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MONITORING OF WEEDS IN CROPS OF LEGUMES AND CEREALS GROWN UNDER CONDITIONS OF
ORGANIC FARMING
Abstract: The efficiency of the machines depends on the completeness of the scope of the indicators and the factors with which they are linked. In choosing the best solutions, it is necessary to evaluate the system metrics, and the optimal option machine or set of machines to be chosen using optimization criteria. Figure 1 shows the system of indicators for complex assessment of agricultural machinery. Some of the indicators are interrelated to such an extent that they can be attributed to several groups, which is not an obstacle to the decision to implement the machines.

Fig.1. System of indicators for complex evaluation of machines

The indicators for the quality assessment of mechanized works should be divided into common types for all mechanized works and for separate groups of technological processes: soil treatment, sowing and planting, plant care, harvesting of crops.

The system of indicators for the evaluation of agricultural machinery is expressed and evaluated with a large number of properties, indicators and characteristics of quality and reliability.

In general, quality has four groups of properties: feasibility, social, bio-ecological and reliability

KEYWORDS: AGRICULTURAL MACHINERY, INDICATORS, QUALITY, OPTIMIZATION CRITERIA, TECHNOLOGICAL PROCESSES

First, we systemize and develop the system for indicators of quality assessment of mechanized works (agro technical indicators)

The indicators characterizing the quality of mechanized works are based on agro-technical requirements and operating technologies.

The indicators for the quality assessment of mechanized works should be divided into common types for all mechanized works and for separate groups of technological processes (Fig.2).
The system of indicators for the evaluation of agricultural machinery is expressed and evaluated with a large number of properties, indicators and characteristics of quality and reliability.

Secondly, the Agricultural Machine Valuation System is expressed and evaluated with a large number of properties, performance indicators and quality and reliability characteristics.
Quality is a set of properties that meet the needs and / or requirements of users, and reliability - a complex property to maintain quality levels within established limits, time, modes and conditions. The main elements of the definition of quality are properties, needs and requirements (fig. 4). Quality properties are expressed by specific and complex indicators, and indicators with numerical and functional characteristics. The main elements of the conceptual definition of reliability are the level of quality, the established boundaries, time, modes and conditions (fig.5).

The quality level is determined by three groups of properties that directly express the quality of the sites and their impact on humans, species and / or the environment (Figure 6).

In general, quality has four groups of properties: feasibility, social, bio-ecological and reliability (fig.7)
Conclusions:
1. An attempt has been made to classify the variety of indicators for the comprehensive assessment of agricultural machinery.
2. There are scientifically qualified qualifications to cover the wide variety of indicators for the comprehensive assessment of agricultural machinery.
3. In the system, the indicators for complex assessment of agricultural machinery include reliability, which is a complex property and in it are reflected in the focus many of the indicators for complex assessment of agricultural machinery.

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3. Михов М. Надеждност на машините в земеделието, С., 2012 г., 130 с.
Abstract: The object of the study is an ultrasonic sensor type UT2F/E7-OEUL which measures the presence of a body in the range of 350 to 6000 mm. The sensor was mounted in a suitable place in the combine harvester. Experiments were conducted on three types of waste vegetation mass (WVM): wheat, beans and alfalfa in field and laboratory conditions. A database of sensor measurements was obtained. A single-factor dispersion analysis task was formulated. The results obtained using relevant specialized software showed that the sensor is operational regardless of the type of WVM.

KEYWORDS: ANOVA, VEGETATION MASS, EXPERIMENT, DISPERSION ANALYZE, ULTRASONIC SENSOR

INTRODUCTION

The waste vegetation mass (WVM) from plant-growing is a stream of plant stems that are obtained after harvesting, i.e. after they are cut off by the cutter bar of the combine harvester. Before the harvest, the stems have some order that is determined by the sowing, but after cutting, this order is disturbed and they form a flow in a chaotic state. This flow is characterized by a different density of flow thickness in the closed space of a combine over the straw walker. This space is determined by a fixed transverse dimension b, which is embedded in the combine harvester construction (Figure 1). The other WVM flow parameter is the speed at which it moves to the input of the machine. This speed is determined by the so-called "load applied" to the combine Q in kg/s, i.e. quantity of harvested mass per unit of time, (Georgiev, I., Stanev St, 1989). If the speed of the combine harvester is greater, Q also increases, resulting in higher losses of unthreshed grain. For a given machine, it is obtained as the linear velocity expressed by the product of the angular velocity along the length of the crankshaft drive of the crank length r (Figure 1). The key of the straw walker is a link with a common plane motion from a four-bar linkage planar mechanism. The both cranks are the same size so that each key performs a flat, circular translational movement. As a result, the linear velocity along its entire length is the same, which ensures a uniform distribution and movement of the straw mixed with grain in the longitudinal direction of the combine harvester.

The object of this study is to measure the volume of WVM above the straw walker with a UT2F/E7-OEUL ultrasonic sensor in different crops to determine their effect on sensor measurements.

EXPOSITION

Stage of the study

The WVM stream in a combine harvester is characterized by the transverse size of the straw walker b, their velocity Vstrw., with which they move the straw and the height h(t) which is variable. Namely, it is subject to measurement by primary transducers. In previous publications, such a solution has been studied using a potentiometric sensor (pos. 18 of Figure 2), (Panayotov, L., & R. Mihaylov, 2015), (Panayotov, L., 2016), (R. Mihajlow , R., L. Panajotov, St. Stoianov & D. Mihaylova, 2016).

Figure 1 shows the dimensions of the parallelepiped along which the WVM passes over a given period of time. The positions in the Figure are: 1 - bearing support on the combine harvester frame; 2 - crank; 3 - bearing support on one of the straw walker keys; 4 - the straw walker key.

Fig. 1. Dimensions of the WVM space in the combine harvester: Lc - length, b - width, h(t) - height of straw layer, and r is the length of the crank.
The positions in Figure 2 are: 1 - grain tank and cover; 2 - cover over the straw walker; 3 - ultrasonic sensor type: UT2F/E7-0EUL; 4 - reflector for the ultrasonic sensor; 5 - the straw walker overload sensor; 6 - uploading auger; 7 - casing at the straw outlet; 8 - straw chopper; 9 - the key of straw walker; 10 - grain pan; 11 - bearing of the drive crank; 12 - rear suspension and wheel of the combine harvester; 13 - bottom sieve; 14 - tailings conveyor; 15 - grain auger; 16 - fan; 17 - grain pan; 18 - rubber curtain (tranquilizer); 19 - potentiometric sensor.

It is known that sensors that emit an ultrasonic high frequency beam are characterized by the so-called "dead zone" (Tomov, P., & A. Angelov, 2011), which for the particular model of that sensor is 350 mm long.

In order to gain a place in the zone where the WVM moves inside a combine harvester, the rays of the sensor are directed to the measuring site after they are reflected by a "mirror" (pos. 4, Figure 2) placed on their path at an angle of 45°.

**Experimental results**

Experiments were carried out with different species of WVM: wheat straw in field conditions, lucerne and bean stalks in laboratory conditions (Fig. 3, 4). The measurement results formed the database.

Solving the task by one-factor dispersion analysis

The problem formulated above is solved by creating a mathematical model, (Mitkov, A., 2011), which includes one factor A with three levels ($m = 3$) of manifestation: $a1$, $a2$ and $a3$, which are determined by the three types of WVM. Ten measurements ($n$) were performed for each crop. The data from the parallel experiments are presented in Table 1.
The task was to establish at a level of significance $\alpha = 0.05$ whether the A-factor influences the parameter $Y$ - the measured thickness of the WVM layer.

Table 1 gives the results of the single-factor dispersion analysis, where $n = 10$. The degrees of freedom: of the sums $SS - k = n-1 = 9$, of the sums $SS_A$, characterizing the deviations from the conditional average arithmetic values - $k_A = m-1 = 2$, and the sums $SS_E$, characterizing the influence of non-steady and unrecorded factors on the parameter $Y$ - $k_E = N-m = 30-3=27$, where $N = \sum_{i=1,j=1}^{30} n_{i,j}$ (1)

The experimental value of the Fisher criterion was obtained, which in true zero hypothesis and fulfilled prerequisites of the dispersion assumptions has $F$ distribution with degrees of freedom $k_A = k_A = 2$ and $k_E = k_E = 27$. The calculated value of $F$ is less ($F = 1.527$, see Table 2.) than the one defined in Appendix 2, (Mitkov, A., 2011), which is: $F_{0.05} (2, 27) = 3.371$.

### Table 1

<table>
<thead>
<tr>
<th>$a$</th>
<th>$y$</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>0.582</td>
</tr>
<tr>
<td>2</td>
<td>0.613</td>
</tr>
<tr>
<td>3</td>
<td>0.480</td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
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<tr>
<td>6</td>
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<tr>
<td>7</td>
<td>0.216</td>
</tr>
<tr>
<td>8</td>
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<tr>
<td>9</td>
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<tr>
<td>10</td>
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<tr>
<td>11</td>
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<td>12</td>
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<tr>
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<td>28</td>
<td>0.539</td>
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<tr>
<td>29</td>
<td>0.370</td>
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<tr>
<td>30</td>
<td>0.361</td>
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</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Factor A</th>
<th>Degree of freedom</th>
<th>Assessments of dispersions</th>
<th>Fisher criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>$SS_A=0.038$</td>
<td>$m-1=2$</td>
<td>$SS_E=0.336$</td>
<td>$N-m=27$</td>
</tr>
<tr>
<td>Random and unreported factors</td>
<td>$S^2=0.019$</td>
<td>$F_A=1.527$</td>
<td></td>
</tr>
<tr>
<td>Simplify influence</td>
<td>$SS=0.374$</td>
<td>$N-1=29$</td>
<td>$S^2=0.0128$</td>
</tr>
</tbody>
</table>

### CONCLUSION

Factor A does not have a significant effect on the values of the WVM thickness of different crops. This means that the ultrasonic sensor can be successfully used to measure the thickness of the WVM layer from different field crops. For this purpose, it is necessary to set a maximum and minimum size for the thickness of the layer in advance as specified in the sensor passport.

### REFERENCES


MECHANISED TECHNOLOGY FOR GROWING AND HARVESTING CORN

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Abstract: Improvement of applied modern mechanized technologies for growing and harvesting of corn, introduction of hybrids with a low and strong stem, suitable for thicker sowing, irrigation, etc. Lead to an increase in average grain yield per hectare.
The best precursors for corn are bean cultures, peas, alfalfa etc. Keeping this crop rotation turns out to be appropriate for successful weed control. Permanent cultivation of corn is also perceived, but it should not last for more than three consecutive years on the same area. In addition, corn is also eligible for cultivation in the case of reduced soil cultivation, incl. And through direct sowing. Obviously, with these extensive opportunities for crop rotation, account should be taken of the period of natural soil compaction and of the type of soil. Production and protection is carried out by two technologies: harvesting of cobs and harvesting of grain.
The main advantages of the first technology are the following: harvesting can be done at higher grain humidity (about 30%) when the stems are still green and can be ensiled; No additional energy costs are required to dry the grain; Timely release of sowing areas for subsequent crops.
When grain maize is harvested, the development of the maturity phase and the decrease of grain moisture should be observed, as the maturity increases considerably in the harvest losses. With the prolongation of the maize harvest, the biological losses are particularly high mainly due to fallen cobs, which reach up to 25%.
With the maturity phase of corn growing, the productivity of combine harvesters’ increases, but taking into account the increase in losses, the optimal harvesting time for corn should be done on an economic basis.

KEYWORDS: MECHANIZED TECHNOLOGIES, CORN, HARVESTING, SOIL TREATMENT, TECHNOLOGICAL OPERATIONS, ECONOMIC JUSTIFICATION

Corn is mainly grown for grain, which is mainly used for fodder. The cornstalk (dry leaf mass) is used for roughage. Corn is a basic silage culture. Corn grain and some of its derived products are also used for victuals, in food and beverage industries, etc. meaning more than 150 products are produced from industrial processing. The aim of the study is to summarize the experience in the Republic of Bulgaria of the applied technologies for corn growing.

