

AN INVESTIGATION ON THE SUNFLOWER HARVESTING IN BULGARIA

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One of the main problems in sunflower production is its harvesting. Because of its insufficient solving, this technological process has become an object of a complex investigation by many authors both in its biological and agrotechnical aspect, and in respect of its mechanization.

In Bulgaria practically the sunflower harvest is made by the so called lifter devices (fig. 1). They consist of lifters-2, inclined shield-3 and a reel-4. The used devices differ in form, length of lifters and design of shields, but the technological scheme is the same. There are devices where the role of the inclined shield is fulfilled by other operating organs — rollers, situated under the lifters in the back end of the stem channels. All devices of this type gather the sunflower after a technology of cutting heads and only a small part of the stem. The other part of the stem is left.

One basic disadvantage of lifter devices are the great losses let during harvesting. This can be explained with the imperfection of the technological scheme before the mass enters for threshing.

As a result of the carried out investigatory and constructory work in 1972 at the Institutes in Roussé and General Toshevo a new device — PShS-6 was created and tested and in 1973 the Machine-building plant Toulbukhin started the zero series production.

The device consists of a worm bar — 1 (fig. 2), left and right separator — 2 with end lifters — 3, shield — 4, upper worm — 5 and a drive. The worm bar is the main knod of the device. It consists of a frame, cutting apparatus, working sections and a platform. Each section consists of a lifter, a cone worm and a back worm. The device is mounted on the header of the combine-harvester SK-4. The technological process runs after the following technological scheme (fig. 3): The combine-harvester is directed through the rows and the reaping machine is put in low position. When the combine-harvester moves, the plants are

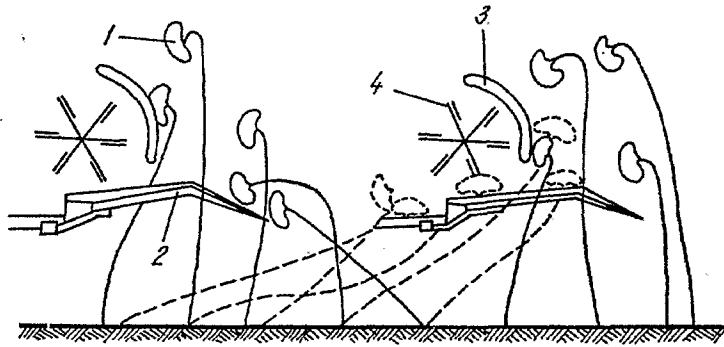


Fig. 1 — Sunflower harvesting by lifter devices.

