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WHEAT HARVESTING TECHNOLOGY

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Abstract: *The purpose of this paper is to show the mechanization technology for wheat harvesting with self-propelled grain harvester. The objectives are well organising the harvesting of grain cereals using the full working time, avoiding unnecessary stalling and empty driving, using the machines at their maximum working rate and fitting into the specific fuel consumption, which requires working properly on plots by choosing the most appropriate method. The recommendation is that for optimal working time use, it will be considered to correlate the number of combines according to the area of the plot to be harvested taking into account the productivity of the combines and the production per hectare. This is of particular importance in shortening the harvesting period because it avoids the movement of combines from one plot to another during the day when conditions permit harvesting The technological process of harvesting cereal grains is generally conditioned by a series of agrobiological factors characteristic of cereal crops such as crop variety, grain and stem maturity, grain-to-stem ratio, grain and stem humidity, stem fall rate, weeding rate, etc . All these factors have made it necessary in time to find suitable constructive solutions so that the mechanized harvesting of the basic product (grains) and of secondary products (straw and chaff) are done in the best conditions, observing the modern agrotechnical requirements, thus avoiding grain loss and damage, while ensuring a high degree of purity of the harvested product . The harvesting of the cereal grains can be done in one phase (full harvesting) or divided into several phases (two or three phases). At present, harvesting of grain cereals is, in most cases, done in a single phase using the combine. But there are situations, especially in damp crops, when they cannot be harvested with a single pass in the optimal period. In these cases, two-phase split harvesting is used, which allows the harvest to be prolonged by 5-8 days, but this harvesting technology requires additional work and equipment. It is recommended that, while operating, the engine should work at maximum speed to work properly the organs of the combine.*

Keywords: *mechanization technology, wheat harvest, self-propelled combine*

INTRODUCTION

From an agri-technical point of view, a crop is fully mechanized and wheat enters almost all agricultural rotation systems, being considered a very good pre-plant, because it has a relatively short period of vegetation, favouring the optimal realization of the works for the preparation of the germinative bed of the following crop (DĂNILĂ I, 1995), The technological process of harvesting cereal grains is generally conditioned by a series of agrobiological factors characteristic of cereal crops such as crop variety, grain and stem maturity, grain-to-stem ratio, grain and stem humidity, fall of stems, degree of weeding, etc. (ILEA R , 2013). All these factors have made it necessary in time to find suitable constructive solutions so that the mechanized harvesting of the basic product (grains) and of the secondary products (straw and chaff) are done in the best conditions, observing modern agrotechnical requirements, thus avoiding grain loss and damage, while ensuring a high degree of purity of the harvested product (ILEA R, 2013).

MATERIAL AND METHOD

Self-propelled combines were designed for direct harvesting of straw cereals, with good results in harvesting grain crops normally developed under favourable weather conditions and low humidity. A harrow cereal harvester has the basic components shown in Figure 1 below.

