AGRICULTURAL
ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

PHYSICAL AND MECHANICAL PROPERTIES AND DIMENSIONAL MASS CHARACTERISTICS OF WHEAT STRAW

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Abstract. This article presents the results of experimental studies on the determination of the physical and mechanical properties and size-mass indicators of wheat straw residue. During the study, the geometric dimensions of wheat straw residue, namely length and diameter, as well as mass, were determined, and their statistical characteristics were calculated. Based on the results obtained, the degree of dispersion of the size-mass indicators and physical properties of the residue straw was assessed, and the main parameters affecting their technological processes were identified.

Keywords: Wheat straw residue, physical-mechanical properties, size-mass indicators, geometric dimensions, length, diameter, mass, coefficient of variation.

Introduction. Today, the effective use of land resources, increasing productivity, and introducing resource-saving agrotechnologies are of great importance in the production of agricultural products worldwide. In recent years, the global production of grain crops has reached 2.7-2.9 billion tons, of which the share of wheat is 750-780 million tons [1]. This expands the possibilities for reusing land after harvesting in wheat-growing regions, that is, introducing repeated crops. After harvesting wheat, a significant amount of plant residues, in particular residual straw, remains in the field. Studies show that on average, up to 2.5-4.5 tons of residual straw are formed after the wheat harvest per hectare [2]. Especially in irrigated fields, these residual straws accumulate in the furrows, complicating subsequent agrotechnical processes. As a result, the quality of soil preparation for cultivation decreases, the sowing process becomes more difficult, and the possibility of planting repeat crops at optimal times is limited.

The physical and mechanical properties and size-mass indicators of residual straws directly affect the processes of their movement and redistribution under mechanical action. According to the results of research, the length of wheat residual straw usually varies within the range of 50–150 mm, diameter 2-6 mm, and mass 0.05–0.15 g [3-4]. The wide range of changes in these parameters determines the inertial properties of the straw, friction conditions, and its reaction to external forces. This creates the need for a scientific selection of the parameters of the working bodies of technical means for mechanical control of straw in field conditions.

In the Republic of Uzbekistan, systematic reforms are being implemented to modernize agriculture, effectively use land resources, and increase the share of repeated crops. In particular, it has been determined that it is possible to increase total productivity by 1.3-1.5 times by using existing arable land twice a year [5]. This further increases the need for technical and technological solutions that ensure high-quality preparation of post-wheat field conditions in a short time. In this regard, the experimental determination of the physical and mechanical properties and dimensional-mass indicators of wheat residue straw, the assessment of their statistical characteristics, and the study of their impact on technological processes are of significant scientific and practical importance.

Literature analysis and problem statement. In our republic and abroad, a number of scientists have conducted scientific research on determining the physical and mechanical properties of plant residues, including wheat straw, studying their dimensional and mass indicators, and substantiating the main parameters for technological processes. In particular, the physical properties of plant materials have been extensively studied by S. Onal, J. Khazaei, M. Ghorbani, A. Tavakoli, S. Mohsenin, R. Polat, M. Guner, E. Dursun, D. Erdogan, I. Gezer, H. Bilim, Y. Rharrabti, A. Aydin, M. Zareiforoush , AA Abdullaev , Sh. U. Urazbaev , A. Rakhmatov and others.

The conducted studies have determined the geometric dimensions, mass, density, moisture-dependent properties, strength and deformation indicators of wheat straw and other plant residues. In particular, it has been established that such dimensional-mass indicators as the length, diameter and mass of straw determine its movement properties under mechanical influence, friction conditions and reaction to external forces. In particular, the physical and mechanical properties of plant residues are of great importance in the processes of their collection, crushing, transportation and processing in field conditions. Based on these indicators, it is possible to correctly select the parameters of the working bodies of agricultural machinery, reduce energy consumption and increase the efficiency of technological processes.

At the same time, the analysis of existing scientific research shows that the issues of determining the size-mass parameters of wheat residue straw and their dispersion level in the conditions of direct irrigated fields, as well as assessing their impact on technological processes, have not been sufficiently studied. Therefore, determining the physical and mechanical properties and size-mass parameters of wheat residue straw and adapting them to practical technological processes is one of the important scientific and practical tasks [5-12].

