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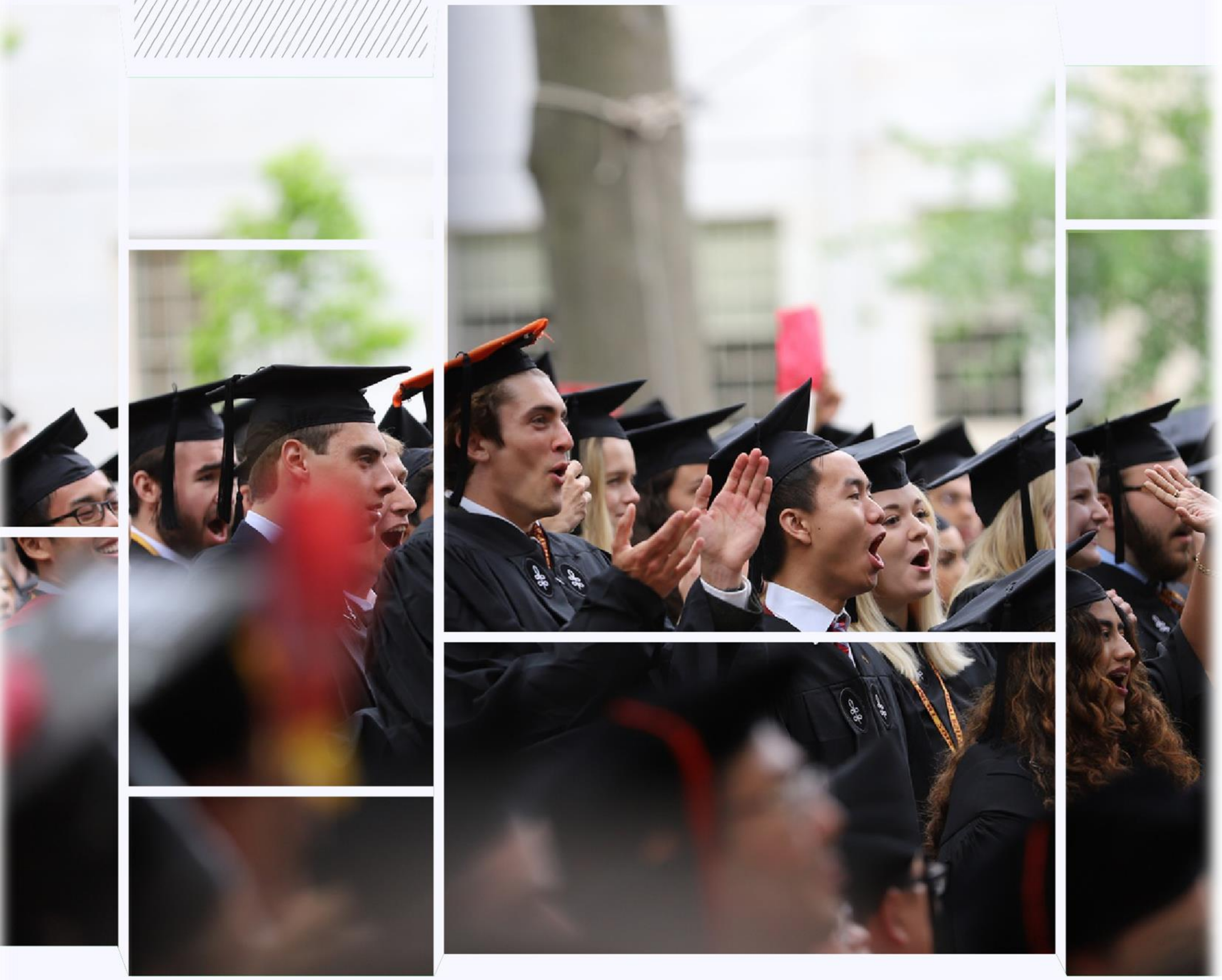

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DETERMINATION OF THE OPTIMAL PARAMETERS OF THE NOV-SHAPED SEED TRANSMITTER USING THE METHOD OF MATHEMATICAL MODELING

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Abstract. The application of modern information technologies using the principles of mathematical modeling and the mathematical theory of systems allows to move to a mathematical model in the study of processes. For this reason, the method of mathematical modeling of experiment planning was used to study the influence of the parameters of the rod-shaped seed conveyor on the unevenness of distribution. As a result, the regression equation representing the process was obtained. Also, on the basis of its numerical solution, a graph of dependence of the slope angle of the rod-shaped seed conveyor on the distribution unevenness was constructed.

Keywords. Seed, conductor, rod, mathematical model, business, planning, parameter, factor, coefficient.

Seed transporters are considered as intermediaries between the planting apparatus and the soil or bulb, and are the main working organs that serve to spread and deliver seeds. Also, seed transporters have an effect on the plane of seed distribution.

