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CONTRIBUTION TO EXPERIMENTAL RESEARCH REGARDING THE DYNAMIC AND ENERGETIC PARAMETERS OF GRASSLAND OVERSOWING MACHINE

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Abstract. *In the paper is presented the equipment and methodology used to experimentally research regarding the dynamics and kinematics of the sowing section (unit) at the oversowing machine. Experimental tests were conducted on three types of furrow with different angles (25°, 35° and 45°) and the results obtained allow us to find constructive and functional optimization solutions for sowing sections in order to reduce the traction forces and fuel consumption of the tractor.*
Keywords*: grassland, oversowing machine, experimental research, measurement installation, data processing.*

1. INTRODUCTION

At the Grassland Research Institute (ICPCP) of Braşov/Romania was designed, realized and tested a new oversowing machine type MSPD-2,5, which works in unit with 35…50 HP wheels tractor. The main advantages of the new oversowing machine are: the copy of the unevenness of the ground on each row processed and sown in the limits of ± 10 cm; achievement of a good uniformity of the distribution on the work breadth; adjustment and constant maintaining in work of the depth of the gutter opening and of the introduction of the seeds in soil.

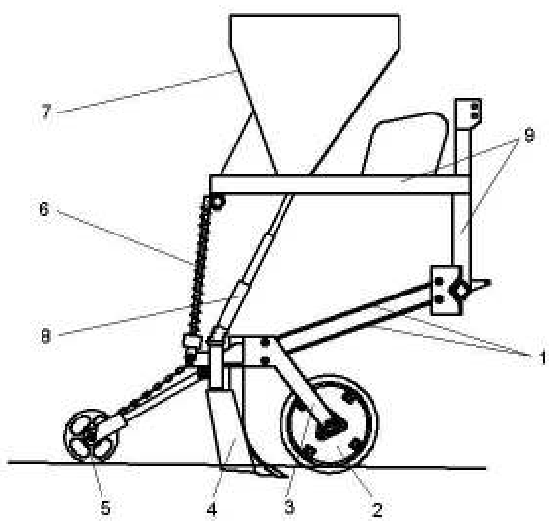


Figure 1. Constructive scheme of grassland oversowing machine:
1-deformable parallelogram mechanisms;
2-disc with rim; 3-body of the section;
4-opening gutter furrow; 5-setting wheel;
6-reglable springs; 7-seed box; 8-tube for the leader ship; 9-frame of machine

2. MATERIAL AND METHODS

The constructive and functional optimization of the machine calls for the analysis of the dynamics and energetics through experimental research of cinematic, dynamic and energetic parameters of both the sowing sections taken separately and the tractor-grassland oversowing machine general system.

To achieve this objective it was necessary to measure, acquire and process the following main parameters: the traction forces from coupling bars of the sowing sections (to determine the traction forces of sections), forces acting on disc wheel with rim, forces acting on the furrow, load forces on section body performed by load tensioned springs, the resistance force to traction of the oversowing machine transmitted by the tractor through the suspension mechanism of the rear three points hitch of the tractor, working speed of machine and working depth of furrow opener. To carry out the experimental researches of the above-mentioned parameters, a series of transducers and sensors were placed on both the tractor and the machine, as shown in figure 2.