Materials and methods. The research was conducted on residual straw samples left in the field after the wheat harvest. A total of 50 wheat residual straw samples were selected for the study. The samples were randomly collected from the field and studied in laboratory conditions while preserving their natural state.

During the study, the following key indicators were determined for each straw sample:

straw length, mm;

straw diameter, mm;

straw mass, g.

The straw length was measured with a metal ruler with an accuracy of 1 mm , and the diameter with a caliper with an accuracy of 0.01 mm . The mass of each sample was determined with an accuracy of 0.01 g using an electronic balance . Based on the experimental data obtained, statistical characteristics of the size-mass parameters of wheat straw residue were calculated. In particular, the following indicators were determined for each parameter:

average value;

standard deviation;

coefficient of variation.

The arithmetic mean is the simplest and most widely used measure of average. It simply involves taking the sum of a group of numbers and then dividing that sum by the number of numbers used in the sequence.

$$\bar{x}=\frac{\sum x}{n} \tag{1}$$

Where: $\bar{x}$- Arithmetic mean, $\sum x$- the sum of the values of each measured quantity, n - the number of experiments. The term variance is a statistical term that describes the size of the distribution of expected values for a given variable. Variance can be calculated and measured using various statistics, such as range, variance, and standard deviation.

To determine the variance, we square the result of the arithmetic mean. Then, we subtract (subtract) 1 from the number of trials in the denominator. Then we divide the rate by the denominator.

No.	Wheat straw dimensions	Mean value	Standart deviation	Variation, %	Exp. error
1	Length, mm	72.61	12.07	16.63	1.71
2	Diameter, mm	4.28	1.01	23.65	0.14
3	Mass, g	0.08	0.04	52.34	0.01

$$S^2=\frac{\sum(x-\bar{x})^2}{n-1} \quad (2)$$

The standard deviation S (or σ) is a measure of how spread out the data is about the mean. A low or small standard deviation indicates that the data is densely clustered around the mean, and a high or large standard deviation indicates that the data is more spread out.

$$S=\sqrt{S^2}=\sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}} \quad (3)$$

The coefficient of variation (CV) is the ratio of the standard deviation to the mean. The higher the coefficient of variation, the greater the degree of dispersion around the mean. It is usually expressed as a percentage.

$$V=\frac{S}{x}\times100\% \quad (4)$$

Research results and their analysis. The determined values were subjected to mathematical and statistical processing, and their minimum and maximum values, mean square deviation, and coefficient of variation were determined.

Main physical and mechanical properties of wheat straw.

This table presents the results of experiments conducted on the main physical and mechanical parameters of wheat straw, namely length, diameter, and mass.

According to the results obtained, the average length of the straw was 72.61 mm, with a standard deviation of 12.07 mm and a coefficient of variation of 16.63%. These values indicate that the straw length has a moderate degree of dispersion. The average value for the straw diameter was 4.28 mm, with a coefficient of variation of 23.65%. This indicator indicates that the variability in diameter is higher than that in length. The standard deviation of 1.01 mm also confirms the significant difference in the diameter indicators.

The average value of the straw mass was 0.08 g, and the coefficient of variation reached 52.34%. This indicates that the mass has the greatest degree of dispersion. The high variation of the mass is explained by the differences in the density and internal structure of the straw. In general, the analysis results show that the most stable among the physical parameters of wheat straw is length, while the most variable is mass. These results are of great importance in selecting the parameters of the device for the crushing, transportation and processing of straw.

