MECHANISATION TECHNOLOGY FOR THE HARVESTING OF GRAIN MAIZE WITH A SELF-PROPELLED COMBINE

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Abstract . *Self-propelled combines for the harvesting of grain maize are made up of two main sub-ensembles: maize cob cropper and maize stem thrasher. The maize cob cropper detaches the maize cobs from the stems, carries the leafless maize cobs to the thrasher and chops the stems. Chopped stems can be recovered in a mean of transportation (tow) or they can be spread over the soil to be later incorporated into the soil. The thrasher thrashes the maize cobs, separates the grains from impurities, and carries the grains to the bunker. Scientific organisation of harvesting grain maize can result in shortening the harvesting period and in increasing labour productivity. To reach all these objectives and to rationally exploit the combines, we need to take such organisational measures as preparing the crop for harvesting, choosing the way combines move in the field, ensuring transportation means, etc. Preparing the field for harvesting starts with identifying ripening state, continues with marking the places with risk for the combines and establishing the access routes for the transportation means, and it ends with identifying fire guard spots. Self-propelled combines enter the plot without opening roads previously because the working width is larger than the thrasher width (it is a T working flow).First, we harvest the ends of the plot (that were sowed transversally), to ensure turning areas for the combines and to allow the access of the means of transportation and of other means necessary for harvesting. Harvesting maize grains with self-propelled combines is done with low losses (grain moisture below 20%). Analysing exploitation and economic indices, we can draw the following conclusions: the self-propelled combine CASE-IH 7088 + CS-8 harvests maize from eight rows over a width of 5.6 m. The combine is equipped with a Diesel engine of 325 HP and it has an hourly productivity of 24 t/h with a feeding flow of the thrashing device of 18 kg/s. For a production of 6 t/ha, fuel consumption reaches 11.2 l/ha (1.0 l/t) and total expenses upon harvesting grain maize reach 79.5 RON/ha, i.e. 13.3 RON/t. To obtain high yields per area unit with low expenses, we need to strictly observe cultivation technologies and use as complex as possible aggregates with the highest efficiency possible.*

Key words: *combine, CASE-IH 7088 + CS-8, exploitation*

INTRODUCTION

Self-propelled combines for the harvesting of grain maize are made up of two main sub-ensembles: maize cob cropper and maize stem thrasher.

The maize cob cropper detaches the maize cobs from the stems, carries the leafless maize cobs to the thrasher and chops the stems.

Chopped stems can be recovered in a mean of transportation (tow) or they can be spread over the soil to be later incorporated into the soil.

The thrasher thrashes the maize cobs, separates the grains from impurities, and carries the grains to the bunker.

Self-propelled combines enter the plot without opening roads previously because the working width is larger than the thrasher width (it is a T working flow).

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MATERIAL AND METOHD

TECHNICAL AND OEPRATING FEATURES OF THE CASE IH 7088 + CS-8 COMBINE

The self-propelled CASE-IH 7088 combine (Figure 1) is equipped with a CS-8 maize cob chopper for eight rows.

Fig. 1. CASE-IH 7088 + CS-8 combine

The combine thrasher is a single-rotor axial apparatus (AXIAL-FLOW) that operates both thrashing and separating (Figure 2).

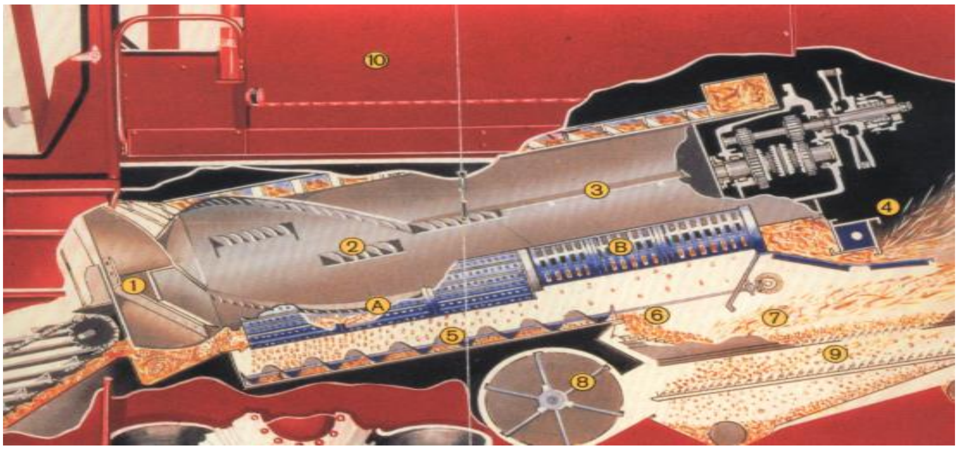

Fig. 2. AXIAL-FLOW system of the CASE IHcombine: 1-feeding blades; 2-rotor bars; 3-axial rotor; 4-straw removal post-batter; 5-helix transporters; 6-feeding transporters; 7-upper sieve;8-centrifuge ventilator; 9-lower sieve; 10-bunker;A-thrashing grids; B-separation grids.

The close axial rotor has a diameter of 61 cm and a length of 2.82 m. Rotor speed can be adjusted within 280-1,260 speeds/min.

The grids of the counter-batter can be easily changed from one crop to another. The helix blades of the rotor ensure even feeding and guides the material to be separated according to a helix trajectory to the separation counter-batters. Due to this, the axial flow system is easily adapted to any type of crop.