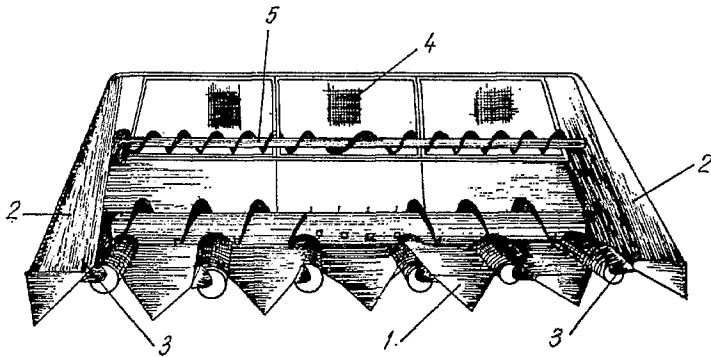


Fig. 2 — Sunflower device PSh-6

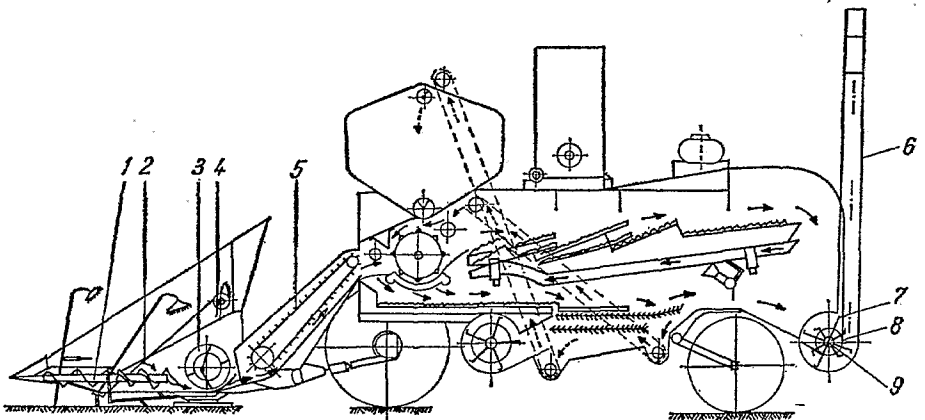


Fig. 3 — The technological scheme of the combine-harvester SK-4 equipped with the PSh-6 device.

caught by the rotating cone worms, which force them to move to the cutting apparatus and at the same time they incline them backwards and to the middle of the reaping machine. The frequency of rotation of the worms is chosen according to the translational speed of the combine-harvester. The cutting height of the plants is 15—20 cm from the ground and they fall freely onto the elongated platform of the reaping machine. From there the back worms direct them at the finger worm of the reaping machine. The high plants which touch the shield are brought down onto the platform. The whole mass of stems and heads is brought to the further organs of the combine-harvester. If the combine-harvester has a crusher, mounted on its back part, the threshed mass without the seeds may be cut and spread in the field or it may be gathered in big trailers and used as fourage after a definite manufacture.

The present investigation is made for finding out the losses rate as a main indicator in the two harvest technologies, realized by the lifter devices and the new one.

For finding out the losses let, practically experiments were carried out in different farms and in different parts of the country. The experiments were carried out in four repetitions and the experimental sown area was 126 m² each plot. The total seed losses for the harvester were defined by the losses of three 1 m sections along the operating width of combine-harvester. The cutting height of the plants is 15—20 cm from the whole experimental area. The yield is defined by adding the total losses to the gathered crop. The losses are found out in standard seed per unit area and in percentage towards a standard yield. There was no difference in the technical situation of the combine-harvesters. The translational speed of the aggregate was chosen in the range of the mean exploitation speed for the definite conditions. The characteristics of the experimental sown areas is given in table 1.

Table 1

Characteristics of the experimental areas in different farms

Indices	Calculated in	APK Pordim	APK Pavlikeny	APK P. Trambesh	APK Tazgrad	APK N. Pazar
Sunflower variety		P E R E D O V I K				
Crop thickness	pls/ha	37800	39400	41000	45100	40800
Plant height						
— mean	cm	153	143	155	157	152
— minimum	cm	135	115	125	125	110
— maximum	cm	177	163	180	190	185
Mean yield	kg/ha	1840	2030	2210	2410	2080
Relief	—	smooth	smooth	inclined	slightly inclined	smooth

In 1972, at the experimental base of the Development and Research Institute for Wheat and Sunflower in Gen. Toshevo were carried out also comparative experiments in laboratorial-and-field conditions for finding

out the losses let during harvesting by the lifter devices and by the worm device. The experimental areas have been cleaned in advance from the inclined plants and the sunflower heads, situated lower than 70 cm. The experiments were carried out in three speed regimes in eight repetitions — four per every of the two directions (along and against the incline of the sunflower heads). The characteristics of the area are shown in table 2.

Table 2

Characteristics of the experimental areas — IPS

Indices	Calculated in	Significance	
		1972	1973
Sunflower variety		Peredovik	
Crop thickness	p ls/ha	51 000	57 800
Plant height — mean	cm	139	197
minimum	cm	108	148
maximum	cm	185	241
Mean yield	kg/ha	2 583	3 131
Broken plants	%	—	8
Scattered seeds in advance	%	—	0.268
Relief		smooth	smothh

A comparative experiment of the improved lifter device PLS-4,2 and the new one PShS-6 in exploitational conditions was carried out in 1973 also at the experimental base in Gen. Toshevo after the given above method, but without removing the broken plants and the preliminary losses which has an effect on the final results. The characteristics of the experimental area are given in table 2.