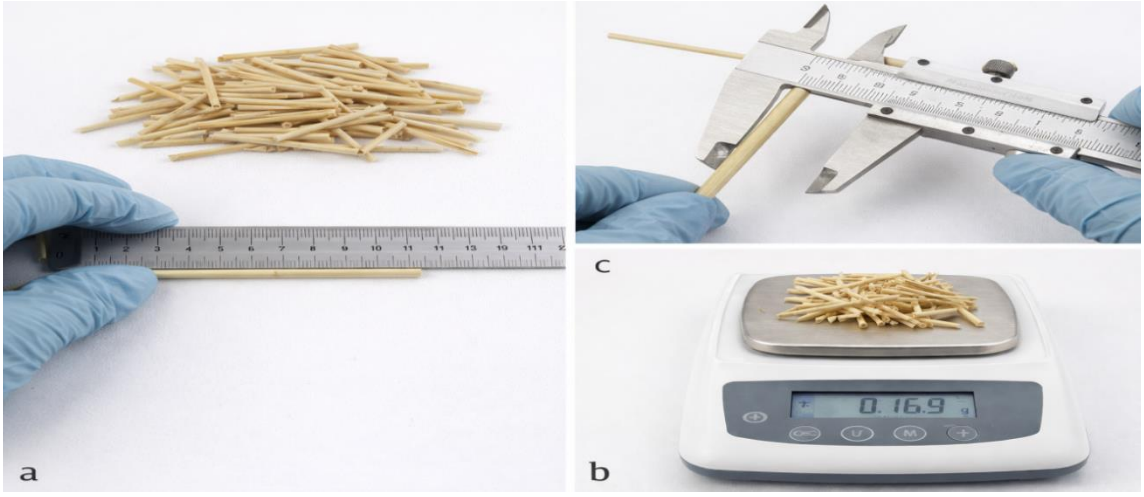

Figure 1. The process of determining the size and mass indicators of wheat straw samples: a-measuring the length of the straw; b-determining the diameter of the straw; c-measuring the mass of the straw sample.

Conclusion. As a result of the conducted experimental studies, the main physical and mechanical properties and size-mass indicators of wheat straw were determined, and their statistical characteristics were evaluated. According to the results of the study, the average length of the straw was 72.61 mm, diameter was 4.28 mm, and mass was 0.08 g. Analysis of the determined coefficients of variation showed that the length of the straw was relatively stable ($V = 16.63$ %), the diameter indicator was moderately variable ($V = 23.65$ %), and the mass had a high degree of dispersion ($V = 52.34$ %). This indicates that among the physical properties of the straw, especially the mass indicator has the greatest variability.

Based on the results obtained, important scientific foundations were created for selecting the parameters of the working bodies of technical equipment used in the processes of collecting, crushing and processing wheat straw residues. In particular, differences in the size and mass indicators of straw directly affect its movement properties under mechanical influence, which affects energy consumption and work efficiency in the crushing and transportation processes. Therefore, it is necessary to optimize the geometric parameters of the working bodies in devices for processing wheat straw residues, as well as to select operating modes (speed, force and impact parameters) on a scientific basis. This will serve to effectively manage straw in field conditions, accelerate agrotechnical processes and increase overall production efficiency.

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AGRICULTURAL ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

PHYSICAL AND MECHANICAL PROPERTIES AND DIMENSIONAL–MASS CHARACTERISTICS OF ALMOND FRUIT

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Abstract. This article presents the results of experimental studies aimed at determining the physical and mechanical properties, as well as the dimensional and mass characteristics of almond fruit, in order to develop a vibrating mechanism used for harvesting almonds. During the research, the geometric dimensions, mass, and physical–mechanical properties of almond fruit were determined, and the main parameters influencing the vibration process were substantiated.

Keywords: almond fruit, physical and mechanical properties, dimensional and mass characteristics, geometric dimensions, mass, density.

Introduction. Today, on a global scale, increasing efficiency in agricultural production, harvesting crops with minimal losses, and introducing resource-saving technologies are of paramount importance. In particular, the volume of almond cultivation - a crop belonging to the nut fruit group - has grown considerably in recent years. According to 2023-2024 data, world almond production is approaching 4.5 million tonnes, with the United States accounting for 55–58%, Spain for 8–10%, Australia for 7–8%, Iran for 5-6%, and Turkey for 3-4% of total output [1]. These figures indicate the need to further improve the mechanization of almond harvesting and processing.

The efficiency of technical tools used in almond harvesting depends largely on the physical and mechanical properties and dimensional–mass characteristics of the fruit. In particular, the length of almond fruit has been found to range from 20–40 mm, the width from 10–20 mm, the mass from 1.0–3.0 g, and the density to constitute 900–1100 kg/m³; these indicators serve as principal parameters in the design of working elements of harvesting equipment [2, 3]. The attachment force, elasticity, and deformation characteristics of the fruit are especially important in vibration-based harvesting mechanisms.