The self-propelled CASE-IH 7088 combine is equipped with a Diesel engine with a nominal power of 325 HP. It has the following operation indices:

- Nominal power $P_n =$ 242 kW = 325 HP;
- Nominal engine speed n_m = 2000 rot/min(ω_m = 210 rad/s);
- Nominal engine moment M_e = 96 daNm;
- Hourly fuel consumption G_h = 46 kg/h = 54 l/h;
- Specific fuel consumption g_s = 215 g/HPh.

The CASE-IH 7088 combine has the following features:

- Working width B_l = 8×0.7 = 5.6m;
- Thrasher feeding flow q = 18 kg/s.

The combine real operation capacity is:

The working capacity per shift is:

RESULTS AND DISCUSSIONS

CALCULUS AND MAKING UP OF THE GRAIN MAIZE HARVESTING AGGREGATE

Calculus of operation indices

Harvesting area is 100 ha;

Plot number is n_p = 4;

CASE-IH 7088 combine number is= 4.

Plot width l is: $l = 250\ m$.

Width of the turn area $E = 33{,}6\ m$ (48 rows).

Length of the working movement: $L_l = L - 2 \cdot E = 930\ m$.

Mean length of empty movement L_g is calculated with the relation:

Working speed is calculated with the relation:

If working speed equals moving speed, the duration of a cycle is:

Theoretical worked area after a cycle is calculated with the relation:

Theoretical hourly working capacity is:

Fuel consumption per ha C_{ha} is calculated with the relation:

Operation indices of the self-propelled CASE-IH 7088 + CS-8 combine are mentioned in the operation chart (table 1).

Table 1

Operation indices of the self-propelled CASE-IH 7088 + CS-8 combine

Basic indices	Features of the technological process
Land features	Harvesting areaS=100 ha; Plot lengthL=930 m; Flat land relief.
Cultivation requirements	Harvesting at the proper time; Grain loss below 3%; Cob loss below 2%; Grain purity minimum 98%.
Aggregate features and preparation for work	Working widthB_l = 5.6 m; Turn radiusR = 10 m; Combine is checked and adjusted for harvesting.
Land preparation	Width of turn area33.6 m; Number of plots4; Width of plot250 m; Plot ends are harvested; Harvesting area is plotted depending on the daily norm.
Work organisation parameters	Cycle durationT_c=795 sec ; Area worked per cycleW_c=1.04 ha/cycle; Hourly working capacityW_h=24 t/h; Shift working capacity W_{sch}=192 t/shift; Fuel consumptionC_c=1.9 l/t; Moving way: linear routes, double turns without loops – through superposition.
Work quality control	Grain loss check; Unharvested cob check.

Calculus of economic indices

Hours/combine: $C_a = \frac{T_s}{W_{sch}^r} = \frac{8}{32} = 0{,}25$ combine-hours/ha.

Coefficient C_m is: $C_m = C_a \cdot m = 0{,}25$ person-hour/ha.

Production expenses

Direct expenses C_d is calculated with the relation:

Wage expenses:

Fuel expenses C_c are:

Aggregate payment expenses C_A are:

Aggregate technical assistance expenses C_{dt} are:

Direct expenses per ploughed ha:

Expenses per grain ton: $C_d = 66 : 6 = 11$ RON/t.

Auxiliary expenses

Total cost of a ploughed ha:

Calculated technological indices are mentioned in the technological chart of the grain maize harvesting (table 2).

Table 2

Technological chart of the grain maize harvesting (CASE-IH 7088 + CS-8 combine)

Economic indices		RON/ha	RON/t
Direct expenses	C_d	66.2	11.1
Of which: - wages	C_S	2.9	0.5
- fuel	C_c	45.6	7.6
- payment	C_A	6.3	1.1
- technical assistance	C_{dt}	11.4	1.9
Auxiliary expenses	C_{ac}	**13.3**	**2.2**
TOTAL	C_T	**79.5**	**13.3**

CONCLUSIONS

Taking into account that harvesting maize techniques have improved considerably lately worldwide, the most important aspect to approach is choosing optimum operation regimes that increase productivity and quality and reduce work costs.

Analysis of literature shows scientific research concerns in the field aiming at improving self-propelled combines for the harvesting of grain maize and of maize cobs to reach both quantitative and qualitative levels in the process of harvesting.

Analysis of operation and economic indices shows the following:

- The CASE-IH 7088 + CS-8 self-propelled combine harvests maize from eight rows over a working width of 5.6 m. the combine is equipped with a 325 HP Diesel engine with an hourly productivity of 24 t/h for a feeding flow of the thrasher of 18 kg/s. For a production of 6 t/ha, fuel consumption is 11.2 l/ha (1.9 l/t) and total expenses with grain maize harvesting reach 79.5 RON/ha, i.e. 13.3 RON/t;
- Besides choosing the most economic technological variant of harvesting grain maize, we would recommend other important ways of reducing costs such as technical and periodical maintenance works, observing optimum feeding flow of the thrasher by correlating speed work with field yield, avoiding empty movements from one plot to another during the day, unloading the bunker while moving, ensuring the daily norm per combine, adjusting the aggregate depending on the maize cultivar, etc.;
- To produce higher amounts per area unit with low costs, we need to strictly observe cultivation technologies using the most complex high-yielding aggregates.

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