Fig. 1. Exemplary corn growing technology

The best precursors for corn are bean cultures, basil, peas, alfalfa, fia mixture, alfalfa. Wheat and barley are good, less suitable are sunflower, sugar beet, sorghum. Observing these crop rotation turns out to be appropriate for successful weed control. Mono crop growth of corn is also perceived, but it should not last for more than three consecutive years on the same area. In addition, corn can be grown in the case of reduced soil cultivation, also through direct sowing. Obviously, with these extensive opportunities for crop rotation, the period of natural soil compaction and of the type of soil should be taken into account. Due to the broader possibilities of growing corn, two types of corn growing technology are now being developed.
The fertilization is carried out before the deep plowing by the introduction of organic phosphorus and potassium mineral fertilizers. Fertilizers are introduced by surface continuous spraying. In soils with a heavy and medium mechanical composition, ½ of the nitrogen fertilizers can be imported in autumn when the temperature is 8-10 ° C, being buried in the soil with pre-treatment (as well as phosphorus and potassium fertilizers). Under irrigation conditions, ½ of nitrogen fertilizers are introduced prior to sowing, and the remaining quantity is for foddering.
An important condition for the good result of fertilizers is their even spreading and deeper burial in the soil. Fertilizing with mineral fertilizers is done with fertilizing machines for surface dispersed fertilization. The fertilizer is transported to the field by universal means of transport.

In our climatic conditions manure is usually introduced with the main soil treatment for spring crops, including for maize. The effect of imported manure lasts for 3-4 years and the quantity depends on the type of soil and the possibility of irrigation. It is sprayed with fertilizer spreaders, which are also used to transport fertilizer from fertilizer storage to the field or through rotor sprinklers. In this case, the fertilizer is transported by universal means of transport, pouring into the piles in heaps, which are then dispersed by the specialized machines.

The liming of acidic soils improves the soil response, the soil's physical properties and the feeding regime of corn. Good results are also obtained from fertilization with zinc (carbonate black-earth and vertisols) and molybdenum (on gray forest soils). When fertilization is not with zinc and molybdenum, permanent slurry fertilizers (leaf fertilization) may be used.

Field preparation depends on the predecessor, entangling, etc., but includes the ice treatments: deep plowing, shallow autumn weed control and spring pre-sowing treatments.

The main treatment of the soil is carried out at a depth of 28-30 cm with weeding plows. In the presence of root weeds, the mechanical treatment is combined with spraying with herbicides and subsequent one, two surface treatments with disc tillage machines.

Pre-sowing treatments include harvesting and cultivation before sowing. Cultivation is done in a meld. It is preferable to use cultivators with spring stands of working bodies or combined tillage machines.

Disking is advisable when there are lumps that have to be scraped. With high chemistry, the number of treatments can be reduced depending on the physical properties of the soil and the degree of entrainment. The surface of the field should be level with well-grounded soil.

Sowing is done with the calibrated and decontaminated seeds of the most suitable for the region hybrids. The protective effect of hydrophobization lasts 40-60 days, allowing for early sowing. Recommended agro-technical sowing time for maize is from April 1 to April 20. The sowing is done in rows with spacing of $g = 70$ cm and depth $a = 6 - 8$ cm, the seeds in the order being 20-30 cm. Recommended seed rate for non-irrigating conditions 5000 - 6000 seeds per acre - for irrigation conditions 5500 - 7000 seeds per acre ie. 1.5-2.0 kg per acre. Pneumatic seeders are used for accurate sowing.

It is advisable to spray with herbicides at the same time as sowing. For this purpose, combined sowing machines and inter-row spraying machines with herbicides are used. To save money, we can skip spraying the in between row space. Here the weeds are destroyed by mechanical processing (hoeing). The sowing of the corn as the first crop is carried out by classical technology and so-called direct sowing.

During the corn vegetation period, the following activities are carried out: fight against soil and weeds, feeding up, irrigation (in irrigation conditions) and fighting against diseases and pests.

The fight against the soil crust is conducted by harrowing, using light and medium type tooth harrows and rotary harrows. It can be done both before and after emergence of 4-5 leaf of culture.

Treatments between the rows begin in phase 4, 6 and continue to 10th leaf. The depth of the first trench should not exceed 7-8 cm, and the second 4-5 cm. If the corn is irrigated without watering, the second treatment can be combined with earthing, but it is necessary to open the irrigation furrows when watering.

Destruction of weeds apart from inter-row processing is also done by using herbicides. The advantages of herbicides are that complete weed destruction is achieved throughout the crop area. The main disadvantage of this method is the pollution of production and soil with poisonous substances. The main drawback of mechanical destruction is that weed control is only achieved in the bandwidth being treated.

The most common weeds in maize crops are annual cereal and dicotyledonous weeds, rootstock species, baller, creeper pigweed, etc. for the eradication of which various herbicides and herbicide combinations are applied.

Mechanical and chemical methods for weed control should be considered as a complete interconnected plant protection system. The achievement of sustainable development and the achievement of very good yields is also achieved through work in three directions: a selective-genetic pathway, with agro technical means, by introducing and adhering to appropriate plant protection setups and treatment of the seeds with preparations. The most important diseases encountered on maize are: common cockle leaf-burn, scab and root rot, rust, molding of seeds, etc.

The integration of agro-technical, biological and chemical activities and means is a prerequisite for successful struggle against the maize pests (fig.2). The most common enemies of corn are: worms; gray corn weevil; corn borer, etc.

---

**Fig.2. Example technology for the protection of maize from diseases, pests and weeds (BASF)**
Irrigation is done gravitationally or by sprinkling. For gravity irrigation, flexible pipelines with deviations for each furrow are used to increase labor productivity. The flexible pipeline is connected to the distribution channel and is located across the rows, with junction hoses being routed to each furrow. The flow rate for each furrow is adjusted individually. Its magnitude is determined by the size of the longitudinal slope of the furrows, so that no water erosion of the soil occurs. Furrowing is carried out with gravitational irrigation of maize areas. It is done with cultivators, complete with groove-forming work tools.

Irrigation by sprinkling is done with sprinklers and installations. This irrigation method is effective in irrigation systems with closed pressure channels and significant field macro equilibria. There is interest in cultivation of corn under reduced soil treatment. Where prerequisites exist: suitable areas; optimal soil density; suitable herbicides; highly efficient combined machines; experience of applying reduced soil treatment within crop rotation, corn can be grown under different soil cultivation options.

The reduction of soil treatment is a reduction in soil cultivation to a degree of non-violation of the biological requirements of the plants concerned to soil density. From this point of view, the cultivation of corn by reducing soil treatment can be divided into three levels: exclusion of surface pre-sowing soil treatments; slitting pre-sowing soil treatment; complete removal of soil treatment.

Fig. 3. Change of silage mass indicators depending on degree of ripeness

The harvesting of the stem corn mass with the simultaneous cutting is most effectively done by self-propelled forage harvesters. As the harvesting of the cut mass directly into the vehicles moving parallel to the combines creates some difficulties for the organization of the mass transport to the silage pits. It is considered an efficient organization of transport when using heavy-duty tractors with a servicing field tractor and serving transport tractors.

Harvesting of corn for grain is carried out by two technologies: harvesting of cobs and harvesting of grain. The main advantages of the first technology are the following: harvesting can be done at higher grain humidity (about 30%) when the stems are still green and can be ensiled; No additional energy costs are required to dry the grain; Timely release of sowing areas for subsequent crops.

Harvesting corn cobs is carried out with corn harvesters complete with cutting machines and tearing rollers. One such combine harvester is serviced by two conveyors - for cut and for cobs. Trailers are more convenient for this purpose, as the harvester is attached to the combine itself. If the combine harvester is not equipped with a peeler, it must be provided as a stationary device at the corn-casserole where the stalks are stored.

When grain humidity is reduced to below 22% in the maturity phase of maize, it is harvested using cereal harvesters, complete with maize harvesters (adapters). The resulting grain must be dried in grain dryers.

When grain corn is harvested, the development of the maturity phase and the decrease of grain moisture should be observed, as the maturity increases considerably the storage losses. Figure 4 shows the effect of shelf life after full maturity on grain losses. From the nature of dependencies, it can be seen that losses of free and broken grain intensely increase after 12-15 days of harvesting (from the beginning of full grain maturity). With the prolongation of the maize harvest, the biological losses mainly due to fallen cobs, which reach up to 25%, are particularly strong.

With the maturity phase of corn growing, the productivity of combine harvesters increases, but taking into account the increase in losses, the optimum harvest time for maize should be determined on an economic basis.
Losses exceed the permissible 5% after the 15th day of commencement of harvest. Assuming that direct costs of production after the 6th day remain constant, it follows that optimal earnings are obtained for 25 days from the harvest period from 20.IX. Until 15.X. Obviously, for greater accuracy in determining the optimal time, a deeper analysis of economic processes is needed. For example, changes in machine productivity, losses and costs, dependency on the harvest duration should be taken into account.

The performance of the harvesters varies considerably in the harvesting process depending on the condition of the crop. In dry and fully ripened corn, the machines develop higher productivity, but with extended shelf life, losses are intensely increasing, especially biological ones.

**Fig. 4** Change in losses during the harvesting period: 1 - biological losses; 2 - broken grain; 3 - loose grain loss.

**Conclusions:**
1. In the synthesized form the basic technological inspections of the cultivation and harvesting of corn with their peculiarities are justified.
2. The typical requirements for corn cultivation and harvesting by types of technological operations are shown.

**References:**
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DYNAMIC COMPUTER MODELING OF ARABLE WALKING TRACTOR WITH PLOW

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Abstract: The subject of the study is a motocultivator whose construction is designed for soil cultivation on small-scale private farms. Magnitudes - variables and constants that characterize the statics and dynamics of the motocultivator are identified. The motion equations are derived based on the corresponding body simplifications that move in the vertical-longitudinal plane with two degrees of freedom. The computerized simulation model of the dynamic system was developed using the Vemsim software. The numerical solution has been obtained. After analysis the relevant conclusions are made to improve the sustainability of the motocultivator movement within the required controllability.

KEYWORDS: DYNAMICS, MODEL, MOTOCULTIVATOR, SUSTAINABILITY, CONTROLLABILITY

INTRODUCTION
The problem of the dynamic sustainability of the movement of soil cultivation machinery is of paramount importance and is subject to the attention of many researchers (Bozhkov, S., at all 2011) (Daskalov, A., 1989) and others. These literary sources deal with different classes of four-wheel tractors that have a production economic purpose. In the articles of (Ovsyannikov, S., & Grib V., 2016) and (Ovsyannikov, S., 2015) the main mass-geometrical characteristics of the motocultivator were determined and the emerging forces were analyzed in his work. It is concluded that the addition of a supporting wheel is a useful solution to ensure the performance of the motocultivator. The dynamic state of the motocultivator is determined by the balance of forces applied to it during the work process. There are examples published on Internet clips that show that under certain conditions this balance can be ascertained that the motocultivator moves making a furrow without any external intervention by the operator, but observation on his part, of course, is very important, since even the smallest change in working conditions leads to a breach of the established balance of the forces.

The subject of the study in this article is the sustainability of the movement of a motocultivator with the task of formulating recommendations and introducing relevant improvements in its construction in order to ease the work of the person who works with it.

EXPOSITION
The calculation scheme and determination of the variables and constant parameters of the motocultivator
The motocultivator is studied as shown in Fig 1. To the original construction a supporting wheel pos. 9. is added. Two power sensors are mounted pos. 6 and 8, with which the forces occurring in the vertical longitudinal plane are measured when the motocultivator is operating. The movement in the direction of axis X is realized by the working wheel pos. 1. Keeping the horizontal movement in the horizontal plane is done by the operator with the rods, pos. 5.

Fig. 1. The calculation scheme of the motocultivator

In a static position on the motocultivator are exerted the forces from the engine block pos. 1, 2 and 3, the attached plow pos. 11 with pedal wheel pos. 10, shoulder pos. 9 and postal pos. 7. These are forces: G_M, G_T, R_1 and R_2 (Fig. 1). These forces and the linear dimensions shown in the figure are the constant magnitudes characterizing the motocultivator. In a dynamic mode, with a plow in the soil at depth a = 20 cm, when the motocultivator moves with a velocity V = 0.6 m/s, occurs pressure distributed over the surface of the plow, which can be represented as a concentrated force R_{xz}, from contact with the soil. This force forms an angle \( \psi = 120^\circ \) according to literature data (Demirev & Bratoev, 2012) with axis X and can be decomposed into two components: R_x and R_z, which are registered by the force sensors pos. 6 and 8. The T_H force occurs and causes the torque of resist as a result of the contact of the engine wheel with the soil.

The speed of motion of the motocultivator and the magnitude of these forces are variable in time according to the operating conditions.

