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STUDIES AND RESEARCHES ON THE PREPARATION OF THE GERMINATION BED WITH HEAVY DISC HARROWS

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ABSTRACT

Agriculture has been around since ancient times and continues to be today a vital area of human activity. It remains the only source of food, an important supplier

of raw materials for industry and also a significant market for its production. Agricultural ecosystems as an integrated organic complex of natural, economic and social factors, require the rational, scientific intervention of the farmer, leading to raising its productivity, its protection and profitability, based on superior parameters of contemporary technology, making full use of market economy mechanisms.

The area occupied in our country by the soils with crops that are established in autumn is about 37% of the total agricultural area. The mechanization technology which includes tillage by removing the stubble and/or preparing the germinated bed on unplowed land, on which the autumn crops are established, it can be applied at a qualitative level corresponding to the agropedological requirements, at a low cost price and with low energy consumption, by using disc harrows.

INTRODUCTION

The strategy of developing agricultural production must be viewed systematically "in the context of the transition process of the entire economy, to the type of market economy", by building a specific management system. Only in this way can agricultural production and its sector of agricultural crops be recovered, taking into account their placement on new principles and mechanisms of socio-economic and technological functioning.

In the new technological management, which is based on the resizing of agricultural holdings, mechanization plays an important role, in which increasing the power of tractors and combine harvesters is defining, in the idea of minimizing the period of land preparation, sowing, harvesting and clearing the land of plant debris (Alexandru T., 2005).

The worldwide trend in the construction of harrows with high working capacity for high-power tractors, at present, is to achieve:

• robust central frame, monogrid or narrow rectangle type;
• rotating the batteries horizontally with a maximum angle of 90°;
• endowment with crushing and leveling organs, of different types, located in the rear part of the harrow.

The current trend, worldwide, at prestigious companies (KUHN; AMAZONE; GRIGOIRE-BESSON; KVERNELAND; RAU, OUIVOGNE, JEAN DE BRU, JOHN DEERE, etc.) is to make disc harrows equipped with additional shredding and leveling parts, located behind disc batteries, in order to perform soil work with higher quality indices than other harrows.

Domestic production disc harrows in operation are not equipped with additional shredding and leveling bodies and do not perform soil work with the same quality indices as those of world-renowned companies.

Also, most of the disc harrows of the above mentioned companies have the transport gauge allowed for traffic on public roads, and the folding of the batteries and rollers is done horizontally (manually or hydraulically), with the rollers placed above the batteries (Bădescu M., Alexandru T., Sărăcin I., Glodeanu M., 2003).

The disc harrow performs, at a single pass, the preparation of the germination bed on fresh plows or on uncultivated land where summer-autumn crops are established, in order to sow straw cereals and hoe plants, at working depths between 5...15 cm.

Fig.1. Heavy disc harrow.

The main constructive characteristics are: harrow type: trailed; tractor required, HP: 260; working width, m: 4.5; overall width in transport, m: 3.0; number of discs: 44; distance between discs, mm: 220. The main functional characteristics are: working depth, cm: 5…15; Working speed, km/h: max. 15 cm.

MATERIAL AND METHOD

During the tests, the following indices were determined or calculated according to the procedures in force (Alexandru T., Glodeanu M., 2009; Bădescu M., Boruz S., 2001):

a) Qualitative work indices:

- Average working depth (a_m) in cm.

$$a_m = \frac{\sum_{1}^{n} a_i}{n} \quad \text{[cm]}$$

where: a_i is themeasured working depth in cm and n the number of measurements performed.

- Average working width (B_m) in cm.

$$B_m = \frac{\sum_{1}^{n} B_i}{n} \text{[m]}$$

where: B_i is the measured working width in m and n the number of measurements.

- Degree of soil shredding (G_{ms}), in %.

The main qualitative indicator of the work of the harrow is the shredding soil degree. For the determination, a soil sample with the dimensions of 1mx1m was delimited (using the metric frame). From the respective sample were separated the soil fractions with dimensions smaller than 50 mm from the lumps and with dimensions larger than 50 mm. The shredding soil degree represents the proportion by weight of the soil fractions with satisfactory shredding, respectively with the dimensions of the lumps of maximum 50 mm, related to the total mass of the soil sample, calculated using the relation:

$$G_m = \frac{\sum_{1}^{n} \frac{M_{ci}}{M_{ti}}}{n} \cdot 100$$

where: M_{ci} is the measured weight of soil lumps with a maximum conventional size of less than 50 mm from the soil sample taken, kg and M_{ti} the measured weight of the whole soil sample taken, in kg.