Due to the complexity and continuity of the technological process of planting seeds, it will not be enough to statically study individual parts of the process. Often, when researching seeders, researchers pay attention to its output indicators, that is, uniformity of planting depth, unevenness of planting between planting devices, general unevenness of planting, distribution of seeds along the feeding area, etc. Studies on spermatozoa are rare [1]. However, this working body works in the most difficult conditions, because the angle and length of the slope relative to the horizon can be variable, which undoubtedly affects the formation of the seed stream delivered to the soil.

When studying the seeding unevenness of seeders, it was found that one of the reasons for the decrease in the value of this indicator is the increase in the time of movement of seeds in the seed conveyor [2]. It is mainly related to the number of impacts of the seeds on the walls of the seed carrier and the height of its installation.

The purpose of the research is to justify the optimal parameters of the rod-shaped seed conveyor of the vegetable seeder using the method of mathematical modeling.

Mathematical modeling of the uneven distribution of seeds to the planting zone is characterized by the system of equations connecting the outgoing and incoming parameters, or the optimization of the sowing process is characterized by the expression of the correlation of parameters with independent factors of this process. The stages of mathematical modeling in planning experiments to determine the optimal parameters of the seed sowing process can be shown using the following scheme (Fig. 1) [3].

Since the main purpose of the research is to determine the parameters of the rod-shaped seed conveyor, we base its slope angle, length, and installation height on the ground.

One of the main requirements for seeders is that the seeds are evenly distributed over the planting area. Therefore, we conduct multivariate experiments in order to determine the uneven distribution of seeds. In this case, we select those listed in Table 1 as input factors.

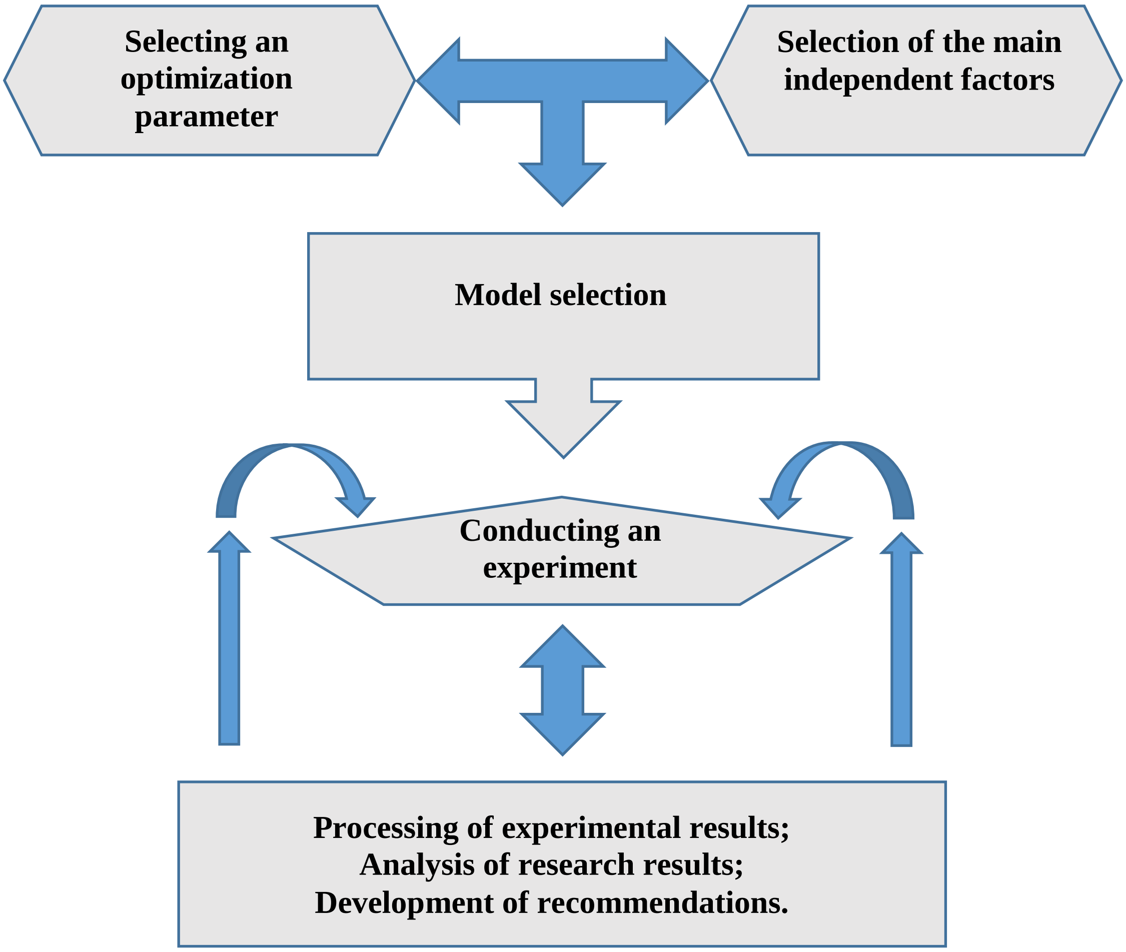

Figure 1. Mathematical modeling stages of planning experiments on the study of unevenness of seed distribution

Table 1.