The equations of movement of the motocultivator
We assume that the object of the survey consists of two concentrated mass points at point M and point T, (Fig. 1). There are two degrees of freedom. The moto block pos. 1, 2 and 3 makes a rectilinear translational movement in the X axis.
direction, and the attachment items, pos. from 6 to 10 - rotary motion at an angle $\varphi$ around a point $O_0$ and $Y$ axis, that is not shown in the scheme given in Figure 1. The movement is performed in the vertical-longitudinal plane defined by the OZX coordinate system with the origin point $O$. It is assumed that the model is a type of elliptical pendulum (Pisarev, A., etc. 1975).

The summarized coordinates $q_{1,2}$ of the model are the cartesian coordinates $x$ and $z$, and the effect of the rotation of point $M$ on angle $\varphi$ can be expressed as:

$$\varphi = \frac{x}{x} O_0 M \sin \varphi$$

Then for $q_{1,2}$ of the point mass $M$ we have:

$$q_{1,2} \rightarrow \begin{cases} x_M = x(t) + O_0 M \sin \varphi(t) \\ z_M = O_0 M \cos \varphi \end{cases}$$

The common kinetic energy of the translational and rotational movement is:

$$T = T_T + T_M$$

where $T_T$ is the kinetic energy of the engine block, and $T_M$ is the kinetic energy of the working machine. They have the following form:

$$T_T = \frac{m_T}{2} x^2 + \frac{m_M}{2} O_0 M \dot{x} \sin \varphi + \frac{1}{2} m_M O_0 M \dot{\varphi}^2$$

The potential energy of the body with the concentrated of mass is:

$$I_1 = -m_M g O_0 M \cos \varphi + r_k$$

where $g$ is the acceleration of the Earth.

The Lagrange's function of the two bodies is:

$$L = T - I_1 = \frac{1}{2} (m_T + m_M) \dot{x}^2 + m_M O_0 M \dot{x} \sin \varphi + \frac{1}{2} m_M O_0 M \dot{\varphi}^2 + m_M g O_0 M \cos \varphi + r_k$$

The movement is expressed by two Lagrange equations of the type:

$$\frac{d}{dt} \left( \frac{\partial L}{\partial \dot{q}} \right) - \frac{\partial L}{\partial q} = Q$$

The summarized active forces at the respective degrees of freedom are:

- along the axis $X$:

$$Q_x = T_{II} - F_x$$

- and along the axis $Z$:

$$Q_z = -R_z - G_T - G_M$$

The system of equations of motion acquires the type:

$$\begin{cases} (m_T + m_M) \ddot{x} + m_M O_0 M \ddot{\varphi} \cos \varphi - m_M O_0 M \dot{\varphi} \sin \varphi = T_{II} - R_x \\ m_M O_0 M \ddot{x} \cos \varphi + m_M O_0 M \ddot{\varphi} + g m_M O_0 M \sin \varphi = -G_M - G_T - R_z \end{cases}$$

In order to simplify the expressions we put: $D = m_M O_0 M$. And since the angle $\varphi$ varies very narrowly, it can be assumed that $\sin \varphi \equiv \varphi$ and $\cos \varphi \equiv 1$, then the system is:

$$\begin{cases} (m_T + m_M) \ddot{x} + D \ddot{\varphi} - D \varphi \dot{\varphi} = T_{II} - R_x \\ D \ddot{x} + D \ddot{\varphi} + g D \dot{\varphi} = -G_M - G_T - R_z \end{cases}$$

The system of equations presented in a matrix form is:

$$\begin{pmatrix} m_T + m_M & D \\ D & D \end{pmatrix} \begin{pmatrix} \ddot{x} \\ \ddot{\varphi} \end{pmatrix} + \begin{pmatrix} 0 & D \varphi \\ 0 & 0 \end{pmatrix} \begin{pmatrix} \dot{x} \\ \dot{\varphi} \end{pmatrix} + \begin{pmatrix} 0 \\ g D \dot{\varphi} \end{pmatrix} = \begin{pmatrix} T_{II} - R_x \\ -G_M - G_T - R_z \end{pmatrix}$$
The abbreviated entry is:

\[ A\ddot{q} + B\dot{q} + Fq = C \]  \hspace{1cm} (17)

Matrix A has the opposite matrix because it contains positive and constant magnitudes. The matrix equation (17) can be represented as a second-order linear differential equation:

\[ \ddot{q} = -A^{-1}B - A^{-1}F + A^{-1}C \]  \hspace{1cm} (18)

The computer simulation of the movement of the motocultivator. Numerical decision. We substitute with the magnitudes of the equations (17) and after the transformations we reach the following system of differential equations:

\[
\begin{align*}
\dot{x} &= dz_1; \\
\dot{z}_1 &= z_2; \\
\dot{z}_2 &= \frac{f}{a-d}z_3 + \frac{d}{a-d}z_3z_4 - \frac{c-b}{a-d} \\
\dot{z}_3 &= z_4 \\
\dot{z}_4 &= \left(-\frac{f}{a-d} + \frac{f}{d}\right)z_3 - \frac{d}{a-d}z_3z_4 + \frac{c-b}{a-d} + \frac{c}{d}
\end{align*}
\]  \hspace{1cm} (19)

where: \( a = 4.1 \); \( b = 12.5 \); \( c = 46.18 \); \( d = 30.6 \); \( f = 300 \).

The resulting fourth-order system (19) is brought to a system of four differential equations of the first order by changing the variables.

\[ x = z_1; \quad \dot{x} = z_2; \quad \varphi = z_3; \quad \dot{\varphi} = z_4 \]  \hspace{1cm} (20)

and acquires the following appearance:

\[
\begin{align*}
\dot{z}_1 &= z_2 \\
\dot{z}_2 &= \frac{f}{a-d}z_3 + \frac{d}{a-d}z_3z_4 - \frac{c-b}{a-d} \\
\dot{z}_3 &= z_4 \\
\dot{z}_4 &= \left(-\frac{f}{a-d} + \frac{f}{d}\right)z_3 - \frac{d}{a-d}z_3z_4 + \frac{c-b}{a-d} + \frac{c}{d}
\end{align*}
\]  \hspace{1cm} (21)

A simulation model (Fig. 2) is drawn using the symbol’s of “Vensim” - a simulator for graphical simulation, and simulation of dynamic systems described with ordinary differential equations (Mitrev, P., 2016).

**The analysis of the sustainability of the linear system**

The system’s differential motion equations (19) are linear, which means that the matrix A own values fully determine the stability of the equilibrium point and the type of the phase portrait. In this case the solutions of its characteristic equation are:

\[ \lambda_1 = 34.7 + 44.3j \quad u \quad \lambda_1 = 3 \]  \hspace{1cm} (22)

These are two complex conjugate numbers with a positive real part, which means that the phase trajectories represent a family of logarithmic spirals which move away from the equilibrium point, i.e. we have an unsustainable focus.

**CONCLUSION**

The dynamic modeling of the moto cultivator has shown that it is an unsustainable system that demands to be continuously regulated with external impact in order to function according to its purpose, namely to pass a rectilinear furrow in the pole.

The insertion of a support wheel does not ultimately solve the issue of sustainability. The additional measures are also required, which, according to the results of the study, are change in the values of the parameters in the matrix A. When the real part of
the roots eq. (21) becomes negative, the phase trajectories become a family of logarithmic spirals that are approaching the equilibrium point called sustained focus. And if the values of the matrix $A$ are purely imaginary numbers, then in this case the phase trajectories will be invested in each other ellipses (or in particular circles) including the equilibrium point that is neutral stable and is called the center. And if the values of the matrix $A$ are purely imaginary numbers, then in this case the phase trajectories will be merged in each other’s ellipses (or in particular circles) including the equilibrium point that is neutral stable and is called the center.

This can be achieved by changing the values of the elements of the matrix $A$, which represent the masses of the two bodies involved in the dynamic model. In other words, it is necessary to introduce reasonable changes in the construction of the moto block by changing some dimensions and materials from which its details are made.

REFERENCES


OPTIMIZATION OF THE NUMBER OF HARVESTING AND TRANSPORT COMPLEXES IN WHEAT FARMING

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Abstract: The efficient operation of the harvesting transport complex (grain harvester - transport aggregate) depends on the organization of the transport service and the identification of the necessary means of transport is a probable task.

An economically viable ratio counts combines, service vehicles for which minimizes the target function:

\[ S = C_{\Pi} \lambda t_{ov} + C_a n \Rightarrow \min \]

Overview of pre-selection - transport complex as a mass service system.

When machines are operating in a group, service requests are continually being carried out on a grain harrow filled grain hopper and after unloading the hopper, the combine is restarted and is a potential source of new orders.

Thus, the "harvester-car" system is considered a mass service system in which a service request per unit time arises on average.

We assume that the stream of queries is a simple (Poisson) stream that is ordinarily, stationary, and without consequences.

The query flow intensity is \( \lambda \), and the bandwidth of the service channel is \( \mu \). Then the average number of grain combinations waiting to be served by transport means \( m_s \):

\[ m_s = \frac{\psi^{n+1}}{n!n(1 - \frac{\psi}{n})^2} \times \left( \sum_{k=0}^{n} \frac{\psi^k}{k!} + \frac{\psi^{n+1}}{n!(n - \psi)} \right)^{-1}. \]

Where \( \Psi = \lambda t_{oac} \), and \( t_{oac} \) is the average wait time for service start requests.

The mathematical model for optimizing the number of vehicles for servicing a group of grain harvesting combines is:

\[ S = C_1 m_s + C_2 n_s \Rightarrow \min \]

\( C_1 \) is the value of the layover time of the combine harvesters, \( C_2 \) - the value of the vehicle's layover, \( n_s \) - the average number vehicles, waiting to be loaded from the combine harvester.

The proposed model is certified with real data for agricultural cooperative in Yambol and the results show that for 5 CLAAS combine harvesters, is optimally served by three cars working in a group.

KEYWORDS: COMBINE HARVESTERS, SERVING CARS, REQUESTS, MASS SERVICE SYSTEM, MATHEMATICAL MODEL, OPTIMIZATION.

The efficient operation of the harvesting transport complex (grain harvester - transport aggregate) depends on the organization of the transport service and the identification of the necessary transport means is a probability task.

The aim of the study is to propose a mathematical model for optimizing the number of harvesting-transport complex in wheat growing and to approbate it into the practice.

An economically viable ratio counts combines and vehicles servicing them, in order to minimize the target function:

\[ S = C_{\Pi} \lambda t_{ov} + C_a n \Rightarrow \min \]

Where \( C_{\Pi} \) are losses per hour stay of harvesters in a state of waiting for service, BGN;
\( \lambda \) - Average number of filled bunkers (service requests) for 1 hour;
\( t_{ov} \) - the average wait time of each service request, h;
\( C_a \) - The hourly loss of a vehicle maintenance (sum of the mid-term evaluation, the value of the renovation allowances and the wages of the driver, BGN / h;
\( n \) - The number of cars in the retractable - transport complex.

We consider a harvesting- transport complex as a system of mass service [1,2,5,6] (fig.1).
When machines are operating in a group, service requests on a grain-filled grain hopper are continually being carried out and, after unloading the hopper, the combine is again started and is a potential source of new orders.

Thus, the “harvester-car” system is seen as a mass service system in which in average arises a service request \( \lambda \) per unit time.

At the same time, each vehicle (service channel) is able to meet a request \( \mu \) per unit of time.

We assume that the flow of requests is a simple (pouasonian) flow that is ordinarily, stationary and without consequences [3,4].

The flow rate of requests is \( \lambda \), and the throughput of the service channel is \( \mu \). Then the average number of grain combines waiting to be served by means of transport \( m_s \) [1,2]:

\[
m_s = \frac{\psi^{n+1}}{n!n\left(1 - \frac{\psi}{n}\right)^2} \sum_{k=0}^{n} \frac{\psi^k}{k!} + \frac{\psi^{n+1}}{n!(n - \psi)}
\]

Where \( \Psi = \lambda \cdot t_{abc} - \mu \cdot t_{abc} \) is the average wait time for service start requests.

The number of standby vehicles is determined by the dependence:

\( n_s = n - \Psi \)

The proposed model is certified with real data for agricultural cooperative in Yambol.

In Fig. 2 there is a graph of the function describing the relationship \( S = f(n) \), where \( S \) is the loss of downtime of the operating machines, and \( n \) is their number. An inflection point of the resulting curve is defined, describing the dependence \( S = f(n) \) by a first derivative.