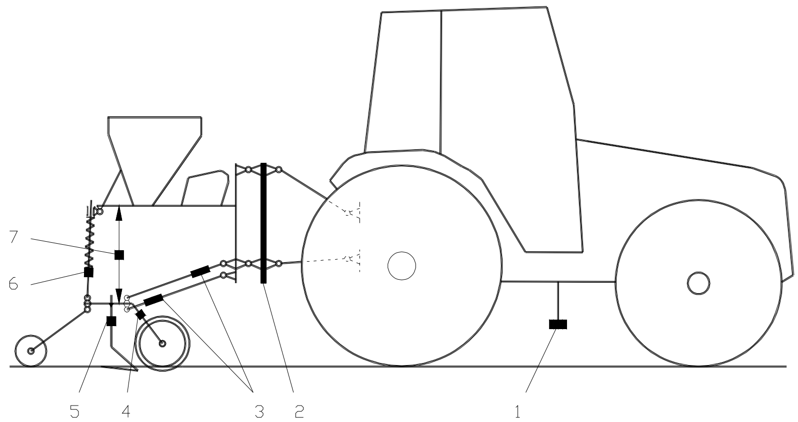


Figure 2. Location scheme of transducers and sensors on the tractor-oversowing machine system
1-optical transducers for measuring of space and speed of machine; 2- frame with tensometric transducers for measuring of the forces in the three points hitch of the tractor; 3- tensometric transducers for measuring of forces in parallelogram mechanisms; 4- tensometric transducers for forces measurement from disc with rim; 5- tensometric transducers for forces measurement from opening gutter furrow; 6- tensometric transducers for forces measurement from springs of sowing section; 7-inductive transducers for measurement of vertical displacements against body of machine

The experimental research was conducted on the system made up of the oversowing machine for degraded grasslands MSPD-2,5 and the four wheel drive tractor New Holland TL100.

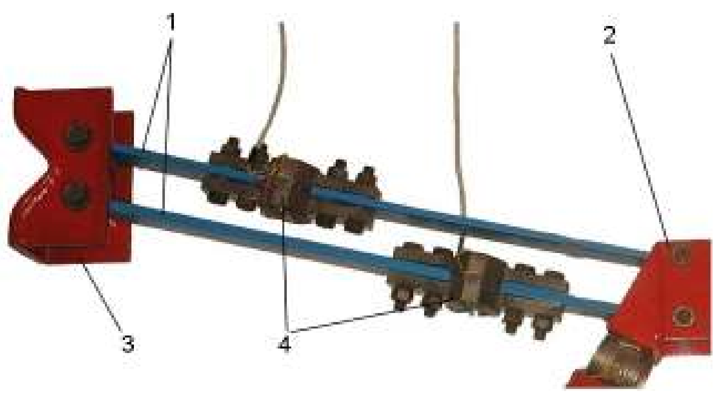
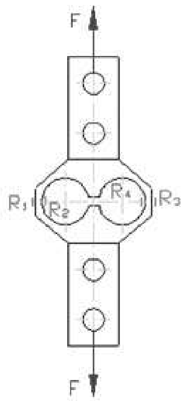


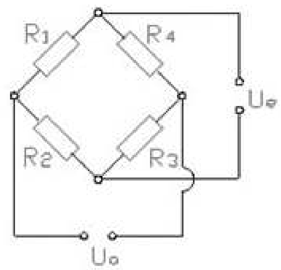
Figure 3. Mounting of the equipment (tensometric rings) from measurement of forces from bars for sowing section conection at the body of machine: 1-conection bars (parallelogram mechanism) between section and body of machine; 2- frame of sowing section; 3- body of the machine; 4- tensometric rings

The measurement of forces from connection bars 1 (Fig. 3) of the sowing section 2 to the frame of the sowing machine 3 was performed by using devices with tensometric traction rings with electro resistive transducers (TER) 4.

The force transmitted through the connection bars was measured with tensometric transducers mounted perpendicularly on the longitudinal axis of the parallelogram's bars (Fig. 4, a). For each tensometric ring there were used 4 transducers of type 6/120 ZY11 (Hottinger), with resistance R=120 Ω and constant K=2,07. The trade strain gauges were mounted on a strain gauge bridge (Fig. 4, b).



a.



b.

Figure 4. Scheme of tensometric rings for forces measurement from connections bars of parallelogram mecanism between sowing sections and body of machine: *a* – the location of strain gauge marks on the tensometric rings; *b* – mounting scheme of trade strain gauge on a strain gauge bridge

The measurement of forces from fork 2 of disc with rim 1 (Fig. 5) was performed by using devices with tensometric traction rings (TER) 3, mounted on direction of fork 2. On inner and external walls of the rings there connected resistive tensometric transducers with strain longitudinal axis placed in the same plane with longitudinal axis of the wheel's fork with rim (Fig. 6, a). There were used 4 trade strain gauges of type 10/120 ZY11 (Hottinger company), with resistance R=120 Ω and constant K=2,07, the trade strain gauges were mounted on a strain gauge bridge as shown in figure 6, b.