The weighings were performed with a portable scale, with a permissible relative error of 1%.

- Degree of destruction of plant debris (G_v) in%.

It is determined by the ratio, expressed as a percentage, between the amount of vegetal mass remaining on the soil surface and the vegetal mass existing on the field surface before the passage of the machine, with the help of the relation:

$$G_v = \frac{\sum_1^n \frac{G_{ti} - G_{Si}}{G_{ti}}}{n} x100 [\%]$$

where: G_{si} is the measured weight of the plant mass remaining at the soil surface, on the sample taken, after passing the machine, in g;

Gti - the measured total weight of the vegetal mass from the soil surface before the passage of the machine, in g;

n - number of measurements.

- Degree of loosening (G_{as}) in% is determined by the relation:

$$G_{as} = \frac{\sum_1^n \frac{h_1 - h_2}{h_2}}{n} \cdot 100 [\%]$$

where: h_1 is the distance from the ground before harowing, in cm and h_2 the distance from the ground after harowing, in cm.

b) Energy indices:

- Effective working speed (V_e), in km/h was calculated using the relation (Bădescu M., Alexandru T, Glodeanu M., Boruz S., 2005):

$$V_e = \frac{3,6s}{t} \text{ [km/h]}$$

where: s is the linear space traveled, in m and t the space travel time, in s.

- Fuel consumption per hectare (q), in l/ha was calculated with the relation:

$$q = \frac{Q}{W_{ef}} \text{ [l/ha]}$$

where: Q is the hourly fuel consumption, in l/h and Wef the hourly work capacity at the actual time, in ha/h.

- Hourly capacity at actual time (W_{ef}) in ha/h was calculated with the relation:

$$W_{ef} = 0{,}1 B_m v \ \text{[ha/h]}$$

where: B_m is the average working width, in m and v the actual working speed, in km/h.

In order to determine the qualitative work indices, the following operations were performed necessary for the preparation of the test aggregates:

- checking the mode of coupling and securing the machine from the unit, on the hydraulic lift of the JOHN DEERE 6920 S tractor, equipped with three-point coupling equipment, category III according to STAS-11022–91;
- checking the operation of the devices and mechanisms from the component of the equipment and adjusting them, with the effective reproduction of the working conditions.

For the determination of the qualitative working indices in accordance with the procedures in force, the following measuring and control apparatus and equipment were used:

- mechanical stopwatch: measurement accuracy ± 0,1 sec;
- roulette 15 m: accuracy class 2;
- apparatus for determining fuel consumption: determination range 0...480 ml;
- electronic balance METTLER PM 6000: measuring range 0...6 kg;
- mechanical scale: measuring range 0...150 kg;
- milestones, pickets;
- site with circular holes of 100; 80; 50; 40; 20 mm;
- metric frame.
- capsules for moisture samples.

RESULTS AND DISCUSSIONS

The field-laboratory and operating tests were performed in the aggregate with the JOHN DEERE 6920 S tractor, between April and October 2020, in accordance with the specific test procedures PSpI-01.10.29 "Disc harrow test" and PSpI-01.00.33 "Determination of energy indices for agricultural aggregates".

The field-laboratory tests were performed under the following conditions:

- soil type: reddish brown;
- previous culture: sunflower, corn;

The autumn tests were performed with a soil moisture in the 0–10 cm layer of 12.9%. The tests in the spring were carried out at a soil moisture: 0...10 cm: 16...18%; 10...20 cm: 15...17%; 20...30 cm: 14...16%. The tests with the heavy disc harrow were performed at the Agricultural Exploitation from Ghercești commune, DOLJ county (fig. 2). The main qualitative indices of the performed work are presented in table 1.

Table 1

Qualitative work indices made by the heavy disc harrow

Qualitative work indices	U.M.	Autumn - Plowed land	Autumn - unplowed land
Average working depth a_{med}	cm	10,7	8,1
Average working width B_{med}	m	4,51	4,38
Degree of soil shredding G_m	%	85,6	90,3
The degree of incorporation of plant debris into the soil G_v	%	95,3	97,8
Degree of soil loosening G_{as}	%	18,7	20,7

Analyzing the data from table 4.1, it is found that the working indices are: average working depth a_{med} =8,1...10,7 cm; average working width B_{med}=4,38...4,51 cm. The variation of the working indices of the heavy-disc harrow is presented in figure 2.