In the Republic of Uzbekistan, systematic reforms are being implemented to develop horticulture, grow export-oriented products, and expand the area of intensive orchards. In particular, Resolution No. PQ-4549 of the President of the Republic of Uzbekistan, dated December 11, 2019, "On Additional Measures for Further Development of the Fruit and Vegetable and Viticulture Sector and Creation of a Value Chain in the Industry," identifies the introduction of modern agrotechnologies, increasing production volumes, and developing processing as priority objectives [4].

Within the framework of these objectives, the scientific improvement of almond cultivation and mechanized harvesting processes is of pressing importance. Therefore, the main purpose of this study is to determine the physical and mechanical properties and dimensional–mass characteristics of almond fruit, to evaluate their effect on the harvesting process, and to create a scientific foundation for developing effective technical tools.

In this study, the Bostonliq and Konsoy almond varieties, which are widely cultivated and of practical significance in Uzbekistan, were selected as experimental objects. These varieties are distinguished by their agrobiological characteristics, productivity, and industrial importance.

The Bostonliq variety is primarily cultivated in foothill areas and is characterized by relatively large fruit, high mass, and a hard shell. This variety is sensitive to mechanical impact and constitutes an important research subject in vibration-based harvesting.

The Konsoy variety, in turn, is distinguished by relatively uniform fruit shape and size, dense arrangement, and stable morphological characteristics. This makes it an important model for developing mechanized harvesting technologies.

Both varieties were cared for according to agrotechnical requirements throughout the growing season; fruit were harvested at full maturity and prepared for laboratory determination of their physical, mechanical, and dimensional–mass characteristics.

Literature Review and Problem Statement. Numerous researchers have studied the determination of physical and mechanical properties of almond fruit, examination of their dimensional–mass characteristics, and substantiation of key parameters for technological processes, both in Uzbekistan and abroad. Among them are: C. Aydin, A.H. Mirzabe, J. Khazaei, G.R. Chegini, O. Gholami, S. Arslan, K.K. Vursuvaş, M. Rasouli, K. Mollazade, R. Fatahi, Z. Zamani, A. Imani, P. Martínez-Gómez, R. Polat, M. Guner, E. Dursun, D. Erdogan, I. Gezer, H.I.C. Bilim, Y. Rharrabti, E. Sakar, Sh.S. Omonturdiev, E. Umurzakov, J. Namozov, Y. Yuldashov, and others.

The studies conducted have determined the geometric dimensions, mass, density, moisture-dependent properties, strength, and deformation characteristics of almond and similar nut fruits. The physical and mechanical properties of fruit are of particular importance in harvesting, transportation, sorting, and processing operations; these indicators make it possible to correctly select the parameters of working elements of technical tools. For this reason, determining the physical and mechanical properties and dimensional–mass characteristics of almond fruit and adapting them to the mechanized harvesting process is one of the important scientific and practical tasks [5-12].

Materials and Methods. The structural composition of the almond fruit crop is of great importance in substantiating the dimensions of the working elements of a vibrating mechanism used in harvesting. Therefore, experiments were conducted to determine the physical and mechanical properties and dimensional–mass characteristics of almonds.

To determine the dimensional–mass characteristics of the almond fruit crop, 50 specimens were taken from each of two almond varieties, and their length, thickness, and mass were measured.

Figure 1. Almond varieties used in the study (1 -Bostonliq; 2 - Konsoy) and the process of determining dimensional–mass characteristics (3)

The arithmetic mean is the simplest and most widely used measure of central tendency. It involves summing a group of numbers and then dividing that sum by the count of numbers in the sequence.

$$\bar{x} = \frac{\sum x}{n} \tag{1}$$

where: -$\bar{x}$ arithmetic mean; x_i - the value of each individual measurement; n - the number of observations.

The term “variance” is a statistical term denoting the extent of the distribution of expected values for a given variable. Variance can be calculated and measured using various statistical indicators such as range, dispersion, and standard deviation.