Table 4.13 Output information to optimize the number of harvesting transport complex in wheat growing

<table>
<thead>
<tr>
<th>n</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m_s )</td>
<td>12,889</td>
<td>0.866</td>
<td>0.448</td>
<td>0.302</td>
<td>0.228</td>
<td>0.183</td>
<td>0.153</td>
<td>0.131</td>
<td>0.115</td>
<td>0.102</td>
</tr>
<tr>
<td>( n_s )</td>
<td>0.072</td>
<td>1.072</td>
<td>2.072</td>
<td>3.072</td>
<td>4.072</td>
<td>5.072</td>
<td>6.072</td>
<td>7.072</td>
<td>8.072</td>
<td>9.072</td>
</tr>
<tr>
<td>S</td>
<td>2579.578</td>
<td>199.934</td>
<td>141.375</td>
<td>137.217</td>
<td>147.380</td>
<td>163.393</td>
<td>182.367</td>
<td>203.044</td>
<td>224.793</td>
<td>247.259</td>
</tr>
</tbody>
</table>
Conclusions:
1. The cereal harvesting process and grain transportation is formalized as a model of a mass service system.
2. A mathematical model has been proposed for optimizing the number of vehicles used for the operation of the grain harvesters in a group.
3. The results for the 5 CLAAS grain harvesters working in a group in the Yambol region are optimally served by three vehicles with a certain load capacity.

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DETERMINATION OF THE LIQUIDITY VALUE OF AGRICULTURAL AND FORESTRY EQUIPMENT

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Abstract: The structure of production in agriculture is changing with the change of priorities, both at EU and national level. On the one hand, this is due to interconnection in individual sub-branches, on the other, to the replacement of traditional technologies with new ones. In both cases, this requires the maintenance of more equipment than is necessary for production and the corresponding increase in the cost of production and the reduction of the profit from production. Significant lagging of the machine-tractor fleet renewal processes and increased loading of the used equipment imply intensive physical wear and obsolescence.

Depending on the reasons for write-off, when determining the liquidation value of the machinery, account shall be taken of special features and the possibilities for further use of individual elements (parts, assemblies and aggregates). Several approaches are used to determine the liquidation value:

- the whole machine is considered scrap. The approach is applicable to working machines and attachments to self-propelled agricultural machinery;
- the whole machine is classified as scrap but is dismantled and divided according to the type of scrap (ferrous and non-ferrous metals). The approach is applicable to retractors and attachments to self-propelled agricultural machinery as well as stationary machinery for primary production processing;
- the machine is rated as scrap of ferrous and non-ferrous metals and second-hand spare parts. The approach is only applicable to physically worn machines.

In addition to that, an improved methodology for assessing the liquidation value of different groups of agricultural machinery for moral and physical extinction with and without residual resource elements is suggested.

Keywords: agricultural machinery, spare parts, liquidation value, scrap, methodology, expenses.

The structure of production in agriculture is changing with the change of priorities, both at EU and national level. On the one hand, this is due to interconnection in individual sub-branches, on the other, to the replacement of traditional technologies with new ones. In both cases, this requires the maintenance of more equipment than is necessary for production and the corresponding increase in the cost of production and the reduction of the profit from production. Significant lagging of the machine-tractor fleet renewal processes and increased loading of the used equipment imply intensive physical wear and obsolescence.

The level of reliability of traditionally used universal and specialized machines increases when loading increases sharply. For example, for the most massive tractors such as “Belarus - 954”, the average workmanship to a 550-hour refusal has dropped to 300 hours. Similar is the situation with self-propelled machinery. Average and workout till failure is from 80 to 90 hours. The results of the occurrence of the most common reasons for refusal given in Fig.1.

Fig.1. Distribution of failures due to occurrence: ПE - continuous operation; ЕН - natural wear; КИ- quality of production; КН - structural disadvantages; НПЕ - violation of exploitation rules; КР - quality of repair.

Maintaining the working capacity of such equipment is extremely labor-intensive and costly. The annual cost of maintenance and repair increase to 20-25% of the machines as 85-95% of the downtime of machines for technical reasons it is to eliminate failures and only 5-15% for maintenance. To reduce them, some of the equipment is removed from the production process without use, and another is used only for spare parts, and is subject to write-off from the company's balance sheet [1].

Depending on the reasons for derecognition, when determining the liquidation value, account must be taken of their peculiarities and possibilities for further use of parts (parts, assemblies and aggregates) of the derecognised machines. The purpose of the report is to propose an improved methodology for determining the liquidation value of agricultural machinery when decommissioning / derecognition /.

When the machine ceases to bring economic benefits to production due to physical or moral degradation, it must be written off from the company’s balance sheet. If the write-off of the machine is due to physical or moral degradation, several methods for determining the liquidation value can be applied:
- the whole machine is considered scrap. The approach is applicable to working machines and attachments to self-propelled agricultural machinery;
- the whole machine is classified as scrap but is dismantled and divided according to the type of scrap (ferrous and non-ferrous metals). The approach is applicable to retractors and attachments to self-propelled agricultural machinery as well as stationary machinery for primary production processing;
- the machine is rated as scrap of ferrous and non-ferrous metals and second-hand spare parts. The approach is only applicable to physically worn machines.

When the machine is physically or morally worn and cannot be used (due to lack of residual resource or economic benefit), then the basis for determining the liquidation value of the machine is the cost of scrap. The machine is rated as scrap.

\[
C_{il} = G_{n} - (C_{tp} + C_{y} + C_{T}) 
\]

\[
C_{ij} = \sum_{k=1}^{K} G_{ke} \cdot C_{k} + \sum_{l=1}^{L} G_{lw} \cdot C_{l} - (C_{p} + C_{y} + C_{T} + C_{tp})
\]

Where

- \( C_{k} \) - the weight of the k-th element of non-ferrous metal, t;
- \( G_{k} \) - the price of non-ferrous metal scrap, BGL / ton;
- \( k = 1 - K \) - the number of non-ferrous metals;
- \( G_{l} \) - the weight of the l-th element of ferrous metals, t;
- \( C_{m} \) - the price of ferrous metal scrap, BGL / ton;
- \( l = 1 - L \) - the number of ferrous metal elements;
- \( C_{p} \) - costs of separation of non-ferrous metals, BGN.

This approach is most commonly applied to one of the harvesting and combination machines with active working bodies, aggregated to tractors and stationary machinery for primary processing of the product - a machine consisting of a small number of elements (aggregates, assemblies and parts) with a relatively simple construction.

The durability and flawlessness of each machine depends on a number of subjective and objective factors such as: qualification of the staff, working environment, nature of the load, periodicity of service and the quality of its performance, etc. When working, even identical elements of a machine refuse through different periods of time. This is true in the case of self-propelled agricultural machinery and there is sufficient reason to assume that taking into account the wear of the individual elements with the valuation of their residual resource is the correct way of determining the liquidation value of the machine. Figure 2 shows the residual resource of basic elements of universal tractors with mechanical transmission after 10 years of use at an average annual load of 600 to 800 mph [2,3].

**fig.2. residual resource of basic elements of tractors belarus and zetor after scrapping after 10 years of use at an average annual load of 600-800 hours: HC- hydraulic lifting system; K- cabin; Д- engine; ЗМ- rear axle; СК- gearbox.**

Valuation of the residual resource requires the use of reliable statistical information about the average resource of the main elements of the machine, the market prices of the new and second-hand spare parts, the requirements and the time for the disassembly and installation of the elements, the need for specialized equipment for settings and adjustments, etc. In this case, it is necessary to perform: disassembly of the machine into elements, verification and separation of the elements of groups with and without residual resource, evaluation of the elements without residual scrap resource and evaluation of the residual resource elements as such second-hand use. For average resource of a new or after a major repairs of a machine, such manufacture is accepted in which its main
elements reach a frontier state. Generally, it can be determined by the formula:

$$t_p = \prod_{i=1}^{n} t_{ie}(n \cdot \nu_p - 1)^{-1},$$

Where \(t_p\) is the resource of the machine till repairs, moto hour or liter of fuel;

\(t_{ie}\) - the resource of the i-th element till reaching the limit state, the moto hour or liter of fuel;

\(n\) - number of the elements of which the machine is divided;

\(\nu\) - the manufacturing cycle in which the main aggregates and assemblies are expected to reach a limit state.

Hence, the determination of the residual value of the individual elements of the machine on the basis of their unused scrapping resource can be made according to the formula:

$$C_{oi} = k_i \left[ \frac{t_{ie} - t_p}{t_{ie}} \right] C_{ne},$$

Where \(C_{oi}\) is the residual value of the i-th element of the machine, BGN;

\(k_i\) - the coefficient counting the number of identical elements of the machine.

\(C_{ne}\) - the price of a new item, BGN.

The dismantling of the machine and the separation of elements is labor-intensive, and labor and material costs for doing so (costs of dismantling, cleaning and commercialization and temporary storage until the sale) should also be taken into account. Where the items have a residual resource, there are two options for further use: to be offered for sale as second-hand items or to be used by the owner of the spare parts machine. In the first option, the owner has to specify a sale price for the item. It is calculated by the formula:

$$C_{ie} = k_i \left[ \frac{t_{ie} - t_p}{t_{ie}} \right] C_{ne} + \left( C_{oi} + C_{ai} + C_{ci} \right) + H_p,$$

Where \(C_{ie}\) is the sale price of i-th second-use item, BGN;

\(C_{oi}\) - is the value of the disassembly work on separating the i-th element of the machine, lv;

\(C_{ai}\) - the cost of the cleaning and commercialization of the i-th element, BGN;

\(C_{ci}\) - Are the cost of storing the i-th element, BGN;

\(H_p\) - - the normative profit, BGN.

With the second option, the owner needs to capture the balance sheet items of his enterprise by residual value. The total value of the residual resource elements that can be used as second-hand spare parts can be determined by the expression:

$$C_o = \sum_{m=1}^{M} \left[ k_m \left( \frac{t_{me} - t_p}{t_{me}} \right) C_{me} + \left( C_{am} + C_{im} + C_{cm} \right) \right],$$

where \(C_o\) is the residual value of the machine elements, lv;

\(m = 1 - M\) the number of machine components that meet the profit condition, BGN.

Then the liquidation value of the machine will be:

Conclusions:
1. The reasons for the physical and moral wear of the machinery used in agricultural production have been examined.
2. An improved methodology for estimating the liquidation value of the three basic groups of agricultural machinery after moral and physical wear with and without elements of residual resource

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INTRODUCTION

In the last decades, a variety of small-scale equipment is available on the market, designed for a wide range of soil and agriculture activities. The small variants of these aggregates (for areas up to several acres) are based exclusively on a motor block with aggregate machines.

In the literature, the term “motor block” is known to be part of the wider concept of “one-axle drawbar”, which is a self-propelled wheeled machine designed to tow a variety of semi-trailer and tractor-propelled machinery and equipment.

This variation of aggregation brings many advantages associated with a lot of functionality, manageability, simplicity of construction, stability, but there are also disadvantages such as the inability to function without an aggregate machine, such as poor bending stability, complicated aggregation.

The area of application of the motor block varies from the cultivation processes: milling, cultivation, plowing, grooving, harvesting of root crops, mowing with knife- or disc apparatuses; carrying goods with a trailer; snow cleaning with rotor or paddle aggregates to construction of all kinds of devices at home.

EXPOSITION

The subject of the present work is the HSD1G-75 motor block, with a maximum power of 6.5 hp at 3000 rpm, a passport mass of 73 kg and two forward and one rear speeds.

Steel and rubber coupling wheels are attached to the unit. To motor block aggregated: milling drums (up to 1 m in width), plows, row cultivators, grooves, potato mowers and subsoiling.

The aim of the study is to establish the technical capabilities of the motor block and aggregated inventory in terms of stability and functionality and to measure some strength, power and exploitation characteristics.

The conditions, means and method of the study include: not necessary to construct a torque equation of the vertical forces with respect to the contact point of the traction wheels:

\[ x = 0,2 \]

\[ \delta = 0,1 \]

\[ \gamma = 0,2 \]

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\[ \delta = 0,2 \]

\[ \gamma = 0,2 \]
and \( R_k \) are respectively the distance to the support wheel and the force on it.

With an average force measured at the support wheel 210 N, a reactive moment of 60 Nm, the mass of the unit 82 kg and the distances: \( x_k = 0.82 \text{ m} \), \( x_z = 0.47 \text{ m} \) and \( x_a = 0.07 \text{ m} \), for the reaction \( R_z \) we obtain 116.6 N, which is very close to the calculated value of 120 N.

Calculations of useful plowing power, based on the traction force (600 N) and the reported aggregate speed (0.6 m/s), show that only 360 W of available power is realized.

Fig. 1. The diagram of the aggregate: 1 - support wheel, 2 - plow body, 3 and 4 - tenzometric sensors, 5- moto block.

