EXPERIMENTAL RESEARCH ON MECHANIZED HARVESTING OF PEANUTS IN ROMANIA

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Abstract. In the current climate conditions in the south-western Romania it is possible to grow peanuts, especially on sand. To provide mechanized harvesting of peanuts a functional model of a machine was designed and developed that achieves direct harvesting of peanuts by: dislocation of the plants, pulling the plants from the soil, detachment of the pods out of plant, separation of impurities. The experimental researches were made in three stages of humidity in the harvest period, on experimental plots of 20 m in length and width corresponding to the distance between rows (0.5…0.7 m), in three repetitions for each working variant. The processing of samples was done on the same day in order to avoid changes of the results due to variations of the physical and mechanical properties of peanut plants and the humidity of pods. The qualitative working indexes were determined: plant pulling out degree, pods removing degree, purity of the material collected, total loss of pods (pods left in the soil, pods left on the plant). The measurements performed have shown the functionality of the experimentally model and the achieved work quality index is adequate with the imposed conditions from work speeds between 0.61…0.92 $m \cdot s^{-1}$ and linear speed of the pulling device of 1.56…2.00 $m \cdot s^{-1}$.

Keywords: peanuts, mechanized harvesting, harvesting machine, experimental research, qualitative indexes.

Introduction

In the current climate conditions in the south-western Romania it is possible to grow peanuts, especially on sand. Because of the conditions of Romanian agriculture, which is going through an intense reorganization process, mechanization ought to be the basis of economical efficiency and high yields. The need for the research which should lead to the realization of a functional model of a peanut harvesting device is related to several points of view:

- first, there are good conditions for raising peanuts in our country, due the possibilities of accumulation of active temperature over 3000 ºC, over the whole period of raising as well as due to other favorable conditions such as: sandy soil, or local climate;
- second, the technology of growing peanuts means a series of works such as preparing and maintenance of the crop, which can be done in good conditions using the machinery already in function in our country.

Materials and methods

The only work which can not be done in satisfying the conditions is harvesting, which is performed by hand, meaning a huge amount of work.

On the basis of the experimental research, a functional model of a harvesting machine has been developed, witch performs direct harvesting of peanuts, following the next stages (Fig. 1) [1; 2]:

- dislocation of the plants in conditions of low humidity;
- pulling the plants out of the soil;
- removing the pods,
- eliminating impurities.

The functional model is carried at the right side of 45 or 65 HP tractors. It is used for harvesting peanuts planted in rows at a range of 50 to 70 cm from one another [3].

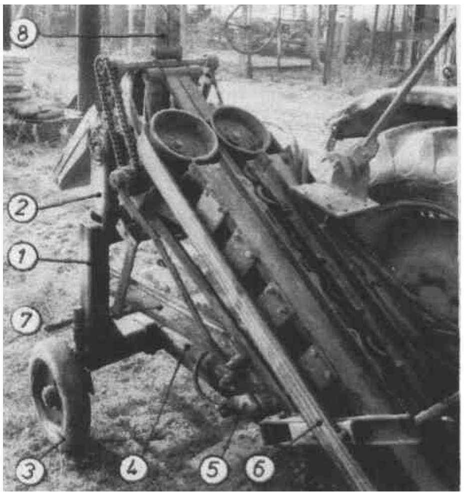

Fig. 1. **Functional model of machine for harvesting peanuts:**
1 – frame of the machine; 2 – support; 3 – copy wheel; 4 – fasten support; 5 – hydraulic cylinder; 6 – trapezoidal belts; 7 – cleaning system; 8 – rotary

Results and discussion

The experiments were performed at three different levels of humidity, during the harvesting period, in Tamburesti, Dolj County (Romania). Optimal adjustments have been used for all subsystems of the machine. The work quality indexes which were noticed were [1]:

- plant pulling out degree;
- pod removing degree;
- purity of the harvested crop;
- pod losses per total, out of which:
  - pods left into the soil;
  - pods left on the plants.

The gathering of these data was made on the experimental plots with a length of 20 m and width according to the distance between the rows (0.5 …0.7 m). There were three repetitions for each work variant.