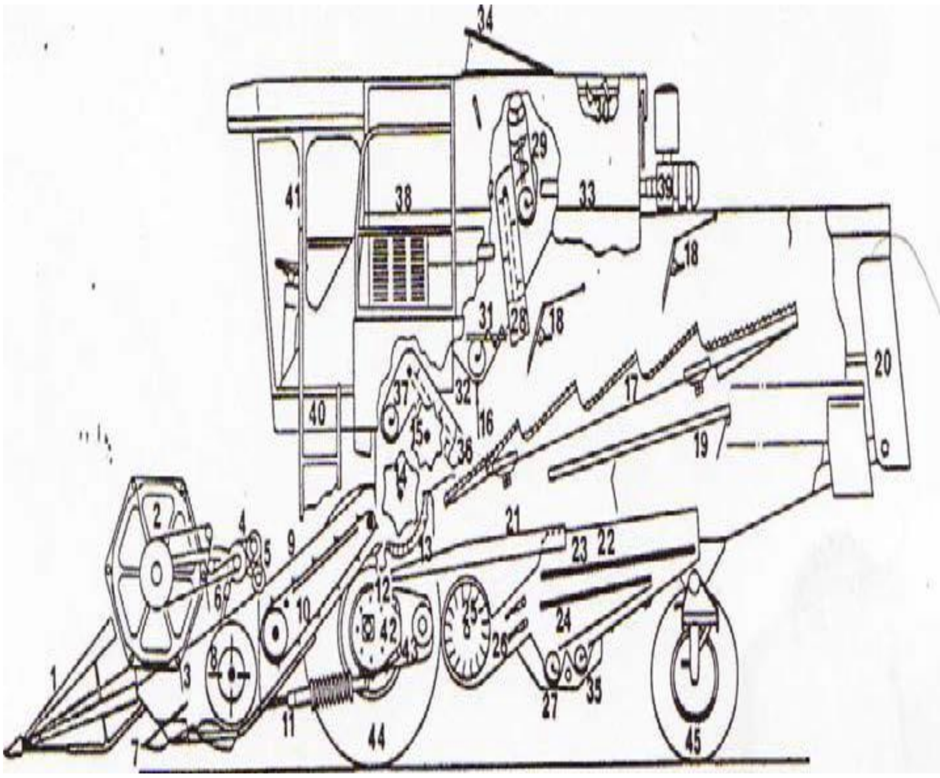

Figure 1. A self-propelled straw cereal harvester

1-chain separator; 2-reel; 3-crown rake; 4-engaging intermediate rake; 5-variable swing training; 6-cylinder reel; 7-plant hoists; 8-screw conveyor; 9-step access combines; 10-plant carrier; 11-cylinder header; The 12-sting gutter; 13-concave; The cam 14; 15 post-beater; 16 apparatus; 17-horse shakers; 18-intensive shakers; 19-plan return under shakes; 20-straw hood; 21-oscillating plan; 22-site sites; 23-superior sites; 24-bottom sites; Fan 25; 26 adjustable flaps; 27-grain snail; 28-grain elevator; 29-grain filling grain; 30-snail grain uniformization; 31-hopper emptying hopper; 32-hopper; 33 engine; 34-bunker lid; 35-protection guard; 36-spike return elevator; 37-spice return snail; 38-hinged access to the engine; 39-air filter; 40-cabin; 41-seat cockpit; 42-gearbox; 43-final transmission; 44-engine propulsion; 45-th bridge rear.

The scientific organization of the harvesting of grain cereals can result in a shortening of the harvest period and an increase in labour productivity. In order to achieve these objectives, as

well as for the rational exploitation of the combines, it is necessary to take a series of organizational measures, out of which one can highlight the following:
- preparing the harvesting line,
- choosing the methods of moving the combine harvesters,
- ensuring the transport of the main production.

The preparation of the field for harvesting begins with the identifying the maturity state, the marking of dangerous places for the combines, the establishment of access roads for the means of transport and the fire points. Self-propelled combines enter the plot without prior road opening. However, it is advisable to initially harvest two to three furrows at the end of the plot from the access road to allow the entrance of the means of transportation and other means of harvesting. The width of the plots should be 0.15-0.25 L (L = plot length) so as to allow the combine to work for at least one day on the same plot. In small lengths, the width may be larger by reaching the same size as the loading length. In the case of lying crops, account shall be taken of the direction of bedding of the plants in order to ensure the harvesting in both directions with minimum losses without emptying. In the case of uneven mature parcels, it is possible to delimit the areas of plants that cannot be harvested yet, entering the plot with the combine and harvesting only areas with mature plants. The pattern of moving of the combine, which ensures a high coefficient of races, is the method circular with starting work on the outside of the right turn and execution of the plot.In order to avoid the planting of the plants on the return surface of the combines, they are executed at the beginning of the work, on each land crossing on the diagonal of the parcels. The width of the diagonal roads between 10-12 m ensures that the turns are made by eliminating the losses caused by the lying of the plants. Roads open on the diagonal of the crane serve also for the circulation of the transport aggregates serving the combines in the work. The right-hand drive method allows the hopper discharge tube to reach the harvested ground. The best way to return to the corner of the plots is to return with the backward movement of the unit. At the end of the furrow, the combines move about 1.5 m in idle by turning the steering wheel to the right while raising the cutting platform, and turning the steering wheel to the left when it stops. Then engage reverse gear and brake the left wheel until the chain is over by the cutting machine about a meter, then stop the combine and start working in the furrow, slightly braking the right wheel if necessary and lowering to the cutting height. The controls provided on the driving platform enable the combine to cope in any situation with preferably minimal harvest losses. Trailers that carry the crop must be sealed and disinfected against wheat weevils. In general, there is still a lot of beans from the former campaign, missed by the joining of the shutters, attracting this pest during the storage period.