Fig. 2. The graph of the traction force

Fig. 3. The graph of the force \( R_k \) in the support wheel
CONCLUSION

- First of all, it should be noted that, in general, the motor block is functional;
- Simultaneously with the above, serious remarks or inability to work the whole unit are also reported;
- Changes in design and workmanship are required to make full use of the unit’s capabilities.

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URL: 
Abstract: The subject of the paper are linked processes in agriculture. Sophisticated relations between operational and transportation farm practises in time, place, and mass balance need compound simulation based on computer software. Important prerequisites for a good solution is a well-founded land management project. The last one have to include at least proper crop rotation plan and corresponding road net. The different combinations of crop yield, bulk density, distant of transportation for distinct plants require many concrete solutions. Furthermore, transportation can be realized with or without intermediate capacity like buffers, bins, overloader trailers, exchangeable trailers, etc. For fastets harvest, computation are made with maximum number of selfpropeler harvesters or enough to end of crop gather in acceptable periods. In the example, a joint work of Claas Lexion 600 and tractor with 9, 12 and/or 21 tons carrying capacity of trailer are discussed. For easy choice of every concrete solution, additional information can be used like linked processes performs and graphic illustration. The proposed optimal procedure garatees enough data for reasonable solution based on real combinations of technology, machinery, vehicles, intermediate and final capacities.

KEYWORDS: LINKED PROCESSES, COMPUTER SIMULATION, GRAPHIC ILLUSTRATION, HARVEST AND TRANSPORTATION.

INTRODUCTION

Associated processes include synphanous or synchronous technological and transport impacts on products with their collection or scatter, followed or preceded by moving them. They are also known as transport and production processes in two varieties: retractable and transport-distribution, including in agriculture (GOST 17460-72).

Especially in agriculture, the connectivity of processes is not only at a time, but also in a location that depends on many factors such as variation of the picked / scattered product in the various fields of the field (yields), volume of capacity, width of work ... (Vizrov, Ch. Zl., Stoyanov K., Evg. & Atanasov, At., 2009), (Parhomenko S. 2012). The complexity of the task of optimization of the system of technological and transport means also increases due to different transport distances, conditions of transport (flooring, intensity of traffic), the interaction of the technique with the warehouses (Bourlakis, MA, Vlachos, PI & Zempekis V. 2011), (Gebresenbet, G. & Bosona, T. 2012), (Vizrov, Ch. Zl. & Kozlev, R. Al., 2006).

Our previous successful attempt to find a local optimum for the system of retractors and vehicles (Vizrov, Ch. Zl., Atanasov, At. Zdr. & Spiridonov, VG 2016) encouraged us to expand the search for an appropriate solution to the task for a whole farm and a full cropping cycle for crop rotation from the accepted crop rotation. In the case of two-year crop rotation with wheat and corn, the global optimum will refer to a two-year business cycle.

EXPLANATION

It is necessary to provide some preconditions for a reasoned, long-term solution to the problem. It is accepted to determine the number of crop rotation, each of them needing an example of the same amount of resources: time to carry out related processes, material and technical equipment, including warehouse facilities, service personnel. In multipurpose crop rotation, this means, for example, the same areas of each field, in particular, of each crop. However, this means a different quantity of shipments for seeds, seedlings, manure, harvested basic and additional production. For example, yields and bulk densities of some major crops for Bulgaria require different capacities for the bodies of cars and trailers: wheat - 445 kg / dka, 750 kg / m³, corn for grain - 527 kg / dka, 720 kg / m³, kg / dka, 480 kg / m³, pepper - 1653 kg / dka, 280 kg / m³, potatoes - 1329 kg / dka, 640 kg / m³, 2013 kg / dka, 600 kg / m³, sunflower - 224 kg / dka, 400 kg / m³, oilseed rape - 212 kg / dka, 670 kg / m³... Correspondingly, the entire body will be filled with a different area and the filling time will be altered depending on the speed of the retractor the basic and additional production and the height of the stubble.

It is also necessary to take into account the likelihood of simultaneously carrying out the same activities as fertilization, harvesting in different crops. For example, the harvesting periods for wheat and oilseed rape may overlap. Except for example, the uniform area (in anticipation and for example near yields) during each of the years of crop rotation, it is also desirable that the average transport distances do not differ significantly. Such a requirement can be achieved by a properly grounded land-use project. It should, in turn, optimize the main and additional road network for the farm.

After ensuring the prerequisites in question, the optimization procedure continues with the collection of the basic information on the conditions under which the related processes will take place. As a rule, the least varied data for each crop crop field in crop rotation is its area, slope, expected average yield of primary and additional production and the ratio between them; the length of the roads in the field, the roads and the permanent pavement between the field and the warehouses. For ease of use with a spreadsheet, the specific metrics for the proposed technique are calculated. In the example of wheat harvesting, some retracting and transport means are shown - figure 1.
Since the interaction between technology and transport means is generally not a stationary process, it is also necessary to take account of the length of the process in the day. Most often it is limited by the possibility of harvesting the produce from the field. Increasing product humidity at night can lead to reduced productivity and even to a lack of quality harvesting. On the other hand, the total area from which the crop is harvested, the type and number of harvesting techniques must ensure that the harvest is completed at optimal time. For crops with higher average yield, bulk density and retraction speed, the above condition can also be achieved with less retraction techniques (also used for other crops). Similarly, the transport situation at a higher bulk density and a slight reduction in speed, assuming similar traffic conditions. This means that the maximum number of retractors is taken into account. For transport, the solution is sought by comparing the indicators for the associated processes for different types and number of transport aggregates (from one to all available). In terms of intermediate capacities (bunkers, overloading trailers, temporary sites or sheds), their number varies from 0 (ie not used) to the maximum possible amount. As a rule optimization is done with maximum number of end capacities (warehouses).

Below are specific master data for the harvesting maize example - Table 1

The maximum number of pickers (in this case, self-propelled grain combines with the corresponding harvesters) and retractors is started. Of course, they can also consist of more than one brand combinations, for example single tractors or tractors (eg one trailer 1PTC-9 and 3PTC-12). No intermediate capacities are involved at the outset. Such an approach implies that the use of all available techniques will allow the work to be done in the shortest possible time. Therefore - and with the least loss of production. It is assumed that no intermediate capacities are available on the holding (further checking whether it is efficient to buy more intermediate capacities, possibly transport and retractable means). As a last resort, it is possible to increase the capacity and capacity of the warehouses (this investment is supposed to be the most expensive). There are obviously too many combinations of items and types of technical equipment for which performance indicators are sought. This also leads to considerable labor intensiveness of the optimum search procedure.

Fig. 1. An example of facilitating the determination of the performance indicators for associated wheat harvesting processes and the transport of grain by tractor trailer
Преуспехлост на работа на прибиращите средства - 720 минути, превоз е на разстояние 2,7 км.

### Таблица 1. Основни данни за оптимизация на процеса - пример за опашка на ячменя

<table>
<thead>
<tr>
<th>Показатель</th>
<th>Размерность</th>
<th>Целевая</th>
<th>Бухгалтерия средства – самоходное зерноуборочное</th>
</tr>
</thead>
<tbody>
<tr>
<td>Вместимость на бункера</td>
<td>m³</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Время на наполнение на един бункер</td>
<td>мин</td>
<td>16,9</td>
<td></td>
</tr>
<tr>
<td>Время на разтоваривание в бункера</td>
<td>мин</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Пропускная способность</td>
<td>kg/с</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Жестянка/шедер/кетербар</td>
<td></td>
<td>-</td>
<td>CONSPEED 8-row, ALL-B или MA-580</td>
</tr>
<tr>
<td>Рабочая ширина</td>
<td>m</td>
<td>5,6</td>
<td></td>
</tr>
<tr>
<td>Трактор/автомобиль влекач тяга</td>
<td></td>
<td>-</td>
<td>К-701</td>
</tr>
<tr>
<td>Ремарк/трейлер прицеп</td>
<td></td>
<td>-</td>
<td>1ПТС-З</td>
</tr>
<tr>
<td>Тягоносность (с грузоподъемностью)</td>
<td>t, m³</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Время на отгонов процесс</td>
<td>мин</td>
<td>12,5</td>
<td></td>
</tr>
<tr>
<td>Время на вращение путь</td>
<td>мин</td>
<td>17,6</td>
<td></td>
</tr>
<tr>
<td>Время на разтоваривание в склад</td>
<td>мин</td>
<td>4,2</td>
<td></td>
</tr>
<tr>
<td>Время на претягание и оформление на документ</td>
<td>мин</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Буфер/буфер, бункер наполнитель, прицеп перегрузчик</td>
<td></td>
<td>Лен-20НПП</td>
<td></td>
</tr>
<tr>
<td>Тягоносность (с грузоподъемностью)</td>
<td>m³</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Время на разтоваривание в превозном средстве</td>
<td>мин</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

| Вместимость на склада                          | m³          | 300     |
| Время для обработки на посевылима продукт в складе | мин   | 4       |
| Сжигание на зерно кг                            |           | 800     |
| Население на полюса                           | -          | Под горота |
| Длина на зерно (для уборки)                     | kg/дка     | 800     |
| Средняя скорость на движение на             | km/h        | 30, 28,5 / 18 |
| Средняя скорость на движение на             | km/h        | 30, 28,5 / 18 |
| Средняя скорость на движение на             | km/h        | 30, 28,5 / 18 |
| Средняя скорость на движение на             | km/h        | 30, 28,5 / 18 |
| Средняя скорость на движение на             | km/h        | 30, 28,5 / 18 |
| Средняя скорость на движение на             | km/h        | 30, 28,5 / 18 |
| Средняя скорость на движение на             | km/h        | 30, 28,5 / 18 |
| Время для перехода на буфера до             | мин         | 2,2     |
| Время для перехода на буфера от             | мин         | 2,2     |

Для упрощения для вычисления машинного средства, сравним различные варианты комбинаций по типу и количеству технических средств для взаимосвязанных процессов, предлагается критерий выбора (критерий). Расчет чисел становится автоматическим и сравнение оставляется на усмотрение дизайнера (инвестора), то есть это человеко-машина схема для принятия решений.

Важным для эффективности взаимосвязанных процессов является их производительность, длительность непродуктивных остановок отдельно для каждого технического средства и типов: демонтаж, транспорт, промежуточный, конечный общий. Кроме того, можно учитывать ожидаемую площадь, из которой будет выращена продукция, специфические затраты на время и стоянку, коэффициент непрерывности и степень снижения производительности различных технических средств. Таким образом, ожидаемая производительность для связанного комплекса может быть рассчитана для специфических комбинаций по типу и объему ресурсов в день (или смену, в час). Это предпосылка для одновременного использования ресурсов для взаимосвязанных процессов, а не отдельно и в стадионах определения времени, работы и технических ресурсов. Графическое представление функционирования каждого из технических средств еще больше упрощает анализ. Например, возможно установить, есть ли стационарность, виды длительных остановок ... Фигуры ниже таблицы показывают конкретные случаи.

Фиг. 2. Продукт в зерне - синий и в автомобиле - в плитке. Объединенная площадь 276 га. Рекрутирующий инструмент использует 60% своих возможностей.

To facilitate comparison between different variants of combinations by type and number of technical means for the connected processes, sample selection criteria (criteria) are offered. The calculation of the numbers in question becomes automatic and the comparison is left to the designer (the investor), i.e. it is a human-machine scheme for decision-making.

It is important for the efficiency of the connected processes to be their productivity, the duration of non-productive stays separately for each technical means and by types: retractable, transport, intermediate, final capacities. Additionally, you can take into account the expected area from which the production is recovered, the specific costs of time and standstill, the continuity factor and the degree of decrease in productivity of the various technical means. Thus, the expected productivity for the associated complex can be spent at the specific combinations by type and amount of resources per day (or shift, per hour). This is a prerequisite for the simultaneous modification of the resources for the related processes, not by the separate and multi-step specification of the time, labor and technical resources. The graphical representation of the functioning of each of the technical tools further facilitates the analysis. For example, it is possible to establish or not the stationarity, to see prolonged stays ... Figures below the table show specific cases.
Fig. 3. Product in grain - blue and in the vehicle - in a tile. Built area 172 dka. The vehicle has a higher capacity and fewer courses.

Fig. 4. Product in grain - blue and in the vehicle - in a tile. Covered area 221 dka. The vehicle is a traction train with a higher capacity and fewer courses.

Fig. 5. Product in grain - blue, in intermediate place - in the tile and in the vehicle - in green. Occupied area 398 dka.