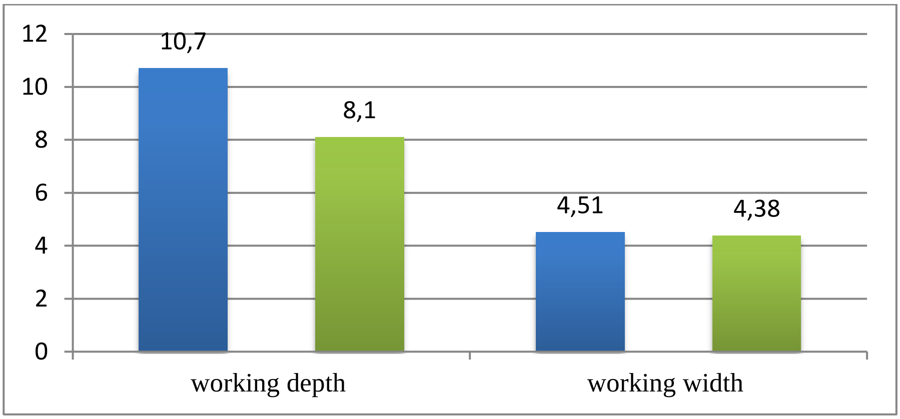

Fig. 2. Variation of the working indices of the heavy-disc harrow.

Graph from figure 2 shows that the effective working width of the harrow has a reduction, compared to the theoretical value of 4.5 m, with an insignificant of 1.01...1.04%.

Regarding the working depth it is found that for unplowed land we have the lowest value of 8.1 cm, and the higher value of 10.7 cm is obtained for the plowed land.

Regarding the qualitative work indices, it is found that: the degree of soil shredding G_m=85,6...90,3%; the degree of incorporation of plant debris into the soil G_v= 95,3...97,8%; the degree of soil loosening G_{as}=18,7...24,5%.

The variation of degree of soil shredding and of incorporation of plant debris into the soil is presented in figure 3.

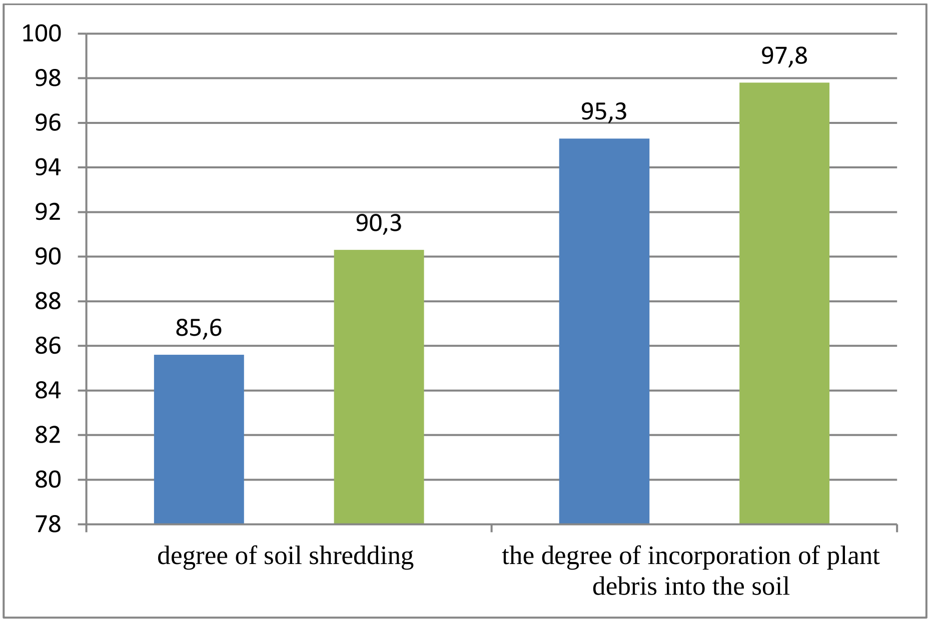

Fig. 3. The variation of degree of soil shredding and of incorporation of plant debris into the soil.

Analyzing the recorded data, it is found that from the point of view of the shredding soil degree, the agrotechnical conditions are met, the values being over 85%. The lowest value was recorded in autumn, when the soil moisture was lower at the plowed land.

The energy indices achieved by the heavy disc harrow are presented in table 2 and the variation of the energy indices are showd in figure 4.