RESULTS AND DISCUSSIONS

Before working, check and prepare workbenches.

Check engine, transmission and combine adjustment.

The main settings of the combine are:
- adjusting the cutter;
- adjusting the speed of the bucket;
- adjusting the speed of the beater;
- adjusting the distance between the beater and the contractor;
- adjusting the opening of blinds;
- adjusting fan airflow.

During work, the technical condition of the combines is checked periodically and the trellis system settings are re-adjusted according to plant humidity. The hourly working capacity of the combine is determined with the relation:

$$W_h^r = \frac{3600 \cdot q \cdot K_s}{m_b \cdot \left(1+\delta_p\right)} \; [ha/h]$$

where:

q - feed rate of the trench material; taking into account that the theoretical flow is *q=10 kg/s*, for normal working conditions and the reduction of losses, the real flow rate *q=8 kg/s*;

K_s - working time utilization factor;

m_b - grain mass per hectare kg/ha;

δ_p - ratio of straw mass to grain mass.

By replacing the data in the previous relationship, we obtain:

$$W_h^r = \frac{3600 \cdot q \cdot K_s}{m_b \cdot \left(1+\delta_p\right)} = \frac{3600 \cdot 8 \cdot 0{,}75}{6000 \cdot \left(1+0{,}44\right)} = 2{,}5 \; ha/h$$

The working capacity of the combine at a production of 6000 kg/ha is 15 t/h, with a daily working capacity of 120 t/day or 20 ha/day. The harvesting of 100 ha is done in 5 days.The working speed correlates with feed rate and working width so as to ensure harvesting without loss and effective combustion capacity. The actual width is 6 meters (less than the width of the header). Taking into account the ratio of straw mass to grain mass, a material quantity of 0.9 kg/m2 results. At the actual flow rate of 8 kg per second, the combine speed must be 1.5 m/s and 5.4 km/h respectively. Therefore, the combination will work at a speed of 5-6 km/h to keep the flow rate of constant material. Fuel consumption per hectare is determined by:

$$C_{ha} = \frac{\lambda_c \cdot C_{hn}}{W_h^r} = \frac{0{,}83 \cdot 54}{2{,}5} = 18 \; l/ha$$

where:

C_{ha} - hourly fuel consumption of the engine at rated speed (54 l/h);

λ_c - correction coefficient that takes into account engine load (0.83).

Fuel consumption per tonne of harvested wheat is 3 l/t.

Calculation of economic indices

Production costs consist of indirect costs and direct expenses.

Indirect costs are those that are incurred to carry out more mechanized works or in the general interest of the enterprise. Indirect costs are recorded separately and then, according to certain criteria, the share is allocated for each mechanically executed work.*Direct expenses* are those that are determined directly and are included in the cost of each work done mechanized. In assessing the economic efficiency of an agricultural aggregate, only the direct expenditure indicator is used, as it expresses the reduction of labour and material expenses by using the respective agricultural aggregate. Direct expenses are expressed in RON/ha.

Direct costs are calculated using: $C_d = C_S + C_c + C_A + C_{dt}$

where:

C_s - expenses for remuneration;

C_c - fuel costs;

C_A - depreciation costs;

C_{dt} - expenditure on technical servicing of the aggregate.

Remuneration costs are expressed in terms of hourly salary S_h and hourly productivity. The salary of a combiner is about 4,000 RON/month, for a number of 22 working days/month, respectively 176 hours/month, which corresponds to an hourly tariff fee of 22 RON/h. Spending for one hectare will be: $C_S = \dfrac{22\ lei/h}{2{,}5\ ha/h} = 9$ RON/ha and 1.5 RON/t respectively.