The processing of the samples was performed on the same day, in order to avoid the modification of the results due to the variation of the physical and mechanical properties of the peanut plants and to the humidity of the pods [1].

1. The pod pulling out degree

It was set while using a flat type of furrow for dislocating the plants. The results are in Table 1.

Table 1

Pod pulling out degree

Soil humidity, %	Pulling out degree, %				Pod losses into the soil, %			
	R1	R2	R3	Average	R1	R2	R3	Average
2.1	99.07	98.09	99.36	98.84	1.30	1,10	1.60	1.33
3.6	99.13	99.17	99.06	99.12	0.75	0.67	0.82	0.75
4.8	100.00	100.00	99.24	99.74	0.15	0.27	0.36	0.26

The pulling out degree is 98 % if the roots are cut at a depth of 10 to 12 cm and if the direction of the rows is properly followed.

2. Pod removing degree

It was set using a removing device which has been provided with separating plates. The pod removing degree was determined for two different moving speeds of 0.62 and 0.92 $m \cdot s^{-1}$ and also for two different linear speeds of the trapezoidal driving belts: 1.56 and 2.50 $m \cdot s^{-1}$ [1].

At the same time with the observation of the removing degree the broken degree of detached pods and pod looses on the plants were also determined. The obtained results are presented in Table 2.

Table 2

Removing degree of pods, damage degree and pod losses on plants

Variant	Working speed, m·s^{-1}	Linear speed of driving belts, m·s^{-1}	Removing degree of pods, %			Damage degree, %			Pod losses on plants, % Mature pods			Pod losses on plants, % Young pods		
			1	2	3	1	2	3	1	2	3	1	2	3
V1	**0.61**	**1.56**	97.1	96.7	96.6	0.48	0.33	0.35	0.98	1.48	1.25	1.91	1.81	2.12
V2		**2.50**	93.7	94.0	92.6	1.15	1.22	1.60	2.27	2.52	2.96	3.97	3.48	4.44
V3	**0.92**	**1.56**	95.8	93.2	94.5	0.83	0.92	0.76	1.26	3.06	2.09	2.94	3.74	3.41
V4		**2.50**	90.3	91.3	91.7	3.65	4.10	4.20	3.88	3.91	3.07	5.82	4.79	5.23

The influence of the machine working speed and of the driving belts linear speed over the removing degree

The increase of the moving speed from 0.61 to 0.92 m·s^{-1} leads to a significant modification of the pod removing degree regardless of graduation of the linear speed of the driving belts, with the only difference that for a speed of 2.5 m·s^{-1} (of the driving belts), the removing degree is distinctly significant [1]. In Figure 2 the values of the removing degree of the pods according to the moving speed of the machine, for two different values of linear speed of the driving belts are plotted.

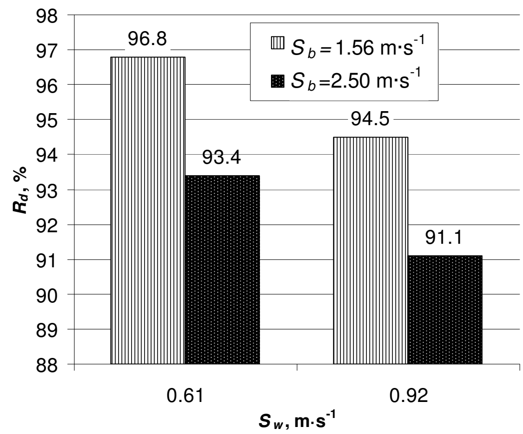

Fig. 2. **Influence of machine moving speed over pod removing degree**

The following issues are obvious:

- increase of the machine working speed from 0.61 to 0.92 m·s^{-1} leads to a significant decrease of the pod removing degree;
- increase of the linear speed of the multiple trapezoidal driving belts from 1.56 to 2.50 m·s^{-1} leads to a significant decrease of the pod removing degree.

The influence of the machine working speed and of the linear speed of the belts over the damaging degree of the pods

The increase of the machine working speed from 0.61 to 0.92 m·s^{-1} leads to a significant increase of the damaging degree of the pods, no matter to value of the linear speed of the driving belts.