Fig. 6. Product in grain - in blue, in trailer 1 - in tile and in trailer 2 - in green. Built area 362 dka.

From the point of view of the highest performance, the option with intermediate capacity is suitable. However, if we have run-of-the-mill trailers, we can deliver performance close to the highest without buying extra capacity.
CONCLUSIONS

The proposed procedure for finding an optimal solution for related processes imitates the real co-operation of different combinations of technology, vehicles, intermediate and final capacities. The specific choice can be based on the analysis of the graphical representation of the processes and the predicted aggregated indicators.

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Abstract: The paper considers the need for designing a dispenser for automated delivery of concentrated feed of small ruminants. Provides an analysis of the criteria for choosing optimal of auger conveyor parameters to ensure the required dosing accuracy for the specific purpose.

KEYWORDS: E-LEARNING, MODEL, EFFICIENCY, EFFECTIVENESS, GPS, PROTECTION

INTRODUCTION: Individual and accurate dosing of concentrated feed is still an unresolved problem for modern and high-yielding goats and sheep. The lack of automated solutions in this area leads to increased costs for animal husbandry and incomplete use of genetic potential. To create such a device to be used on livestock farms where the environment is unfavorable, it is necessary to find an effective solution with a simple, reliable and inexpensive construction that guarantees the necessary feed distribution accuracy.

EXPLANATION: The amount of feed consumed by small ruminants is strongly associated with the intake of nutrients. The level of available nutrients determines how much milk can be produced. Available nutrients can come from what is consumed through the diet or taken from their reserves. If nutrient consumption is not enough to meet nutrient requirements for milk production, animals will have to mobilize their nutritional reserves in the body to provide the missing nutrients. The reserve nutrients that animals usually mobilize are energy (fats) and proteins (tissues). When this happens, the animal loses body weight, which is normal for high-performance HDI. The combination of nutrients provided by the diet and derived from body supplies must be sufficient to provide the necessary nutrients for the amount of milk that is produced. If these two sources can not obtain adequate nutrients, HDI will reduce milk production to match the available nutrients: nutrients (diet + body reserves) = production (milk + body weight). When HDI feeds on a high nutritional level but does not have the genetic capacity to produce the corresponding amount of milk, they will accumulate the excess energy they consume as body fat. In this way they accumulate weight.

Therefore, appropriate amounts of nutrients should be provided to maintain the level of milk production that are genetically capable of producing. Concentrated feed has a high cost and its ineffective application reduces the cost of production in the herd.

Existing GPP practice of concentrated feed does not take into account the individual needs of animals. Now nutrition is the same for all animals. This leads to malnutrition of animals with higher productivity and ineffective feeding of animals with lower productivity.

The technical and technological capabilities for animal identification (RFID) exist and, moreover, official veterinary identification is required throughout the EU. It is possible, however, to use these achievements in conjunction with appropriate hardware and software to manage an appropriate metered dose dispenser for concentrated feed.

There is no evidence of research and implementation of such a decision in scientific and company literature (Kellems, R., 2009).

In this connection, the author of the article develops a dissertation on the topic "Investigation of an automated feeding device for farms for small ruminants". For this purpose, it is envisaged to use a precision screw dispenser (Figure 1) for individual nutrition of HDW using RFID and electronic mechanical control.

Systemic studies of auger conveyors, dispensers, mixers began in the early 1960s (Rehkgugler, G., & Boyd, L., 1961). Research has evolved both theoretically and experimentally. In the field of theoretical studies up to this period the calculations of the auger parameters refer purely to their geometric parameters.

As a result of the observations of the auger operation, there are discrepancies between the calculated values of the augers and the expected performance, energy consumption indicators. In practice, performance is lower than the nominal.

![Fig. 1. Principal scheme of a screw conveyor for concentrated feed](image-url)
In this regard, the researchers apply the theory of dimensions and the theory of similarity. Thus, they achieve a significant extension of the research criteria. This enables detailed experimental research on various new arguments and benchmarks on the workflow in terms of productivity, the power required. The volume efficiency criterion of the auger is entered.

Studies using the theory of similarity and dimensions were conducted in Bulgaria by Professor Ivan Georgiev with regard to auger mixers.

Researchers from the United States, Australia, Hungary, Germany, as well as institutions such as the Association of Agricultural Engineers and Biology ASABE (American Society of Agricultural and Biological Engineers).

As a result of these studies over 60 years it has been found that the processes of the auger conveyors are complex and contradictory.

When choosing parameters for a screw conveyor, the characteristics of the materials transported, the construction parameters, the kinematic parameters (Benkő, J., 1997) must be taken into account.

The controversy of the process is expressed in the discrepancy between theoretical and experimental performance. Experimental performance is less than theoretical. This also determines the demand for such a combination of constructive and kinematic parameters in accordance with the characteristics of the transported (dosed) material so as to achieve compactness and acceptable dosing accuracy.

In order to achieve the required accuracy, up to 5% combined with the compactness of the device, appropriate diameter, step, diameter ratio, minimum rotational speed, suitable auger material, which will be subjected to conveying of concentrated feed aggression of fat, carbohydrates, proteins and various microelements.

From the review, it has been found that in order to achieve high precision, it is necessary to combine such parameters as to allow for a high constant coefficient of filling of the auger. The high degree of filling of the auger must also be achieved at different humidity and level of the concentrated feed in the hopper. The researchers agree that the ratio of the step to the diameter of the auger should be within the range of 0.8 ... 1.1. In order to achieve high dosing accuracy, it is advisable that the step is small. Then for one turn the dose will be small. The ability to control the dose by stopping the rotation for less than one turn makes it possible to control small doses. For example, if the auger control can stop it at 4, 6, 8, 10, and more than one turn, this will result in higher dose accuracy.

Designer dosing calculations include determination of performance, propulsion power and estimation of the dosing error.

Screw dosers are used to feed and dispense grain, powder and related materials. Their application takes into account the characteristic Weingartner, which is inevitable as a result of grinding the particles of material between them and contact with the working organs. For this reason, in grain and seed transport, agriculture is preferable to rational and elevators, but in the present case, in the final stage of dosing, they are most suitable. The screw dispensers are characterized by stable flow and sustainable transport technology.

Continuous dosing provides a constant flow rate at a certain rate of material.

При непрекъснато обемно дозиране за основен показател за работа на дозатора служи неговият обемен разход \( Q_f \), \( m^3/s \):

\[ Q_f = S \cdot V, \]  

where \( S \) is the cross-sectional area of the through-hole, \( m^2 \);

\( V \) - the average flow rate of the material through the through-hole, \( m/s \).

Under certain conditions, the work of the doser is compared with the zootechnical requirements for dosing accuracy. This is a technological tolerance that is calculated by the expression:

\[ \Delta = \left( Q_{\text{max}} - Q_{\text{min}} \right) / Q_{cp}, \]  

where, \( Q_{\text{max}}, Q_{\text{min}} \) and \( Q_{cp} \) are respectively the maximum, minimum and average yield of the dispenser, \( kg/s \) (m^3/s). The normal distribution of the error values of the dispenser \( \Delta \) can be calculated by means of the square quadratic deviation \( \sigma \), i.e.:

\[ \sigma_{\text{max}} = t_\beta \cdot \sigma \leq \Delta, \]  

where \( \sigma_{\text{max}} \) is the biggest error;

\( t_\beta \) - confidence rating at confidence.

In continuous dosing the mean value of the absolute error is:

\[ \delta = \sum_{i=1}^{m} \frac{Q_i - Q_\beta}{m}, \]  

where \( Q_i \) is the actual performance of the dispenser in i dimension, kg/s (m^3/s);

\( Q_\beta \) - the specified dispenser performance;

\( m \) - the number of measurements.

The relative error of the device can be estimated by the coefficient of variation \( V \) :

\[ V = \pm \frac{100\sigma}{Q}, \]  

where \( Q \) is the mean value of the doser's performance of samples, kg/s (m^3/s).

The performance of single-screw dispensers is determined by different expressions:

\[ q = 47.1 \cdot \left(D^2/2\delta^2 - d^2\right) \cdot S \cdot K \cdot n \cdot P, \]  

\( q = 47.1 \cdot \left(D^3/3\delta^2 - d^3\right) \cdot S \cdot K \cdot n \cdot P, \)  

\( q = 47.1 \cdot D^2 \cdot S \cdot K \cdot n \cdot P, \)  

where \( D \) is the diameter of the auger, m;

\( d \) - the diameter of the auger shaft, m;

\( \delta \) - the radial gap between the periphery of the auger and the inner one surface of the auger housing, m;

\( S \) - the auger step, m (S = (0.8 ... 1.2) D);

\( K \) - the filling factor (K = 0.8 ... 1.0);

\( n \) - rotational speed of the auger, s-1;

\( \gamma \) - the bulk density, t/m^3;

\( C \) - the coefficient that measures the angle of the slope \( \beta \) to the horizon on the performance of the dispenser.

Table 1 gives adjustments to the performance of the dosator from the angle of inclination to the horizon.

<table>
<thead>
<tr>
<th>Angle of slope ( \beta ), degrees</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the coefficient ( C )</td>
<td>1.00</td>
<td>0.90</td>
<td>0.80</td>
<td>0.70</td>
<td>0.65</td>
<td>0.58</td>
<td>0.52</td>
<td>0.48</td>
</tr>
</tbody>
</table>
Expression (6) shows the diameter of the auger, the shaft and the gap between the auger and the casing. Expression (7) does not account for the gap between the auger and the casing, while the expression (8) does not take into account the gap between the auger and the casing and also the shaft diameter. For the forward calculations we will use an expression (7). The play has a more complex aspect of productivity, because in this space the speed of the material is different. We will set the minimum possible gap according to the technological capabilities of the device. We believe that dropping the diameter of the shaft is inadmissible. Not reading this constructive parameter will result in a significant difference between the theoretical and actual performance, which will lead to a significant constant dosing error.

The graphical performance dependency $Q$ is linear. Upon augmentation of auger rotation speed, productivity and power requirements are increased with the following dependencies:

$$Q = k_1 \cdot n, \text{t/h} \quad (9)$$
$$N = k_2 \cdot n, \text{kW} \quad (10)$$

The dose per revolution of the auger $Q_0$ is calculated using the formula

$$Q_0 = 60 \cdot G \cdot n^{-1} \cdot t^{-1}, \quad (12)$$

where $G$ is the weight of the feed collected by the dispenser in the collection volume, g;
$n$ - screw speed, min$^{-1}$;
$t$ - duration of the experiment, s.

The critical rotational speed of the auger $n$ is determined by:

$$n = 0.5 \pi \sqrt{\frac{g \cdot tg(\alpha + \varphi_1)}{r \cdot \mu_k}}, \quad (13)$$

where $\alpha$ is the angle of helical lift;
$\mu_k$ - the coefficient of friction of the feed on the surface of the casing;
$r$ - the internal radius of the auger;
$\varphi_1 = arctg \left( \frac{\mu_k}{\cos \theta} \right)$.

$\theta$ - the angle between the normal reaction on the surface of the auger and its axis. Detailed information on the friction coefficient of the feed on the surface of the casing can be found at: [http://www.teleskopicheskie-pogruzchiki.ru/catalog/obshe-svedeniya/klassifikatsiya-i-harakteristika-gruzov.html](http://www.teleskopicheskie-pogruzchiki.ru/catalog/obshe-svedeniya/klassifikatsiya-i-harakteristika-gruzov.html)

The coefficients $k_1$ and $k_2$ are constant for each particular dispenser as performance is mainly governed by varying the screw rotation speed.

We determine the power of the dosator according to the formula (Owen, P. & Cleary, P., 2009):

$$N = \frac{Q}{367} (L_x \cdot W + H), \text{ kW} \quad (11)$$

where $L_x$ is the horizontal projection of the material displacement path, m;
$H$ - height of material lifting, m;
$W$ - the experimental coefficient of motion resistance of the material along the canal.

The coefficient of motion resistance of the channel is determined by Table 2 (Owen, P. & Cleary, P., 2009):

<table>
<thead>
<tr>
<th>Material</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry non-abrasive (cereal products, flour, sawdust, etc.)</td>
<td>1,2</td>
</tr>
<tr>
<td>Wet non-abrasive (sugar-refined, raw malt,)</td>
<td>1,2</td>
</tr>
<tr>
<td>Semi-abrasive (soda, coal, cooking salt)</td>
<td>2,5</td>
</tr>
<tr>
<td>Abrasive (gravel, sand, cement)</td>
<td>3,2</td>
</tr>
<tr>
<td>Highly abrasive and sticky (ash, molding, lime, sulfur)</td>
<td>4,0</td>
</tr>
</tbody>
</table>

CONCLUSIONS

For the specific needs, it is advisable to use a screw dispenser, given the simple construction, relatively easy control, low value and high reliability.