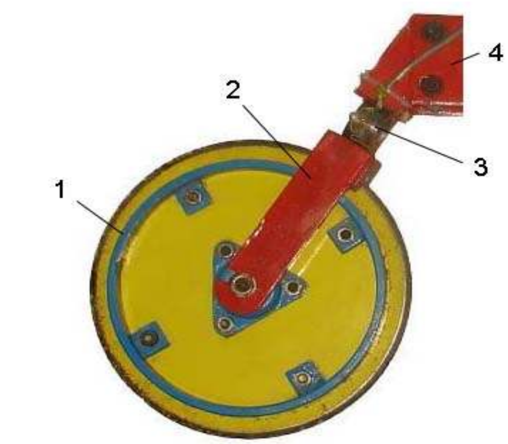
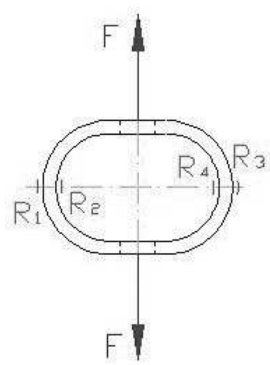
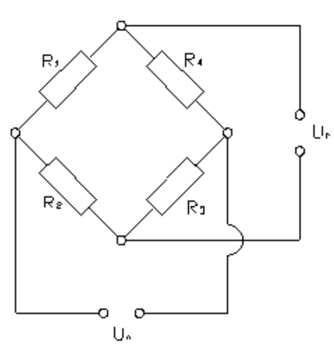


Figure 5. Mounting of the tensometric rings to measure the resultant force at fork of disc with rim: 1-disc with rim; 2-fork of disc with rim; 3- tensometric ring for forces measuring acting on the fork's direction; 4-body of sowing section



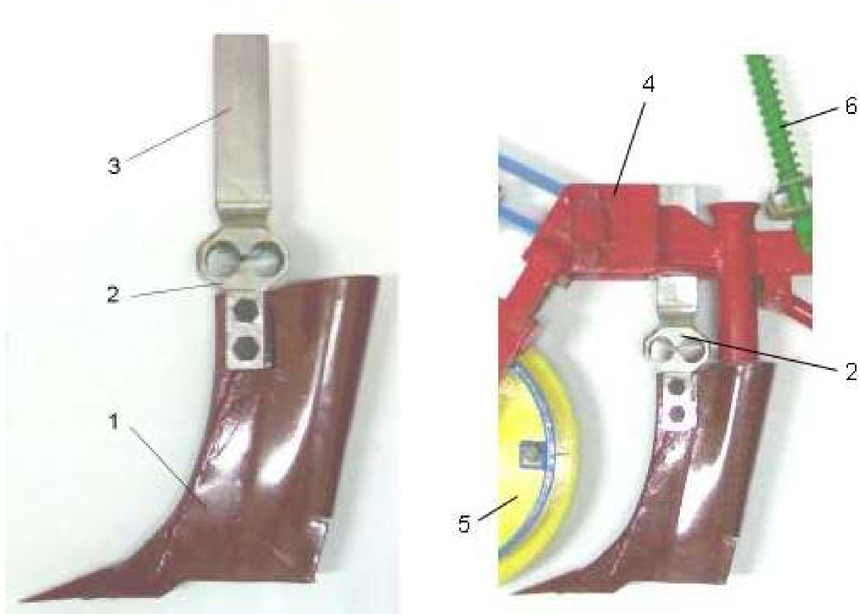
a.



b.

Figure 6. Scheme of tensometric rings for forces measurement from fork of disc with rim: a – the location of trade strain gauges on the ring of the disc with rim; b – mounting scheme of trade strain gauge on a strain gauge bridge.