The average yield was defined from 10 m² yield areas. From the table is evident that the experiments are carried out with intensive sowing with greater consistence (57 800 plants/ha), considerable height of the plants (about 197 cm) and great percentage of broken plants — 8 per cent.

The results of the experiments about the let losses in some of the farms from different parts of the country are given in table 3.

The data show that the losses vary from 7.14 to 15.36 per cent. They are the lowest in APK Razgrad, where a lifter device without a shield and with a little reel was used. For the concrete conditions of the experiment the given construction was suitable but when the seed humidity is low (at a greater stage of ripeness), the losses considerably increase as a result of the strokes of the wheel-paddles on the sunflower heads.

The used in APK Pavlikeny and APK Polsky Trambesh lifter devices without a shield but with rollers, let total losses of 9.53 to 12.47

Table 3

Results of the experiments carried out for indicating the losses in different farms of the country

Indices	Calculated in	APK Pordim	APK Pavlikeny	APK P. Trambesh	APK Razgrad	APK N. Pazar
Device used		Lifter-old type	Lifter-shieldless with rollers	Lifter-shieldless with rollers	Lifter-shieldless with a reel Ø 800 mm	ZhKN-2,6 M.
Operating speed	km/h	2.12	3.27	3.48	3.08	4.31
Total seed losses	%	8.20	9.53	12.47	7.14	15.36
incl. pure seed	%	0.64	1.81	1.09	1.18	2.01
seed of ungathered heads	%	7.56	7.72	11.36	5.96	13.35

per cent. With them the losses of pure seed and ungathered sunflower heads are considerable — respectively from 1.09 to 1.81 per cent and 7.72 to 11.36 per cent which can be explained by the influence of the tri-paddled bitter on the heads and the felling of the plants.

In APK Pordim, Plevan district using an old type of a lifter device (with a wooden shield and a little reel) let losses were of 8.20 per cent. Here the pure seed losses are comparatively low because of the low operating speed of the combine-harvester but the losses of ungathered heads are considerable — 7.56 per cent.

The greatest total losses are let by the ZKN-2,6M — 15.36 per cent. This is due to the influence of the reel on sunflower heads and the breaking of the plants whose heads fall out of the operating parameters of the reaping machine.

From the data is evident that with increasing of the operating speed of the lifter devices — from 2.12 to 3.48 km/h the losses increase. The speed limitations and the connected with them usage of the combine-harvester at a regime of optimal load is regulated by the increasing of the losses. In APK N. Pazar the operating speed of the aggregates is higher — 4.31 km/h but for harvesting is used the maize reaping machine ZKN-2,6M which gathers only 3—4 rows.

The results from the carried out comparative experiment about the losses let by the lifter devices old type, the improved lifter device PLS-4,2, product of the Tutrakan plant and the prototype of PShS-6 are shown in table 4. The greatest total losses are made by the lifter device old type — from 5.82 to 7.47 per cent and as a dominating part of them are those of the ungathered sunflower heads. The pure seed losses are not considerable — from 0.24 to 0.40 per cent. The improved lifter device lets the lowest losses — from 4.69 to 6.51 per cent because of the form of the lifters, the presence of the good form of the separators and the net shield. The prototype of PShS-6 has let total losses from 1.25 to 2.32 per cent which are considerably lower than the losses of the other devices. This is due to the principally new design and the

Table 4

Results of comparative experiments under laboratorial and field conditions

Indices	Calculated in	Devices								
		Lifter-old type			Improved lifter PLS-4,2			Prototype PShS-6		
Operating speed	km/h	2.61	3.37	4.55	2.63	3.38	5.00	2.69	3.15	4.92
Total losses of seed incl. pure seed	%	5.82	7.47	7.62	4.69	5.70	6.51	2.32	1.68	1.25
seed of ungathered heads	%	0.24	0.35	0.40	0.28	0.37	0.48	0.15	0.18	0.16
red heads	%	5.58	7.12	7.22	4.41	5.33	6.03	2.17	1.50	1.09

changed technological scheme. The low position of the operating organs and the compulsory drive with inclining of the plants to the cutting apparatus help for harvesting of the sunflower heads also from the low and the broken plants, for avoiding the mechanical effect on the sunflower heads and the blocking up of the operating channels which is one of the reasons for the high losses of all the other devices.