Fuel costs C_c are based on fuel consumption G_{ha} (l/unit of work) and fuel cost p_l (RON/l), i.e. $C_c = G_{ha} \cdot p_i = 18 \cdot 5 = 90$ RON/ha and 15 RON/t. Expenditures for depreciation of the combine C_A are calculated taking into account the initial value of the combine V_i (546,000 RON), the residual value of the combine V_r (6,000 RON), the working capacity per shift W_{sch}^{r} (20 ha), the number of shifts n_s, the number of days worked in a year n_z, and service duration D (10 years), i.e.: $C_A = \dfrac{V_i - V_r}{W_{sch}^{r} \cdot n_s \cdot n_z \cdot D} = \dfrac{546000 - 6000}{20 \cdot 1 \cdot 90 \cdot 10} = 30$ RON/ha and 5 RON/t respectively.

Expenditures for technical servicing of the aggregate are: technical maintenance expenses, technical revision expenses and repair costs. These costs are determined throughout the service life of tractors and aggregate machinery.

For tractor, technical service costs are calculated with: $C_{dt} = \dfrac{V_i \cdot G_{ha}}{C_n} = \dfrac{546000 \cdot 18}{650000} = 15$ RON/ha, respectively 2.5 RON/t.

where G_n - standard fuel consumption during service (650,000 l).

Direct costs per hectare harvested are: $C_d = C_S + C_c + C_A + C_{dt} = 9 + 90 + 30 + 15 = 144$ RON/ha. $C_d = C_S + C_c + C_A + C_{dt} = 1{,}5 + 15 + 5 + 2{,}5 = 24$ RON/t.

Auxiliary costs are expenditures for main and auxiliary materials, costs for storing and preserving agricultural machinery. They are calculated per cent (15-20%) of direct expenses.

$C_{ac} = 0{,}17 \cdot 144 = 24$ RON/ha, respectively 4 RON/t.The total costs for harvesting one hectare of wheat are: $C_T = C_d + C_{ac} = 144 + 24 = 168$ RON/ha, respectively 28 RON/t.

CONCLUSIONS

The well-organized harvesting of grain cereals, through full use of working time, avoiding unnecessary stalling and empty journeys, using machines at their maximum work rate and fitting into specific fuel consumption requires that they work correctly on plots, choosing the most appropriate method.The empty movements of the machines result mostly from their returns to the ends of the parcels. The hopper of the combines will be unloaded, otherwise the daily productivity decreases due to stopping the harvest during the discharge.In order to ensure continuous operation, technical assistance will be provided through a mobile maintenance and repair workshop equipped with the necessary equipment. It is of great importance to carry out daily maintenance to avoid faults and thus to stop the combines. Any malfunctions during work will be remedied as soon as possible.It is recommended that during operation, the engine should operate at maximum speed to work properly on the organs of the catwalk. For the optimal use of working time, it will be considered to correlate the number of combines according to the surface of the plot to be harvested, taking into account the productivity of the combines and the production per hectare. This is of particular importance if we need to shorten the harvesting period because it avoids the movement of combines from one plot to another during the day when conditions permit harvesting.Exceptionally, if there are not enough combines to harvest the crop, the harvesting period can be increased by 1-3 days from the full maturity phase and after the end of this phase by properly adjusting the machines; because the grains are harder to bake in the maturity stage, increase the losses in untreated spikes and in the breeding phase the straw is broken down much by making the shaking, shaking and separating process difficult.To increase the use of combines it is recommended to cultivate plant varieties with split maturity phases and to reduce losses, it is recommended to use plant varieties resistant to dropping and shaking.During work, the travel speed will be correlated to the condition of the chain in such a way that the combine thresher is fed with an optimum flow of material and constantly providing maximum productivity with minimal losses.In order to ensure maximum working capacity and minimum fuel consumption, the combines will be adequately assured with sufficient means of transportation of the harvested products. The number of means of transport will be correlated to the hourly productivity of the combines and the transport distance of the products.

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