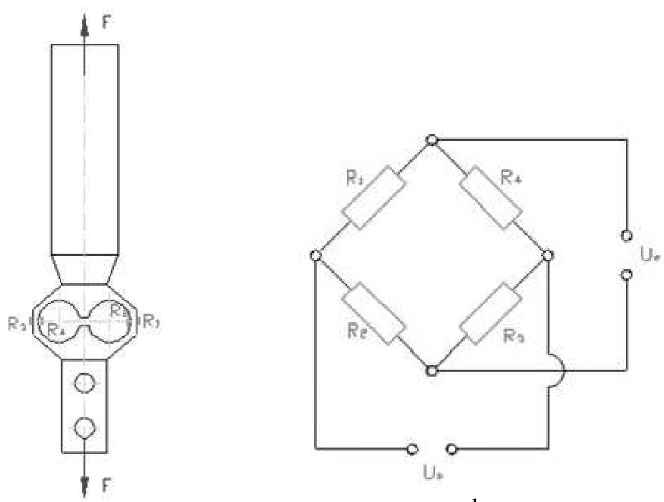
The measurement of forces at furrow 1 of the sowing section (Fig. 7) was performed by using devices with tensometric traction rings with electro-resistive transducers (TER) 2 mounted on the fixing bar 3 of furrow 1 to the frame 4 of the sowing section.



a. *b.*

Figure 7. Tensometric ring device for measurament of the force at furrow: a- mounting the tensometric ring at the furrow; b- furrow mounting on the body of the sowing section:
1-furrow; 2-tensometric ring for measuring the load force; 3-fixing arm tensometric device at the furrow;
4- body of sowing section; 5- disc with rim; 6-resort of section

To design the transducer with tensometric ring (Fig. 8, a) there were used 4 strain gauges of type 6/120 ZY11 (Hottinger), with resistance R=120 Ω and constant K=2,07. The strain gauges were mounted on a strain gauge bridge 8 (Fig. 8, b.).



a. b.

Figure 8. Scheme of tensometric rings for forces measurement from connection bars of parallelogram between sowing section and body of machine: a-the location of trade strain gauges on the tensometric ring; b - mounting scheme of trade strain gauge on a strain gauge bridge

The measurement of forces from springs 3 (Fig. 9) that act on the direction of the rod axis 4 of spring and presses the body 1 of the sowing section was performed with tensometric electroresistive transducers (TER) ring 2. The electroresistive transducers were mounted on a device with compression rings similar to those shown in figure 6. When mounting the tensometric rings on the bars on the spring rod the researchers had in view that the rings should not have negative influences during the working process (the should not overstrain the spring and should allow the tubes to be mounted on the section).

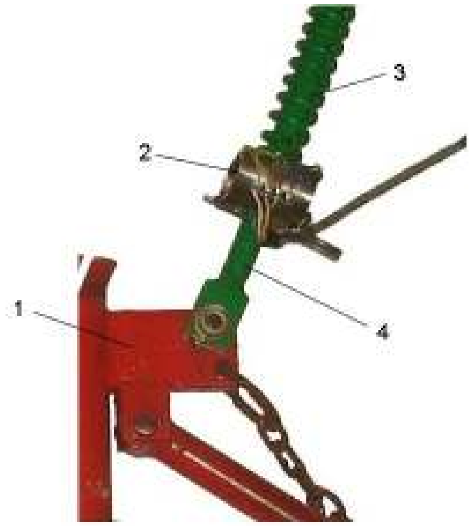


Figure 9. Mounting of tensometric ring for forces measuring of the spring of the sowing section body:
1-body of sowing section;
2- tensometric ring for spring force measurament;
3-spring; 4- rod spring.

The measurement of linking forces between the tractor and the oversowing grassland machine (the resistance force to traction of machine) was performed with a device with tensometric transducers (tensometric frame) presented in figure 10. The device is made of 3 frames (central 1 and sides 2, 3) and five strain gauges supports which can be assembled in three positions, making it possible to couple it to the suspension mechanisms at 3 hitch points and to the coupling devices of the agriculture machine.

The frame is coupled to the rear three points hitch of the tractor by coupling the side and central links of the tractor to the side bolts 4 and central bolts 5 on the frame. Side bolts 4 and central bolt 5 are fixed to side strain gauges 6 and central strain gauges 7 which are made of clamping plates to the frame bolts, plates with incorporated ball joint for bolts coupling to the coupling devices of agriculture machine and elastic rings on which tensometric forces transducers are mounted. The side strain gauges supports 6 are connected through bolts 8 to vertical strain gauges supports 9 made of clamping plates, threaded rod and elastic ring. Through the threaded rod of vertical strain gauges supports the parallelism position of side strain gauges supports to the soil and the position of the agricultural machine to the tractor are adjusted.

