

## INNOVATIVE SOLUTIONS IN POTATO HARVESTING TECHNIQUES

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**Summary.** Potatoes play a crucial role in ensuring nutrition for the population. In Slovakia, they are almost as important as bread. It is significant to obtain the lowest possible losses and damage at cultivation as well as at harvest. This can be achieved only by a modern, but also a high-performance technique and cultivation technology in order to harvest in time and without high losses. The use of proper harvesting technology is clearly reflected in the quality and consequently in the sale price of the product.

**Key words:** potato, harvest technology, harvest, damage, soil compaction

### Introduction

In Slovakia, over 20 years the area of 60.000 ha has reduced to 11.000 ha. Cultivation has moved from mountain and sub-montage regions in the southern lowlands to south-western Slovakia, where a number of important potato acreage from 150 ha to 400 ha was created. A cultivation area of higher rank requires, especially at harvest, either deploying more equipment, or equipment with higher performance. We are not going to solve the problems of reduction of the cultivation area; we want to touch the issue of harvest technology, its quality and performance [Frančák 2001].

### Results and Discussion

Potatoes are one of the riskiest crop in cultivation especially at harvest. Therefore, a major task of technique and production technology is reduction of losses of potato tubers at harvest and storing in proper conditions [Budyn 2002; Kielbasa 2006].

Old worn-out equipment does not meet the basic criteria of work quality. It is both morally and physically worn out. To improve the state of the collected material firstly we have

to consider the quality of harvesting machines. Whether these are single-line and two-line potato harvesters, or four-line self-driving harvesters they must be designed as follows:

- low specific pressure on ground (equipment with wide flotation tires, or tracked chassis),
- disposal of tops either before harvest or simultaneously with the harvest so that rotary crushing tops are mounted in front of lifter ploughshares,
- suitable regulations of grave undermine depth and its separation. In dry growing conditions to improve undermining and separating according to the soil moisture, possibility of irrigation before harvest, thus reducing damage of tubers, influences better lumps crushing.
- speed control of potato movement along sieving conveyors and drop height to the tray, or in vehicles. Harvesting equipment of machines with conveyors also with lateral movement of belts to avoid abrasion of an even unpaved potato peel.

Total average damage –  $Z_p$ :

$$Z_p = 0.1 \cdot P_p + 0.3 \cdot S_p + 1.0 \cdot T_p \quad [\text{kg}] \quad (1)$$

where:

- $Z_p$  – total average damage,
- $P_p$  – surface damage up to the depth of 1.5 mm, respectively skin scratching,
- $S_p$  – medium damage up to the depth of 5 mm,
- $T_p$  – heavy damage up to the depth of more than 5 mm, respectively cutting potato tubers.

$$P_z = \frac{Z_p}{U} \cdot 100 \quad [\%] \quad (2)$$

where:

- $P_z$  – percentage of potato tubers damage,
- $U$  – yield from the measured area.

- Good uptime and low failure harvest technique to prevent violation of the harvest process.

One of these machines that meet the criteria is four lines self-driving potato harvester Dewulf, which works on the land of Ing. George Mačaj in Kráľová at Senca and potatoes grow on the area of 450 ha. It is the largest potato producer in Slovakia near Bratislava with good sales potential. Cultivated soil is light and sandy with deep gravel sub-soil and must be fully equipped with irrigation.

The advantage of the collector is a tracked chassis for reducing the specific pressure on the land and the possibility of using it also in less bearing ground (wet, rain, clayey soil). Furthermore, it is the wide rear control tire, which provides good guidance of lifter system for lines.



*Photo by: Maroš Korenko*

Fig. 1. Four-lines self driving harvester with tracked chassis  
Rys. 1. Samojezdny 4-rzędowy kombajn do zbioru ziemniaków z gąsienicowym układem jezdny



*Photo by: Maroš Korenko*

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Fig. 2. Details of tracked chassis  
Rys. 2. Szczegóły gąsienicowego układu jezd-  
nego

Fig. 3. Wide rear tire management  
Rys. 3. Praca tylnej opony

Despite the tracked chassis and the wide rear tire, high specific pressure on the land and its compaction is also visible on dry land. It is due to both high weight of the machine, but also a large 8-tonne tray (Fig. 3 and 4).