The rotation rate for the particular application should be in the range of 10 ... 60 min$^{-1}$. Feed speeds above the upper limit lead to an increasing decrease in the filling factor and consequently a reduction in the volume efficiency of the auger. This means a larger error in the doser's operation between the calculated and the actual. It is also necessary to take into account the technological possibilities for implementing the construction parameters of the auger. It is also advisable to look for a minimum value of the gap between the diameter and the auger casing.

REFERENCES

A METHODOLOGICAL APPROACH TO THE STUDY OF THE PLANT AND LIVESTOCK RESIDUES COMPOSTING PROCESS

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Abstract: A methodology of the study of the process of composting plant and livestock breeding residues has been proposed. Wheat straw and poultry manure are used to study the composting process. The main factors that are most relevant to the composting process are the following: compost humidity, the carbon-nitrogen ratio and the straw-cutting size. A chemical analysis of the straw and poultry manure was determined before and after the experiments.

Key words: Composting Process, Plant and Livestock Residues, Wheat Straw, Poultry Manure, Waste Biomass from Agriculture, Utilization.

INTRODUCTION
Maintaining a positive balance of humus in arable land is one of the most important and difficult problems in agricultural production. In recent years worldwide has been experiencing a shortage of traditional organic fertilizers. About 74% of the agricultural land in southern Europe is occupied by areas with less than 2% organic carbon in the layer 0-20 cm [12]. In order to increase the humus content of the soil it is necessary to systematically introduce organic fertilizers. The use of plant residues, manure, compost and organic sludge in arable land is one of the measures to limit soil degradation [6].

Pre-treatment of these wastes in the soil creates in some cases the risk of contamination by heavy metals and pathogenic microorganisms, as well as the immobilisation of nutrients and photosynthesis in the soil. These adverse effects can be avoided by pre-composting the waste products from agricultural production [1,5].

Composting is the most popular and widely applicable method that allows more than 50% of organic waste to be dumped. Besides being an environmentally friendly process, composting is also valuable from an agronomic point of view. In practice, it imports an organic substance that can be used to recover lost in normal farming [8]. Composting is therefore a solution for two interrelated problems - the recovery of plant and livestock waste and the creation of a product with a high content of organic soil fertilizer.

OBJECTIVE AND METHODS OF THE STUDY
The purpose of the study is to justify and develop a methodology for the study of the composting process of the residues from plant and livestock breeding.

The subject of the study is the composting process for the residues from plant and livestock breeding.

The process of composting plant residues in a mixture with livestock manure was studied by many authors [2,4]. The results of these studies are outlined in the literature. In our study, the composting process will be considered in terms of shortening the process time without the use of different chemical accelerators.

An in-depth study of the composting process is due to the unknown nature of its process, which is often called "black box". For this, the cybernetic approach was used to conduct the study. A great number of factors influence the process. Some of them can be managed in a planned multifactor experiment and the rest should be used with the best possible values in it.

The most important factors affecting the composting process are: carbon-nitrogen ratio C/N, humidity, temperature, medium pH, aeration, particle size and others [11]. Knowledge and proper use make the process of decomposition of organic waste accelerated and the quality of the final product improved.

Carbon-nitrogen ratio C/N.
The degree of decomposition of organic waste depends on the appropriate balance between carbon and nitrogen. Rapid composting is achieved when the waste has a carbon / nitrogen ratio of C/N ratio of between 15 and 35 [10]. Lower ratios can affect ammonia loss, while higher ones slow down composting speed. If the original C/N ratio is higher than 35, the microorganisms have to go through multiple life cycles, oxidizing excess carbon until they reach a more appropriate C/N ratio for their metabolism.

Higher values mean that there is not enough nitrogen for optimal growth of microbial populations, so the compost will remain relatively cold and decomposition will continue slower. Low values will lead to nitrogen loss through the evaporation of ammonia, especially at high pH and temperature.

Humidity of compost.
Maintaining optimum humidity during composting is a very important factor for good microbiological activity. Drought and over-humidation aggravate the development of microorganisms and retard ripening of compost. Water is released during the microbiological decomposition of organisms, and increased microbial activity is also a cause of elevated temperature and hence increased evaporation [9]. The moisture content and aeration content are closely related to the air flow in the processes. Optimal moisture content in composting varies and depends largely on the physical state and size of the particles and the composting system used. Too low means an early dehydration of the pile, which stops biological processes. Conversely, too much moisture prevents aeration by sticking the pores.

The decrease in moisture content during the composting process can be explained by the heat release resulting from the microbiological activity causing increased drought. If the moisture content is below 40%, the decomposition is aerobic but slow. At a humidity below 30% of the total mass, the rate of biological processes sharply drops, and below 20% they almost cease. The compost humidity below 30% will restrict microbiological activity, as there will be insufficient water to dissolve the nutrients, which will slow organic processes and lead to physically sustainable but biologically unsustainable compost [7].

Size of straw cutting.
Microbiological activity takes place on the surface of organic particles. Reducing the particle size to a certain extent, increasing the free surface, stimulates the activity of the microorganisms and the degree of decomposition. Particle sizes are closely related to humidity and aeration of compost. Larger ones are better aerated, but they dry faster. Smaller particles in turn increase the moisture-retaining ability. However, when the particles are too small, they become clogged and hamper the access of oxygen, carbon and nitrogen to micro-organisms and hamper their activity. Wide wooden cuttings, for example, are a good filler that provides good aeration through the pile, but they provide less accessible carbon than if they are in the form of shavings or sawdust.

Initially, decomposition takes place on or near the particle surface where the diffusion of oxygen in the aqueous film coating the particle is suitable for aerobic metabolism and the substrate itself is readily available to microorganisms and their cellular enzymes. Small particles have a larger surface area per unit mass or volume than large ones, so if aeration is appropriate, small particles will decompose more quickly. Attempts suggest that digesting materials
can double the degree of decomposition. The recommended particle size of 13 to 76 mm, the lower values refer to forced aeration or constantly stirred systems, and the higher for windrow and other static aerated systems. The optimal size for composting systems with agitation and forced aeration is 12.5 mm, and for fixed piles with natural aeration - 50 mm.

In the present study, wheat straw and poultry manure are used as plant and livestock residues respectively. Table 1 shows the chemical analysis and humidity of straw and bird fertilizer prior to the experiment.

Table 1: Chemical analysis and humidity of straw and bird fertilizer prior to the experiment

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Straw</th>
<th>Bird manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N, %</td>
<td>0.343</td>
<td>2.552</td>
</tr>
<tr>
<td>Total C, %</td>
<td>37.5</td>
<td>19.06</td>
</tr>
<tr>
<td>Mineral N, mg/kg</td>
<td>-</td>
<td>509</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.17</td>
<td>-</td>
</tr>
<tr>
<td>Potassium, %</td>
<td>0.85</td>
<td>-</td>
</tr>
<tr>
<td>Accepted phosphorus, mg/100 g</td>
<td>78.9</td>
<td>4.7</td>
</tr>
<tr>
<td>Accepted Potassium, mg/100 g</td>
<td>2195.7</td>
<td>27.9</td>
</tr>
<tr>
<td>Ash, %</td>
<td>4.8</td>
<td>17</td>
</tr>
<tr>
<td>Humidity, %</td>
<td>7.25</td>
<td>54.85</td>
</tr>
</tbody>
</table>

Preliminary studies have shown that the most important influence on the composting process is due to the following factors: compost humidity, %; carbon-nitrogen ratio and straw chopping, mm. The length of the straw influences the composting process. It will be one of the driving factors in our research. The slice is pre-cut on three levels: 32.8 mm, 53.3 mm and 78.3 mm. To obtain the upper level, the straw was cut by hand with sheet metal shears and the average value was lsr = 78.3 mm. The other two grouts were obtained by cutting the straw with a straw cutter. The average level of the size was obtained by cutting the straw with a knife on the cutter and the average particle size of lср = 53.3 mm and the lower level of the groove was realized by cutting the straw with two knives of the cutter drum - lвл = 32.8 mm.

The average particle size of straw is determined by the following formula:

$$l_{cp} = \frac{\sum l_i m_i}{m_{i}}$$  \hspace{1cm} (1)

where \(l_{cp}\) is the average particle size of the straw, mm;

$$W_{cm} = \frac{(m_{cm} + m_{cm}^{sw}) - [m_{cm}^{sw}(1 - W_{cm}) + m_{cm}^{sw}(1 - W_{cm})]}{m_{cm}^{sw} + m_{cm}^{sw}}$$  \hspace{1cm} (2)

where \(W_{cm}\) is the humidity of the resulting mixture, %;

\(m_{cm}^{sw}\) - the mass of the wet straw in the mixture, kg;

\(m_{cm}^{sw}\) - the mass of the poultry manure in the mixture, kg;

\(W_{cm}^{sw}\) - the moisture content of the sample prior to mixing, %;

\(W_{cm}^{sw}\) - the moisture content of the poultry manure before mixing, %.

To determine the humidity of a mixture of straw and fresh poultry manure is determined by knowing the humidity of the two components separately by the following formula:

$$W = \frac{W_{cm} - W_{cm}^{sw}}{W_{cm}^{sw}} \times 100\%$$  \hspace{1cm} (3)

where \(W\) is the moisture content of the mixture, %;

\(W_{cm}\) - the moisture content of the sample prior to drying, %;

\(W_{cm}^{sw}\) - the moisture content of the mixture.

To determine the C/N ratio of straw and poultry manure, the formula shall be applied:

$$C : N = \frac{100 - a \cdot B}{100 \cdot A}$$  \hspace{1cm} (4)

where \(C : N\) is a carbon-nitrogen ratio; \(100 - a\) - organic matter, %;

\(a\) - the ash content in the dry matter, %;

\(B\) - Carbon content in dry matter, %.

\(A\) - the nitrogen content in the dry matter, %.

To determine the \(C : N\) ratio of the mixture prepared for the tests, the formula:

$$C : N_{cm}^{sw} = \frac{m_{cm}(100 - W_{cm})(100 - a)_{cm}B_{cm} + m_{cm}^{sw}(100 - W_{cm}^{sw})(100 - a^{sw}B_{cm})}{100[m_{cm}(100 - W_{cm}) + m_{cm}^{sw}(100 - W_{cm}^{sw})]}$$  \hspace{1cm} (5)

where \(m_{cm}\) is the quantity of water added, kg;

\(m_{cm}^{sw}\) - the mass of the poultry manure and the straw have been and are, kg;

\(W_{cm}\) and \(W_{cm}^{sw}\) - the humidity of poultry manure and straw, %;
the very beginning of the process.

The material of each test was placed in a plastic bag with a capacity of about 70-80 l was built into which the mixture of poultry manure and straw was mixed.

For the purposes of the experiment, a container with a capacity of about 70-80 l was built into which the mixture of poultry manure and straw was mixed. The bags are arranged in rows, each attempt being three times repeatable. The bags are placed in the Soil Channel of the Laboratory of Soil Machines of the Mechanization and Hydromelioration Department of the “N.Pushkarov” Soil Science Institute, Sofia.

The rule is that the repeatability “one” of the experience is located on the side of the formed path between the two rows of bags, in the middle there is repeatability “two” and on the side of the walls the repeatability number “three”.

Temperature measurement is done every day for the first 10 days, then for 3 days and finally for one week, until the product temperature and room temperature of the room are not even. During the first days after measuring the temperature every three days aeration of the product was made and after the 20th day of each week. For each aeration, the sample moisture level is monitored.

The material of each test was placed in a plastic bag with a capacity of about 70-80 l was built into which the mixture of poultry manure and straw was mixed.

For controlled factors, which have a significant influence on the studied parameters of the composting process, are adopted:

- \( X_1(W) \) - the compost humidity, %;
- \( X_2(C:N) \) - the carbon-nitrogen ratio;
- \( X_3(n) \) - the straw chopping capacity, mm.

Intervals of change of manageable factors are taken from literary data. Based on this information, the following intervals were established:

- for \( X_1 \) - from 40% to 80%;
- for \( X_2 \) - 20 to 40;
- for \( X_3 \) - from 32.8 to 78.3 mm.

To evaluate the composting process, the following initial parameter was adopted:

- \( YT \) - the average temperature of the compost during the test, oC.

The temperature is determined for each experiment in three times repeatability.