The results from the experiments of the two technologies show that the losses of PShS-6 are the lowest — from 0.8 to 2.8 per cent, and

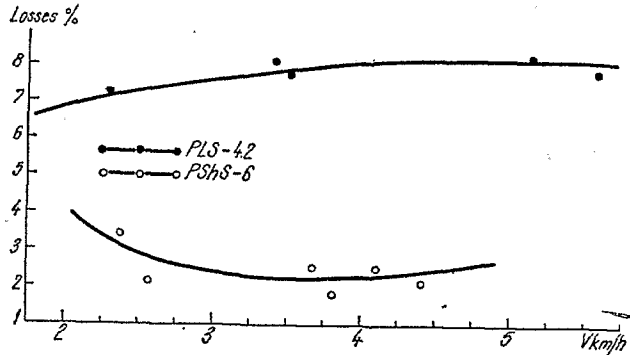


Fig. 4 — The pure seed losses of the aggregates PLS-4.2/SK-4 and PShS-6/SK-4.

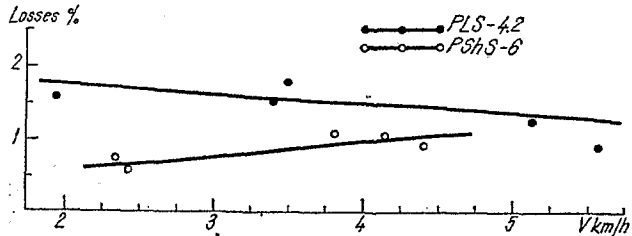


Fig. 5 — The total seed losses of the aggregates PLS-4.2/SK-4 and PShS-6/SK-4.

for the chosen rotating frequency of the worms the minimal losses are obtained at a speed of the combine-harvester 3.8—4 km/h.

The pure seed losses of the reaping and threshing machine of the combine-harvester for the aggregate PLS-4,2 — SK-4 vary from 0.9 to 1.75 per cent, and for PShS-6 — SK-4 from 0.7 to 1.1 per cent (fig. 4). With the increase of the translational speed of the combine-harvester the pure seed losses for aggregate with PShS-6 increase for the sake of the increasing losses from the cleaning device of the combine-harvester but they remain lower than those of the aggregate with PLS-4.2.

The total seed losses (fig. 5) are a sum of the losses from the un-gathered sunflower heads and the pure seed. For PLS-4,2 they are from 6.0 to 8.2 per cent, and for PShS-6 — from 1.8 to 3.5 per cent. From the chart is seen that the difference between the total losses, let by the two devices is from 2.5 to 5.5 per cent which proves the advantages of the new device.

As a result of the carried out experiments may be made the following

CONCLUSIONS

1. At laboratorial-and-field conditions the improved lifter device PLS-4,2 lets total losses from 4.60 to 6.50 per cent and at the same conditions the worm device PshS-6 — from 1.25 to 2.32 per cent. The old type lifter device lets the greater losses — from 5.82 to 7.47 per cent.

2. At the operating conditions the improved lifter device PLS-4,2 lets total losses from 6.0 to 8.2 per cent, and the worm device PShS-6 — from 1.8 to 3.5 per cent, or with 2.5 to 5.5 per cent less.

3. At the technology of PShS-6 the harvesting cycle is closed and the field is cleaned from the plants at one drive of the gathering aggregate, that is why this technology is the most suitable when applying the industrial methods in the group sunflower — wheat.