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The name of the factor	Coding-resurrected sign	The actual value of the factor			Change range
		-1	0	+1	
Slope angle of funnel-shaped seed conveyor, grad	x1	40	50	60	10
The length of the funnel-shaped seed conductor, cm	x2	50	60	70	10

Installation height of the funnel-shaped seed conveyor relative to the soil, cm	x3	15	20	25	5

To construct a mathematical model representing the process under study, we write the second order regression equation for three-factor experiments as follows

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2 + b_{12}x_1x_2 +$$

[4] $$+ b_{13}x_1x_3 + b_{23}x_2x_3 \quad (1)$$

in this b_0, b_1, b_2, b_3, b_{11}, b_{12}, b_{13}, b_{23}, b_{33} - regression coefficients; x_1, x_2, x_3 – coded values of incoming factors.

The mathematical model obtained as a result of planning the experiments in coded values of the input factors allows to estimate the effect of each of them and their multiples on the parameter being optimized (through regression coefficients). Taking into account the values of the regression coefficients determined by calculation, we write the initial form of the regression equation representing the process under study using (1) as follows

$$y = 8{,}044208 + 1{,}047705x_1 - 0{,}721217x_2 + 0{,}647367x_3 + 3{,}950829x_1^2 +$$
$$+ 2{,}593085x_2^2 - 0{,}03047x_3^2 + 0{,}1x_1x_2 - 0x_1x_3 - 1{,}95x_2x_3 \quad (2)$$

According to [4], if the coefficients in the obtained regression equation are smaller than the confidence intervals, these coefficients are excluded from the equation. In the case under consideration, since b22, b33, b12, b13, and b23 are smaller than the confidence intervals, we drop them from the regression equation, and expression (2) becomes $y = 8{,}044208 + 3{,}950829x_1^2 + 2{,}593085x_2^2$ (3)

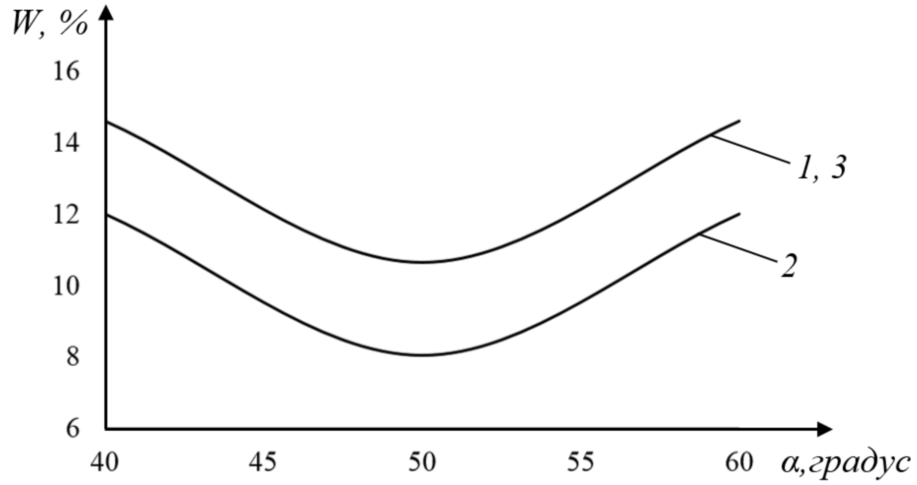
In order for the regression equation to be suitable for the process being studied, the value of Fisher's criterion in the table should be greater than the calculated value, that is, the condition should be fulfilled [5].

The value of the Fisher criterion in the table was chosen in the following order, that is, since the degree of freedom in determining the image of the expression (3.25) is 12 and the degree of freedom in determining the denominator is 5, according to [6].

It was found that the constructed regression equation fits due to the fact that the specified condition for the researched process is fulfilled.

For the purpose of deeper analysis of the conducted studies, we implement the numerical solution of the regression equation (3) in the Excel program of EXM. Based on the solutions, a parameter dependence graph was obtained (Fig. 2).

Figure 2 shows the graph of the slope angle of the rod-shaped seed conveyor as a function of the unevenness of the seed distribution, according to which we can see that the unevenness of the seed distribution changes based on the parabolic law with the change of the inclined angle of the rod. In addition, as the length of the rod-shaped seed conveyor increases or decreases, the distribution of seeds worsens.



1-L=50 cm; 2-L=60 cm; 3-L=70 cm

Figure 2. Graph of dependence of slope angle of funnel-shaped seed conveyor on unevenness of distribution

The analysis showed that when the slope angle of the rod-shaped seed drill is 40^0 and the length of the seed drill is 50 cm, the unevenness of distribution is 14.58%, and when the length of the seed drill is 60 cm, the unevenness of distribution is 11.99%. It was observed that the unevenness of distribution was 10.63% when the slope angle of the funnel-shaped seed conveyor was 50^0 and the length of the seed conveyor was 50 cm, and when the length of the seed conveyor was 60 cm, the distribution unevenness was 8.04%.

In conclusion, it can be said that the unevenness of seed distribution is at the lowest values when the length of the seed bed is 60 cm and the slope angle is in the range of 45^0-55^0.

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