% do not cause any damage even under unfavourable circumstances. The average throughput time and the average number of shocks, however, were recorded over the entire measurement series because they clearly show the difference between the two configurations.

Results and Discussion

The alterations of the cleaning system enabled a significant improvement with regard to the load-relevant parameters to be achieved. In the 2003 configuration, the average maximum and average shock intensity are almost 20% below the level of the 2002 version. The throughput time, which was on average 2 seconds shorter, is also reflected in the average number of shocks, which is more than one third lower, because longer throughput time generally also results in a larger number of shocks. The difference between the two configurations becomes particularly apparent if the shocks are differentiated according to load classes. In the 2002 configuration, the classes (≥ 30 %) account for 28.3 percent of all shocks as compared with 5.6% of all shocks in the 2003 version (*Table 1*). In the 2002 configuration, even 18.3% of the shocks were in the 40 - 50 load range, which results in certain damage to potatoes.

Conclusions

Self-propelled four-row potato harvesters have very large harvesting capacity, which can quite well stand a comparison with the performance of six-row tankers for the sugar beet harvest. However, potatoes require very gentle treatment. Appropriate modifications enable further improvements to be achieved in this point, as trials with an "electronic potato" have shown. Currently, in particular a large percentage of stones is causing problems because these stones are not yet able to be separated satisfactorily. In the future, more efficient harvesting machinery will lead to extreme requirements to be fulfilled by haulage- and storage logistics as well as by harvest planning.

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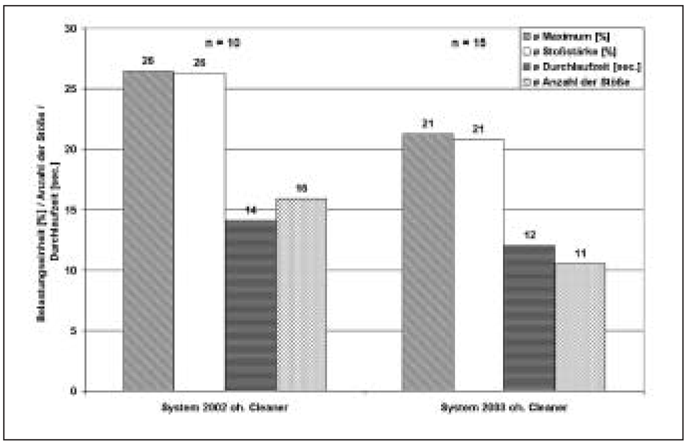

Fig. 2: Comparing load parameters of both systems