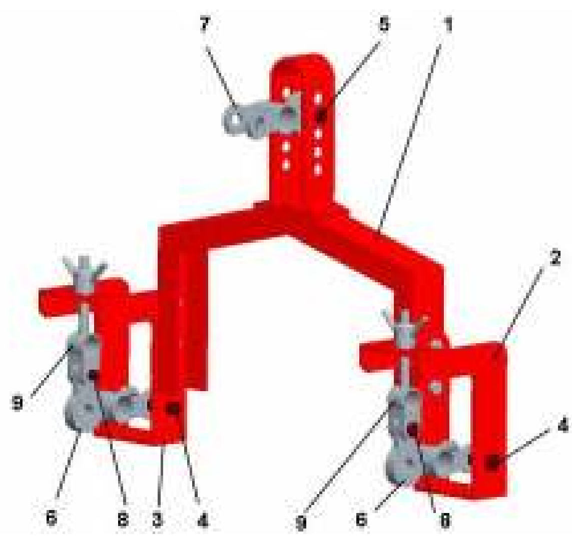


Figure10. Intermediate frame with tensometric rings for forces measurament of machine traction force:
1-central frame; 2,3-lateral frame;
4- lateral pin; 5- central pin;
6- horizontal lateral supports strain gauges; 7- central supports strain gauges;
8-pin; 9- vertical lateral supports strain gauges.

The measurement of the working speed of tractor-grassland oversowing machine system was performed with speed transducers of optical type made by CORRSSYS DATRON Company, AQUA L 350 type. The transducers is presented in figure 11,a and the mounting method on the tractor is presented in figure 11, b.

a.

b.

Figure 11. Optical speed transducers AQUA L 350 type (a) and transducer location on the tractor (b): 1-tractor New Holland tractor (TL 100 type); 2-oversowing machine (type) MSPD-2,5; 3-optical transducers of speed and deplasament.

The measurement of the vertical displacement of sowing sections in order to determine the vertical position of sowing sections as well as the measurement of the working depth of furrows, was performed with inductive transducers of linear displacement type WAL 100 (±50 mm) for short section and WAL 200 (±100 mm) for long section (made by Hottinger company). The values of linear displacement and the conversion mathematical formulae were applied in order to calculate the angular position of coupling bars of parallelogram mechanism of sowing sections in view of correlating the resulting force from parallelogram mechanism bars with resistance forces to traction and with normal load forces of sowing sections.

The equipment for measuring data acquisition used for experimental tests of the system made of tractor 1 (Fig. 12) and oversowing machine 2 it was made of power supply 4, voltage stabilizer 5 (UPS), booster modular system 6 (MGC plus) and laptop (type P4) 7, all this components being mounted on the grassland oversowing machine 2 through frame 3.

Figure 12. Location of measurement and data acquisition equipment on the system: 1-tractor; 2-grassland oversowing machine; 3-frame for location of measurement and data acquisition equipment; 4-power supply; 5- voltage stabilizer; 6- booster modular system (MGCplus); 7-laptop P4

The characteristics of the soil where experimental researches were determined by measuring the soil humidity, using PT-1 type soil capacitive humid meter, (made by Kapacitiv KKT Budapest Company) and for measuring the degree of soil compaction, using SCT type penetrometer (made by DICKEY-JOHN Company).

The experimental researches were carried out at ICDP Magurele in Brasov, on grassland, on the leaching chemozem soil for different displacements conditions (2 travelling speeds: v_1=5,5 km/h and v_2=7,5 km/h), 2 working depth (d_1=2 cm and d_2=4 cm) and 3 constructive type of furrow (with inclination angle: α_1=25^o, α_2=35^o and α_3=45^o)). 18 parameters, which were recorded simultaneously, enabled us to determine the influence of working conditions and constructive parameters of the furrow upon forces variation.