Temperature is not a sufficient indicator to assess the composting process, but it can be used to determine the stage of fermentation. There are enough indicators for the quality of compost, such as the quantity of the various chemical elements, N, P, K, etc., but the stage of the composting process indicates the ratio of humic to fulvic acids. This will be the subject of the next, in-depth study.

\[ a_{oc} \text{ and } a_{as} \] - the ash content in poultry manure and straw, %.

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The report was presented to the plenary session on 27 October 2017 with an original title in Bulgarian: METHODOLOGICAL APPROACH TO THE STUDY OF THE COMPOSITION OF THE RESIDUES OF PLANT AND ANIMALS
MONITORING OF WEEDS IN CROPS OF LEGUMES AND CEREALS GROWN UNDER CONDITIONS OF ORGANIC FARMING

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Abstract: During the period 2011 - 2013 a field experiment was conducted at the experimental field of IASS “Obrazcov chiflik” – Ruse, with ecologically grounded crop rotation, including the cultivation of two legumes /field beans, peas/ and two cereals /wheat, maltling barley/ on an area after conversion. The experiment started after the eightfold scheme of Georges Ville in 3 replications, situated after Ryumker, the size of the harvesting plot being 52.5m². Pesticides were not applied on the crops, also and synthetic fertilizers and improvers of soil, prohibited for the organic production.

The objective of the study was to observe and describe the biological regulation of weeds in legumes and cereals, grown under conditions of organic farming.

In the organic field, the diversity of weed species was influenced by climatic conditions, soil tillage and crops. There were differences in weed infestation of crops only in terms of quantity of weeds per m². In that case the differences in weed infestation were in direct relationship with certain biological characteristics of the crops. The species Matricaria chamomilla (L.), Anthemis arvensis (L), Capsella bursa-pastoris (L.), Setaria viridis (L.), Echinochloa crusgalli (L.), Digitaria sanguinale (L.), Lamium purpureum (L.), Convolvulus arvensis (L.) u Cirsium arvense(L.) were reported over the whole three-year period.

KEY WORDS: ORGANIC FARMING, MONITORING, WEEDS, FIELD BEANS, PEAS, WHEAT, MALTING BARLEY

INTRODUCTION

Weeds, along with diseases and pests, are one of the main factors limiting the opportunities for obtaining optimal and qualitative crop yields (Rice, 1974; Golubinova et al., 2015). The relatively low competitiveness of the crops in the early stages of their development determines the weed species as a limiting factor in the formation of the yield (Marinov-Serafinov, Dimitrov, 2007). Establishing methods for successful weed control in organic farming systems is of particular importance for limiting production risk. For good phytosanitary control relies on a complex of agrotechnical measures: strict observance of crop rotation with alternating grain-legumes and grain-cereals for suppressing the weed vegetation (Kostadinova, Popov, 2012); introducing mechanical methods for destroying the available weed groups (Nikolich et all, 2011; Farmeselli et all, 2013); balanced use of nutrients and organic matter in the soil; recycling of nutrients (composted manure, plant residues, etc.); growing of local varieties of plants, if possible. (Atanasova et al., 2014, Ilieva, Mitova, 2014, Atanasova et al., 2008).

One of the main ways for the biological regulation of weeds is to create conditions that enhance the competitiveness of crop plants through appropriate crop rotation, varieties, time limits and sowing standards, etc. (Spar, 2004). The purpose of this study is to observe and describe the biological regulation of weeds in cereal crops and cereal crops grown in organic farming conditions.

MATERIAL AND METHODS

Since 2005, the Institute of Agriculture and Seed Science "Obrazcov Chiflik" - Ruse has started a focused research on the development of technologies for organic growing of grain cereals and grain legumes after conversion. As a preparatory study, the period up to 2008, during which preliminary studies on the productivity of individual cereals and pulses without the use of mineral fertilizers and level of entanglement without the use of chemical plant protection chemicals were made.

The first stage includes the selection of an appropriate agricultural plot and its preparation for the establishment of a field for organic farming, complying with the requirements of Ordinance No 1 of 7 February 2013 of the Ministry of Agriculture and Food for applying the rules of organic production of plants, animals and aquaculture, products, aquaculture products and food, their labeling and production and labeling control, Prom. SG. February 16, 19 February 2013.

A location that is located for this purpose is located on the territory of the Institute with an area of 5 da. The soil type on which the experiment is based is a highly leached black earth and is characterized by a poor humus content of 1.65%, poorly stocked with mineral N (10.75 mg / 1000 g soil) and mobile P2O5 (6.31 mg / 1000 g soil) and well stocked with K2O (22.50 mg / 1000 g soil) in the 0 - 40 cm layer. The soil reaction is medium acidic (pH in KCl - 5.01%). The mechanical composition of the soil is heavily sandy-clayey. Leached chernozems are soils of high natural fertility and, when properly treated, yield the highest yields of arable crops.

During the period 2011 - 2013, field experiment with ecologically well-rounded crop rotation, including the cultivation of: Venka 1 wheat variety, Rouse 1 spring peas, Obzor brewed barley, and Obrakcov chiflik 12, were carried out after conversion. The experience is based on Georges Villa's eight-replicated Osmobile scheme, located on Rümker, with a harvest size of 52.5m2. Leguminous crops are included to improve the nitrogen regime of the soil and winter-crops for good anti-erosion effect.

The sowing and all agro-technical measures have been carried out according to the accepted technology for organic farming in Bulgaria (Ordinance No 1 of 7 February 2013 of the Ministry of Agriculture and Food), observing the agrotechnical terms, depending on the biological requirements of the crop, crops in rotation alternating in time place. No pesticides, fertilizers and soil improvers prohibited for organic farming have been applied to the crops grown. Fighting weeds in spring crops is mechanically guided, carried out - a stalk at the depth of 15 cm, a deep tillage of 25 cm, a fusion of 12 cm deep, two mechanized and two manual treatments / a mowing in the field of beans and weeding for feed peas).

In order to increase the yield and the quality of the seeds, the foliar feeding with Biohumus liquid organic fertilizer was carried out in the phasing and grading phases for wheat and brewing barley, blooming and rounding of field beans and fodder peas with a dose of 25 l/da working solution for one spray , at a concentration indicated by the manufacturer (10%).

The organic manure is presented for testing by a production farm for Biohumus in the village of Nikolovo Rouse. Biohumus is a completely organic "live fertilizer" that is produced by growing Red Californian worms (Lumbricus rubellus). Biohumus does not contain harmful substances and pathogenic organisms. It is rich in useful microorganisms, enzymes, vitamins, amino acids and is applicable in all fields of plant breeding. Biohumus increases crop yield by 30 to 70% depending on culture, and the effect increases proportionally to the duration of its use. Increases the resistance of plants to diseases and stress. It stimulates the growth of soil microflora, which leads to the accelerated transformation of soil organogenic elements into a form which is assimilated to the plants.
An additional effect of the increase in the quantity of beneficial soil microorganisms is the suppression of the development of soil phytopathogens. Increases the resistance of plants to diseases and harmful insects. As a result of the complex effects on soil, soil microflora and plants, there is a significant increase in yields.

For the purposes of the survey, the monitoring plots have been monitored for the area of 5 da. The survey was carried out according to the adopted methodology for reporting and mapping of the weeding in the main arable crops. Experimental plots have reported the species composition and density of weeds. The weed counting was carried out by the quantitative weighing method (g/m²; g/m²) in the breeding and start-up phases of the grain-cereals and buttoning and the beginning of flowering in the cereal-leguminous crops.

RESULTS AND DISCUSSION

The institute is located in the northern climatic region of the Danube Plain. This climatic area has well-defined continental features with average annual precipitation from 500 to 600 mm. Compared to the other non-mountainous regions of the country, the winter in this region is the coldest, the summer is the hottest, the spring is short and cool and the autumn is long and warm. The obtaining of high and sustainable yields from agricultural crops is closely related both to the agro-technical measures carried out and to the specific meteorological conditions of the individual years.

During the three years of study no significant deviations from the values of the average daily temperature were observed compared to the crop requirements and the multi-year period (Fig.1).
Figure 1 shows that weeding varies in individual years, with the total number of weeds during the three years being about 50 pcs/m² with a slight fresh biomass of 12.6 g/m². The largest number of weeds was reported in 2012 - 74 pcs/m² with fresh biomass 18.13 g/m².

One-year-old weeds are the main biological group, with the main species of winter-spring species: leegrass - *Matricaria chamomilla* (L.), Polish ant - *purpureum* (L.), holly oyster - *Holosteum umbellatum* (L.) and sheep pouch - *Capsella bursa-pastoris* (L.) which is typical of this reporting period. The significance of this weed group by number and biomass is about 80%. Perennial weeds are represented by a field bush - *Convolvulus arvensis* (L.), which is not a dangerous species and could be expected to be constrained by subsequent rotation and agrotechnical events.

Greater barrenness in winter barley is due to the late sowing of the crop, which required, at a later stage, manual cleaning of the experimental plots.

Wheat is closely related to overwintering, harrowing and the quality of its sowing. The variety of sailplanes in wheat crops is large and the species weeding them are over 100. Mainly in the crops are: Black Grass Dog - *Solanum nigrum* (L.), Polish Easter - *Veronica arvensis* (L.), Striped Chamomile - *Matricaria Chameleon*, *Capella bursa-pastoris* (L.), *Senecio vernalis* WK, *Erigeron Canadensis* (L.), Polish ant - *Anthemis arvensis* (L.), *Convolvulus arvensis* (L.) and others.

In wheat, weeding is less pronounced than winter barley, with the total number of weeds varying from 14 to 57 m² with a negligible fresh biomass of 10.88 g/m² on average over the period (Figure 2). As with the previous crop, one-year weeds are the major biological group, with their total significance (determined by the number and biomass weight) of 91%.
In the case of the field bean, the broader bands create favorable conditions for the emergence and development of a large number of weeds, the main species in the weed associations being: green hawthorn - Setaria viridis (L.), millet hen - Echinochloa crusgalli (L.), blood mildew - Digitaria sanguinaule (L.), Chenopodium album (L.), Common Shag - Amaranthus retroflexus (L.), Striped Chamomile - Matricaria chamomilla (L.), Butterfly - Agrimony Eupatoria (L.). In the later stages of the development of Polish beans there is a secondary catch-up with representatives of the root-lobster - Convolvulus arvensis (L.) and the palamid - Cirsium arvense (L.) and the rhubarb - Sorghum halepense (L.). In Polish beans, weeding is more pronounced compared to Polish forage, the total number of weeds ranging from 88 to 156 pcs/m² and a significant fresh biomass of 59.56 g/m². Figure 3 shows that one-year-old weeds have greater significance in terms of their number but less significance in terms of total biomass, whereas in the case of perennial weeds it is back. Although in single units they have higher biomass. As the bean vegetation advances and increases its roofing capacity and after the second chopping, the phytosanitary status of the weed culture is very good.

The field fodder peas is a crop that grows slowly and easily in the first days after germination and is easily mutilated by weeds. In the crops, mainly early-spring weeds - bean - Polygonum convolvulus (L.) and red dead nettle - Lamium purpureum (L.), and more limited late-leaved - white dog bob - Chenopodium album (L.), Amaranthus retroflexus (L.), green hazel - Setaria viridis (L.), millet hen - Echinochloa crusgalli (L.). Of the perennial species with the most prevalent and most densely populated species are the Convolvulus arvensis (L.) and the palamid - Cirsium arvense (L.). The weed vegetation in
Forage peas averaged between 46 and 104 pcs/m² with significant fresh biomass - 73.53 g/m² (Figure 4).

Fig. 4. Weaning (quantity and weight of weeds) during the vegetation of fodder peas in 2011 – 2013

Peach weed population shows that there is no significant increase in overall weeding, despite the late-spring weeds emerging as the vegetation period progresses. The main entanglements are from the group of annual weeds. The total significance of this group of weeds, expressed by the relative share in the total entanglement, is significant in number of 90% and in biomass - 80%.

CONCLUSIONS

• In the biological field, the species diversity of weeds is influenced by climatic conditions, soil treatments and crops.
• Cultivation differences exist only in terms of the amount of weeds per m². In this case, the differences in wilting are directly related to some biological features of the crop plants.
• Species of the mature Matricaria chamomilla (L.), Anthemis arvensis (L.), Capsella bursa-pastoris (L.), Setaria viridis (L.), Echinochloa crusgalli L., Digitaria sanguinale L., Lamium purpureum L.), Convolvulus arvensis (L.) and Cirsium arvense (L.) have met in the three years.

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