

AGROTECHNICAL RESEARCH OF SUBSOIL CHISEL TOOLS

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Abstract: In the course of the comparative investigation, energetic and working-quality tests were carried out with three frequently used soil-loosening implement types in field-land conditions – such as wide blade, duck-foot and chisel undercutting (‘Paraplow’) type loosening elements. When evaluating the results of the test, we qualified the implement-tools with the help an arbitrarily defined constructional factor; in this way, an order of the tool constructions was determined.

KEYWORDS: agrotechnical research, looseness “L” of soil, measurement of loosening, “k_{sz}” tool factor

1 Introduction, methods and materials

The determination of the required tractive effort of the subsoiler tools was carried out with the help of a tractor *CASE IH 7210*. Both lower hitch links as well as the third upper link (support spindle) are equipped with strain-gauge tapes.

Data received from all of the transmitters described in connection with the energetic properties were transferred to the amplifier data logger unit mounted on the ballast-weight pieces. The logger unit consists of a 160-MHZ computer, a measuring card *Advantech PCL 818* and an *APC* uninterruptable power supply unit; the measurement system is capable of receiving data through 16 analogue and 16 digital channels. The measuring system was controlled by a portable computer connected to serial port of the measuring computer, from the cab of the tractor.



Fig. 1 CASE IH 7210 tractor with Paraplow tools and with Computer

During the tests, to measure the traveller speed of the tractor, the rear wheels were equipped with revolution transducers. These were inductive measuring transducers – they scanned passing-through elements (existing or separately fixed) on the rotating wheels.

The averages of the values measured along the experimental sections were simultaneously displayed on the screen of the PC thereby the operation of the measurement system was provided immediately on the spot.

According to the spirit of this, the research was confined to *the comparative testing of different subsoiler tools*.

The brief summary of the objectives conceived during the research are as follows:

1. comparison of three middle-deep subsoiler tools according to the agro-technical parameters, and
2. comparison of three middle-deep subsoiler tools according to the energetic parameters.

2 Conditions of investigation

Table 1: Conditions of tests carried out in loamy soil

Test field	Plain cereal stubble
Moisture content of soil [V/V%]	19.5
Penetration resistance of soil ₀₋₄₀ [MPa]	3.8
Arany's soil-cohesiveness K_A	41
Physical type of soil	loam

3 Technical properties of the middle-deep subsoilers put to tests

Tool type Paraplow: The web-plate of the loosening tool is made with right-handed bent design. The wing part of special design, bevelled at an angle of 25°, is mounted on the bottom part of the 20-mm thick web-plate by plough bolts and the chisel-form loosening piece – of which both ends are bevelled at an angle of 23° – is fixed in the web-plate by two rivets, under the wing. (Figure 2).



Fig. 2 Type of the *Praplow*

Parabolic loosening blade: The arc pattern tool is constructed with a round-profile iron of 20-mm diameter welded on the blade. The wing type loosening shoe is 220 mm wide and 150 mm long. The wings with a V-angle of 180° are mounted on the loosening wedge with bottom bevel, by two plough bolts, respectively. The wing type loosening shoe is pulled on the end of the web-plate, and fixed by a plough bolt. (Figure 3)



Fig. 3 Type of the *Kühne*

Straight loosening blade: The inclination angle of the lower part of the 30-mm wide web-plate (bevelled at an angle of 60°) to the level is 60° forward. The upper part of the web is made at right angles to the level. The loosening wedge is bevelled from below with a loosening angle of 25°, and made with a working width of 50 mm. The welded case is mounted on the bottom of the web-plate with plough bolts – the loosening wedge is fitted on the case. This unit on the tool is exchangeable. (Figure 4)



Fig. 4 Type of the *Jimpa*

4 Results

Qualification of the tested tools by my introduced specific-performance index

In order to evaluate or qualify the work of subsoiler tools, I introduced the so-called specific power index for characterizing the loosening tools. With the help of this index, I intend to express the power requirement of the unity looseness k_{sz} . Its definition is

$$k_{sz} = \frac{P_L}{L} = \frac{F_L \cdot v_h}{L} \quad [\text{kW}] \quad (1)$$

where

- F_L : tractive effort required by the loosening tool [kW]
- v_h : travel speed of the machine combination [m/s]
- L : quotient of areas of surface elevation and loosened section [-].

Obviously, the lower the value of k_{sz} is the better is the construction and the energetic index of the loosening tool (subsoiler). Otherwise, the good subsoiler tool or blade achieves the possible best looseness against the possible least power use.

Table 2 Data measured for the calculation of the tool factor during the test of the loosening tool, at a working depth of 40 cm, repeated three times

Tool types	$L = \Delta A/A_0$	v_h [m/s]	F_L [kN]
Paraplow – type tool	0,1171	2,15	7,65
	0,1114	2,15	8,23
	0,1097	2,15	7,97
Loosening – wedge tool	0,0959	2,15	7,4
	0,0968	2,15	7,22
	0,0863	2,15	7,03
Wing- type loosening tool	0,1687	2,15	11,1
	0,169	2,15	10,84
	0,1615	2,15	11,32

Table 3 Values of tool factors k_{sz} determined with the three tested subsoiler implements

Test serial number	Paraplow- type tool [kW]	Loosening- wedge tool [kW]	Wing-type loosening tool [kW]
1.	39	46	39,2
2.	44,1	44,5	38,3
3.	43,3	48,6	41,8
Average	42,1	46,3	39,7

CONCLUSION

On the base of qualifying by this specified factor (more exactly the average values of the triple replications), the wing-type loosening tool proved itself to be the best. The power requirement of this construction as a function of the actual looseness is the lowest therefore the value of k_{sz} is the lowest here. In accordance with this, the qualification order is: the *wing-type* (1), the *Paraplow-* type (2) and, finally, the *loosening-wedge* subsoiling tool. This order reflects well the differences arisen from the characteristic deviations of the three types in construction. The k_{sz} value of the wing-type tool is the highest. It can be explained in the way that the tractive power of the wing type is approximately the same as that of the toll type *Paraplow* but the degree of looseness with the wedge tool is lower.

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