Considering that the working speed is the same and the linear speed of the belts increases, there can be noticed a significant increase of the damaging degree (Fig. 3).

The influence of the machine working speed and of the linear speed of the belts over the pod losses

There were analised the losses of the mature pods, not taking into account the penut pods which had not reached the maturity.

The data obtained through the experiments reveal the fact that changing the working speed from 0.61 to 0.92 m·s^{-1} led to a significant increase of the pod losses on plants (for the linear speed of the belts of 2.50 m·s^{-1}). For 1.56 m·s^{-1} linear speed of the driving belts, the pod losses are distinctly significant, from 1.24 % to 3.62 %. This fact is shown in Figure 4.

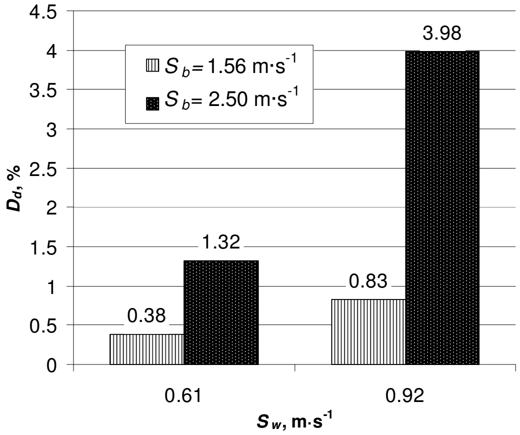

Fig. 3. **Influence of working speed and of linear speed of belts over damaging degree**

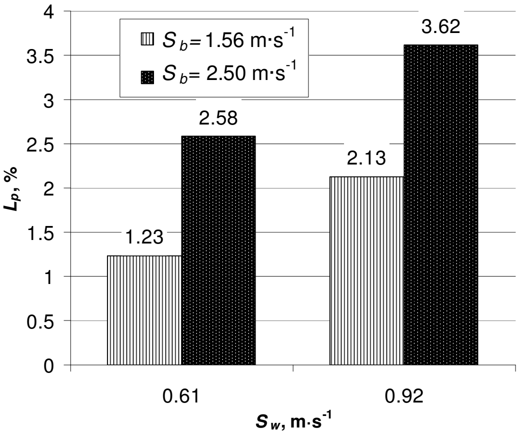

Fig. 4. **Influence of working speed and of linear speed of belts over pod losses**

The increase of the working speed and the linear speed of the belts leads to reduction of the working parameters of the detachment device.

3. Purity of the harvested crop

The purity of the harvested crop was determined by changing the values of the working speed (0.61 and 0.92 m·s^{-1}) and also the values of the linear speed of the belts (1.56 and 2.50 m·s^{-1}). The samples collected (sand, leaves, pods) were analyzed. The results concerning the components of the harvested material are shown in Table 3.

Table 3

Components of harvested material

Variant	Working speed, m·s^{-1}	Linear speed of driving belts, m·s^{-1}	Components of harvested material, %								
			Pods			Sand			Leaves		
			1	2	3	1	2	3	1	2	3
V1	0.61	1.56	95.30	94.30	96.50	2.12	3.30	1.97	2.58	2.40	1.53
V2		2.50	92.13	91.86	92.80	3.67	4.29	3.35	4.20	3.85	4.45
V3	0.92	1.56	91.40	91.75	91.20	4.56	5.10	4.87	4.05	4.15	4.93
V4		2.50	89.53	90.22	93.76	3.82	3.55	2.17	6.65	6.23	6.05

The influence of the machine working speed and of the linear speed of the belts over the contents of the harvested material

Analyzing the obtained results by data processing through Duncan Test, there were established the connections between the determined fractions. The number of pods in the harvested material suffers significant changes by increasing the linear speed of the belts, for a displacement velocity of the machine of 0.61 m·s^{-1}. When the working speed of the machine is 0.92 m·s^{-1}, it can be noticed that the graduation of the linear speed of the belts does not matter, the number of pods is not modified. This fact is shown in Figure 5.