Table 2

Energy indices achieved by the heavy disc harrow

Energy indices	U.M.	Autumn - Plowed land	Autumn - unplowed land
Work speed v_l	km/h	7,17	8,35
Work capacity at the actual time W_{ef}	ha/h	3,23	3,65
Fuel consumption Q	l/ha	4,31	3,08

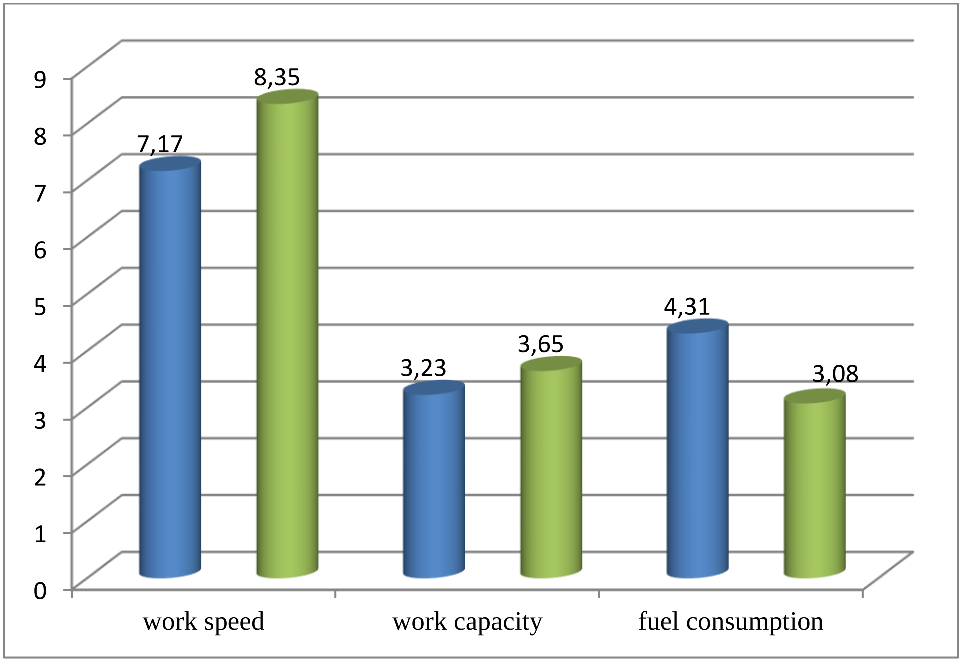

Fig. 4. The variation of the energy indices of the heavy disc harrow.

Analyzing the data from table 2 it results that: the work speed v_e=7,17...8,35 km/h; the work capacity at the actual time W_{ef} =3,23…3,65 ha/h; the fuel consumption Q=3,08…4,31 l/ha. From the data presented in graph 3 it is highlighted that the heavy disc harrow ensures high working speeds, compared to the agricultural units from the endowment of the exploitations in the area, which are endowed with Romanian equipment. We also find that a high hourly productivity of 3.65 ha is achieved for a fuel consumption of 3.08 l/ha.

The influence of the soil mobilization method on the autumn wheat crop is presented in table 4.

Table 4

The influence of the soil mobilization method on the autumn wheat crop

Soil mobilization variant	Average production		Specific fuel consumption for mobilization works	
	q/ha	%	l/t	%
Plowing + harrowing	52,1	100	7,13	100
Harrowing twice	49,7	95,4	6,04	84,71

It can be observed that for the first variant of soil mobilization, the average production is is 4.6% higher.

The specific fuel consumption per unit of product has the lowest value in case of land preparation only by harrowing, being 15.29% lower than the plowing work.

Taking into account the production, it turns out that this is an optimal option, but it should be noted that this work can not be repeated year after year and that the rainfall was favorable during the vegetation period of wheat.

CONCLUSIONS

1. From the documentary study it is observed that worldwide in the construction of disc harrows for high power tractors, there are the following trends:
• robust central frame, monogrid or narrow rectangle type;
• rotating the batteries horizontally with a maximum angle of 90°;
• endowment with crushing and leveling organs, of different types, located in the rear part of the harrow.
2. The heavy-duty disc harrow for the JOHN DEERE 6920 S tractor was made with “V” batteries and additional shredding and compaction organs, with a working width of 4.5 m;
3. The heavy disc harrow is used in summer-autumn (in some situations in spring) on fresh plows, in all types of soil on flat lands or with a slope up to 6 °; the heavy disc harrow is robust, simple from a constructive and functional point of view, it is easy to handle, maintain and operate in the work process and carried out quality works, with a high degree of soil shredding and burial of plant debris;
4. Taking into account the production, it turns out that this is an optimal option, but it should be noted that this work can not be repeated every year and that the rainfall was favorable during the vegetation period of wheat.

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