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RATIONALIZATION OF THE PROCESS OF SUNFLOWER HARVESTING

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Summary

A method of time and motion study was used to investigate possibilities of increasing the economy of labor and machinery inputs in the process of sunflower harvesting. The obtained results indicated that the process may be considerably rationalized, with respect to both, efficient use of labor and machinery and efficiency in carrying out the agrotechnical practices involved.

The investigation showed that the productivity of work and other factors within the process of sunflower harvesting at agricultural estates in the social sector are not at the desired level although trained manpower and harvesting equipment are available. It was also established that the productivity of work is considerably affected by the yields achieved, duration of the process of harvesting, and the use of machinery. Taking into account the present restirictive financial situation which precludes the application of other forms of rationalization, we found that the productivity of work in the process of sunflower harvesting, as the most important part in the process of sunflower production, may be increased by about 55% by the measures of organizational rationalization alone.

METHOD AND DATA SOURCES

A detailed investigation of the process of sunflower harvesting and the designing of standard models of time and efficiency inputs were carried out by a method of time and motion study. The labor input was measured on the hourly basis, the time necessary for the turning and unloading of the harvester tank was measured by a chronometer. The output of harvester per shift was calculated by the formula:

$$\text{Output in ha} = \frac{T - (tac + tar + tp + ti)}{te_1 + tav_1}$$

where T is the period of the shift, tac = the time of servicing, tar = the time of a break, tp = preparation/closing time, ti = the time of travel from machine park to the plot and back, te_1 = the basic time per ha, tav_1 = the time of harvester turning per ha. The investigation was conducted at two agricultural estates in the social sector located in the region of Srem, Vojvodina Province. The inputs of labor time and machinery time were taken from accounting books and operational evidence of the estates

with objective of assessing possibilities of rationalizing the process of sunflower harvesting.

RESULTS

The decision to carry out this investigation was brought on account of a large effect of the process on yield level, quality of the product, costs of the operation, and its specific features in respect to the other processes. According to Gumenyuk (USSR), who assessed the results of an experimental station in Kirovgrad, yield losses at sunflower harvest conducted at the optimum time are 1.4%, with a 5-day delay 4.2%, with a 15-day delay 6.1%, and with a 25-day delay 12.3%.

The harvester examined in this investigation was the self-propelled universal combine harvester "Zmaj-141" adapted for sunflower harvesting, whose daily output, according to the efficiency regulations of the examined agricultural estates, is 10 t. This efficiency norm does not secure a rational performance of the process of sunflower harvesting and increases in the productivity of work because it does not include the most important factors which affect the working time (length of plot, distance between machine park and plot, crop condition, degree of weed infestation, yield level, etc.).

The constructional width of the harvester is 4.45 m, while the actual operational width was 4.2 m (6 rows 0.7 meters apart). The investigated plots were flat, with a low degree of weed infestation. Sunflower plants stood erect in 80% of the investigated plots. The plots, shaped to fit the ratio 1 : 8-10 for the front and the sides, respectively, were harvested starting from the peripheral rows and proceeding towards the middle ones. The average speed of the harvester was 4.37 km/hr, the actual speeds varying from 4.17 to 4.59 kg/hr. The harvesters were operated by highly qualified or qualified drivers between the age of 38 and 52.

According to an investigation conducted by J. Mićić and L. Tadić, the losses on the drum in the course of sunflower harvest depend to a large measure on the speed of the harvester. In the case of the harvester "Zmaj-141", the losses on the drum at the speeds of 2.59, 5.46, and 6 km/ha were 1.55, 3.66, and 4.42%, respectively. The above authors concluded that the optimum speed of "Zmaj-141" for sunflower harvesting is 5 km/hr.

Table 1 shows the possibilities of increasing the productivity of work at the examined plots by projecting time and output norms according to the improved organization of work. The projecting was based on the premise that there will be no changes in the type of harvester used, plots, and working hours.

The outputs in the analysed plots were 1.36 hours of labor time and 1.36 hours of harvester time per ha. According to the projection based on the improved organization of work, the respective figures should be 0.70 and 0.70.