The percentage of sand in the harvested material gets modified significantly when the linear speed of the belts increases. Also, the percentage of sand in the harvested material suffers distinct significantly changes, when the working speed of the machine increases. This fact is shown in Figure 6.

It is proved that when the working speed of the machine increases, the sand percentage in the harvested material also increases, while the linear speed of the belts is 1.56 m·s^{-1}. When the belt speed is 2.50 m·s^{-1}, and the working speed increases, the sand percentage decreases.

Analyzing the percentage of leaves in can be seen that this parameter has a significant increase when the linear speed of the belts is modified. The parameter changes significantly when the working speed increases in conditions of a linear speed of the belts of 2.50 m·s^{-1}.

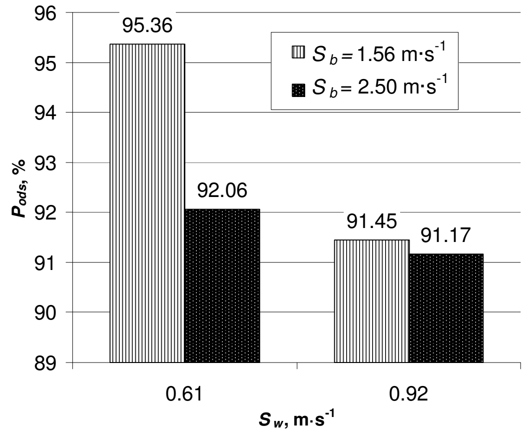

Fig. 5. **Influence of working speed over percentage of pods in harvested material**

As shown in Figure 7, the percentage of leaves in the harvested material is practically constant when the working speed increases from 0.61 to 0.92 m·s^{-1} and when the linear speed of the belts decreases from 2.50 to 1.56 m·s^{-1}.

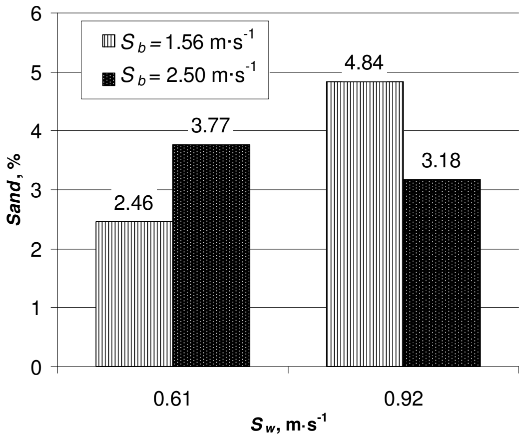

Fig. 6. **Influence of working speed over percentage of sand in harvested material**

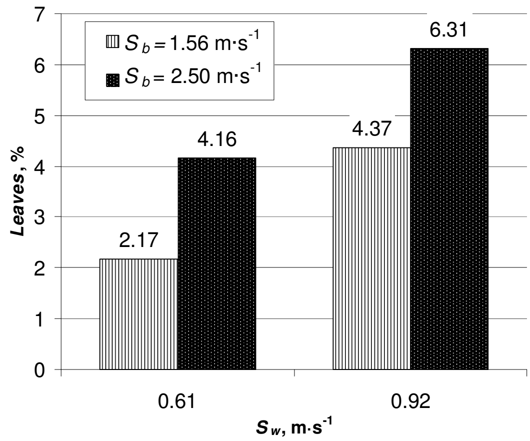

Fig. 7. **Influence of working speed over** percentage of leaves in harvested material

The data processing shows that the percentage of impurities in the harvested material increases in direct proportion to the two parameters (working speed and linear speed of the belts).

Conclusions

1. The experimental results concerning the pod removing degree have shown that the increase of the linear speed of the belts determined a significant decrease of the separation degree of pods.
2. Through the experiments performed on the functional model made, it results that the working speed of the machine should be from 0.61 to 0.92 m·s^{-1} and the linear speed of the pulling out device from 1.56 to 2.50 m·s^{-1}, in order to achieve adequate qualitative indices of work.
3. The obtained results in testing the functional model of the machine for harvesting peanuts, equipped with trapezoidal belts certify that the chosen constructive solution corresponds to the requirements imposed to mechanized harvesting of peanuts, under specific conditions of Romania.

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