The following graphs present the variation curves of traction forces of the section and traction forces of the tractor. Figure 13 show the traction force variation in time of the sowing section of the machine depending on the furrow attack angle and in the figure 14 is presented the tractor traction force variation in time depending on the furrow attack angle (the signals are filtered).

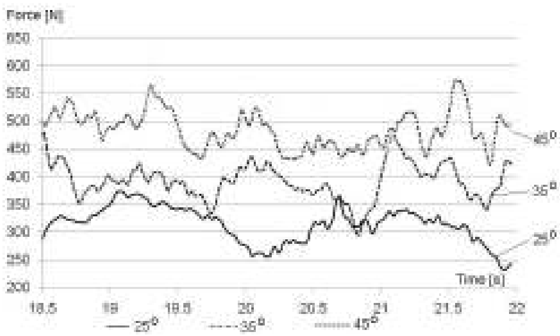


Figure 13. Section resistance force variation in time depending on the furrow attack angle.

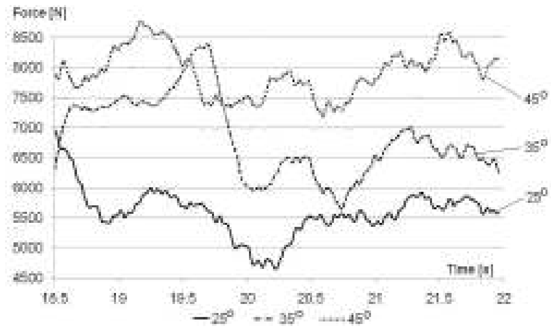


Figure 14. Tractor traction force variation in time depending on the furrow attack angle.

3. CONCLUSIONS

The equipment and methodology used to experimentally research allow simultaneous in time registration of the variations of the kinematics and dynamic parameters characterizing behaviour of both the sowing sections taken separately and the tractor-grassland oversowing machine general system at work in different conditions (traveller speed and depth work).

Processing of obtained experimental data allow to determine average values of traction resistance of sowing sections taken separately and the tractor-grassland oversowing machine general system and traveller speed that it can be establish power required to machine traction

The average traction resistance of sowing section and grassland oversowing machine encrease once with furrow angle, the average values are: 307 N (25^o furrow type), 383 N (35^o furrow type) and 475 N (45^o furrow type). Therefore the average traction resistance of tractor encrease too, the average values are: 5300 N (25^o furrow type), 6600 N (35^o furrow type) and 8000 N (45^o furrow type).

REFERENCES

[1]. Asch, G.: Les capteurs en instrumentation industrielle. Dunod Paris, 1999.

[2]. Ene, T. A, Popescu, S. Contributions to study of the dynamics of the system of the tractor - machine for grassland oversowing. In: Anales of the University of Craiova, Agricultură, Montanologie, Cadastru (ISSN 1841-8317), Vol. XXXVI/B 2006, p.138-145.

[3]. Hermenean. I., V. Mocanu, S.Popescu. Realisation and testing of a new machine for grassland oversowing. In: Proceedings of the International Congress on Information Technology in Agriculture and Food Industry-*itafe´ 03*-Izmir (Turkey), 2003, p. 670-673.

[4]. Hoffmann, K., 1987. Eine Einführung in die Technik des Messens mit Dehnungsmessstreifen. HBM-Messtechnik, Darmstadt.

[5]. Karamousantas, D., Ros, V., Gheres, M.I., Fechete, L.V. Optimization of the driving mechanism of the hoe machines. The 29. International symposium on agricultural engineering, Opatija/Croatia, 06. – 09, February 2001.

[6]. Popescu, S., Czyborra, M. Apparatur und Methode zur experimentellen Forschung betreffend die Dynamik von Traktor – Frontlader Systemen. În: Buletinul Institutului Politehnic din Iasi, Tomul L (LIV), Fascicula 6B2, 2004, Secția Construcția de Mașini, pag. 165-172.

[7]. Popescu, S. Contributions regarding the experimental research on the dynamic behaviour of the tractor front loader system. In: Bulletin of the Transilvania University of Brasov, Serie A, Vol 11 (46), 2004, pag. 101-106.