Tab. 1 – A projection of time and output norms for sunflower harvesting with the harvester "Zmaj-141"*

Plot	Plot length, m	Shift, min	Projected			Output in ha	
			Basic time min/ha te1	Turning time min/ha tav1	Actual	Projected	Actual= index 100
1	760	495.06	28.57	1.56	5.84	12.44	213
2	760	396.80	28.57	1.56	3.19	9.18	287
3	760	362.40	28.57	1.56	4.33	8.04	185
4	960	448.00	28.57	1.24	5.94	11.00	187
5	960	453.20	28.57	1.24	5.64	11.18	198
6	930	455.50	28.57	1.28	7.04	11.24	160
Average		435.2	–	–	5.33	10.51	–
Index		–	–	–	100	197	–

* Preparatory times used: Tac = 40 min, tar = 30 min, ti = 40 min, tp = 10 min. The time of one turn = 0.50 min.

The projected output exceeds the average actual output by 97% due to the following.

a) In the course of the actual process, 85.7 minutes or 19.69% of the working time was lost on stalls (Table 2). The largest loss of 54.05 minutes or 12.41% occurred due to mechanical breakdows. An inadequate organization of work, i.e., the unloading at the turns, transportation units serving more than one plot instead of simultaneous harvesting and unloading, took 31.65 minutes or 7.28% of the working time.

Tab. 2 – Structure of labor input for sunflower harvesting with the harvester "Zmaj-141" (average for 6 plots)

Operation	Duration of operation	
	Minutes	In % from total time of a shift
1. Basic time (te)	244.57	56.20
2. Preparatory time (ts)	63.33	14.56
– turning (tav)	10.86	2.49
– break (tar)	17.16	3.94
– service (tac)	35.31	8.11
3. Time of travel to the plot and back (ti)	41.60	9.55
4. Losses – stalls (tm)	85.70	19.69
– mechanical breakdowns (tmf)	54.05	12.41
– inadequate organization of work (tmd)	31.65	7.28
Total	435.20	100

b) The basic working time per shift was 56.20% on the average, ranging from 40.15 to 78.97% of the working day.

c) The projection implied a simultaneous harvesting and unloading of the harvester and the speed of 5 km/hr which accelerate the process of sunflower hraveting by about 14%.

Tab. 3 - Standard projection of time and output norms for sunflower harvesting with the harvester "Zmaj-141"*

Plot length in m.	Basic time te_i in min/ha at the speed of km/ha			Turning time tav_i min/h	Projected norms					
					Output in ha			Time in hr/ha		
					At the speed in km/ha					
	4	5	6		4	5	6	4	5	6
400	-	-	-	2.97	7.75	9.51	11.20	0.90	0.74	0.62
600	35.71	28.57	23.81	1.98	7.96	9.82	11.63	0.88	0.71	0.60
800	-	-	-	1.49	8.06	9.98	11.86	0.87	0.70	0.59
1,000	-	-	-	1.19	8.13	10.08	12.00	0.86	0.69	0.58

* The projected figures: the working time of 7 hrs, preparatory times of 40 min for tac, 30 min for tar, 40 min for ti, 10 min for tp, 0.50 min for one turn of the harvester.

CONCLUSION

With the objective of assessing the effects of principal factors which affect the process of sunflower harvesting, standard models of time and efficiency inputs were designed on the basis of the results obtained in this investigation (Table 3).

The projecting was done on the basis of the same principles used in the investigation of the work processes involved, with emphasis placed on a better utilization of harvesters and basic working time within a shift. The other elements were projected on the basis of the data established in the course of the execution of the process itself.

The following conclusions were drawn.

1. The increase in the speed of the harvester ("Zmaj-141", unloaded simultanously with harvesting) by 1 km/ha, i.e., the use of the optimum actual speeds (4-6 km/ha), increases the output by about 21%. This is a clear indication that the working speed is a powerful tool for increasing the productivity of work and reducing the costs of production.

2. Using the harvester "Zmaj-141" unloaded simultaneously with harvesting, the speeds of 4, 5, and 6 km/hr increase the output by 5, 6, and 7%, respectively, in a plot 1,000 meters long as compared with a plot 400 meters long.

3. When using the self-propelled universal harvester "Zmaj-141", maximum effects are achieved if all important factors, i.e., the speed, plot length, and simultaneous harvesting and unloading, are fully exploited. For example, the harvester working at the speed of 6 km/he in a 1,000-meter plot increases the output by about 55% in relation to the harvester working at the speed of 4 km/hr in a 400-meter plot.

LITERATURE

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