Self-driving collector is equipped with rubberized sieving and staging conveyors with a wide sieving area, as well as a high-volume tray weighing 8 tons.



Photo by: Maroš Korenko

Fig. 4. Tire pressure on land (dry subsoil)  
Rys. 4. Nacisk opony na ziemię (suche podglebie)



Photo by: Maroš Korenko

Fig. 5 Harvester tray  
Rys. 5 Kosz przyjęciowy

Careful regulation of potato fall height into the tray and from the tray into a vehicle is very important. Large-scale tractor trailers from 10 to 22 tons are used for transportation from the harvester. The trailers are equipped with rubberized strips to reduce the damage, skewed walls and bottom discharge rubberized belt conveyors, which greatly reduce the damage to mainly immature potato tubers as compared with the conventional vehicles. Any transport damage is reduced by 50% in comparison to conventional transport trailers [Žitňák 2008; Kuboń 2005].



Photo by: Maroš Korenko

Fig. 6. Large Capacity 22 ton tractor trailer  
Rys. 6. Wysokowydajna 22-tonowa przyczepa



Photo by: Maroš Korenko

Fig. 7. Wide irrigation  
Rys. 7. Oprysk o szerokim zasięgu

In order to obtain a high quality of the product, possessing an efficient and wide sprinkler in highly specialised enterprises, which cultivate potatoes, becomes a necessity. It results from the need to systematically irrigate potato plantations. It has been especially visible in the recent years. Systematic irrigation results in the decrease of energy consumption, decreasing the number of lumps, which consequently leads to reduction of damage to potato tubers.

### **Summary**

Comparison of the quality of work of 4 of line self-driving harvester Dewulf with two-line collector of potatoes proved the following:

- 4 line harvester performance was 1.5 to 1.8 times higher than in case of a two-line collector,
- damage at harvest in flat harvesting conditions was 20-30% lower compared to the previous machine (evaluation according to the formula No. 1 and 2, samples were collected on the same ground where the harvesters worked simultaneously),
- special transportation equipment also took part in the significant reduction of damage, especially moving sides unloading conveyors which prevent abrasion of the surface of freshly harvested potato tubers.
- in case of a new machine, the failure rate was zero,
- a given machine requires a high cultivation area, or solution through the use of cooperation, or service,
- a high purchase price (€ 480.000) is a downside as well as a demand for high-performance transport and a post-harvest line which processes a harvested product.

### **Conclusion**

Based on a review of performance and quality of work of the 4 line self-driving harvester the following must be observed:

- minimum concentration of potato growing of 200 hectares,
- cultivation of early, mid-early and late cultivars allows the use of expensive, highly efficient equipment,
- equipment of the company with efficient transport machinery, a post-harvest line and storage facilities, including packaging and handling technology, in order to guarantee the continuity of the technical elements of machine lines,
- quality, enough technically prepared operation,
- to achieve the economically efficient seasonal performance use of the machine in the extended shifts, but also at the night operation.

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**Streszczenie.** Ziemniaki są uprawą, która odgrywa istotną rolę zapewniając pożywienie dla ludności. W Słowacji są prawie tak ważne jak chleb. Ważne jest aby przy uprawie jak również zbiorze ziemniaków osiągnąć jak najniższe straty i uszkodzenia. Można to osiągnąć za pomocą nowoczesnej wysokowydajnej techniki i technologii uprawy, która umożliwi terminowy zbiór bez ponoszenia wysokich strat. Zastosowanie odpowiedniej technologii zbioru, ma wyraźne odzwierciedlenie w jakości a także w cenie produktu.

**Słowa kluczowe:** ziemniak, technologia zbioru, zbiory, uszkodzenia, zagęszczenie gleby

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