To determine the variance, we square the result of the arithmetic mean. Then we subtract 1 from the number of observations in the denominator. Then we divide by the denominator.

$$S^2 = \frac{\sum(x-\bar{x})^2}{n-1} \tag{2}$$

Standard deviation S (or σ) is a measure of how dispersed the data are relative to the mean. A low or small standard deviation indicates that the data are clustered closely around the mean, while a high or large standard deviation indicates that the data are more widely spread.

$$S = \sqrt{S^2} = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \tag{3}$$

The coefficient of variation (CV) is the ratio of the standard deviation to the mean. The higher the coefficient of variation, the greater the degree of dispersion around the mean. It is typically expressed as a percentage.

$$V = \frac{S}{x} \times 100\% \tag{4}$$

Results and Discussion.

Physical and Mechanical Properties of Almond Fruit. Table 1 presents the principal geometric dimensions and mass characteristics of the Bostonliq almond variety, along with their mean values and coefficients of variation derived from mathematical-statistical processing.

Table 1

Principal dimensional–mass parameters of the Bostonliq almond variety and their degree of variation

No.	Parameter	Mean value, $\bar{x}$	Std. dev., S	Coeff. of variation, %
1	Length, mm	27.17	2.21	8.14
2	Width, mm	18.06	1.91	10.58
3	Thickness, mm	13.15	1.32	10.01
4	Mass, g	2.61	0.77	29.48

According to the analysis results, the mean length of Bostonliq almond fruit was 27.17 mm, with a coefficient of variation of 8.14%. This value indicates a low level of dispersion and shows that the fruit are relatively uniform in length. This enables stable length parameters to be adopted in designing the working elements of vibrating mechanisms.

The mean width of the fruit was 18.06 mm, with a coefficient of variation of 10.58%. This indicator represents a moderate level of variability and shows that some difference exists in the lateral dimensions of the fruit. Accordingly, the receiving and gripping elements of the harvesting device should have a flexible design.

With regard to thickness, the mean value was 13.15 mm, with a coefficient of variation of 10.01%. This result also indicates that the fruit are relatively stable in terms of thickness. This ensures that fruit move in a uniform physical state during mechanical separation and transportation.

The mass parameter was 2.61 g, with a coefficient of variation of 29.48%. This represents a high level of dispersion and indicates that the inertial properties of the fruit vary considerably. This factor is precisely the main challenge in vibration-based mechanisms, as separating fruit of different masses under the same regime becomes difficult.

For this reason, it is advisable to use mechanisms with the ability to adjust vibration frequency and amplitude when harvesting Bostonliq almond fruit.

Table 2

Principal dimensional–mass parameters of the Konsoy almond variety and their degree of variation

No.	Parameter	Mean value, $\bar{x}$	Std. dev., S	Coeff. of variation, %
1	Length, mm	26.43	1.63	6.18
2	Width, mm	17.70	1.45	8.19
3	Thickness, mm	13.40	1.27	9.46
4	Mass, g	2.66	0.60	22.59

According to the results obtained, the mean length of Konsoy almond fruit was 26.43 mm, with a coefficient of variation of 6.18%. This value indicates very low dispersion and shows that the fruit have a high degree of uniformity in length. This ensures stable transmission of vibration effects during the mechanized harvesting process.

The mean width of the fruit was 17.70 mm, with a coefficient of variation of 8.19%.

This result also indicates that the fruit are relatively stable in terms of lateral dimensions. This condition has a positive effect on the efficient operation of receiving elements and sorting devices of the mechanisms. With regard to thickness, the mean value was 13.40 mm, with a coefficient of variation of 9.46%. This indicator suggests a moderate level of stability in fruit thickness and enables the deformation behavior under mechanical impact to be predicted in advance. The mass parameter was 2.66 g, with a coefficient of variation of 22.59%. Although this value is relatively high, it demonstrates lower dispersion compared to the Bostonliq variety. Consequently, the inertial properties of Konsoy almond fruit are relatively more stable, which contributes to improving the efficiency of vibration-based harvesting mechanisms.On this basis, it is determined that a relatively stable frequency and amplitude range can be applied in vibrating mechanisms for Konsoy almond fruit. The experimental results showed that the geometric dimensions of fruit (length, width, and thickness) for both varieties had relatively low coefficients of variation, ranging from 6.18% to 10.58%. This indicates that almond fruit are sufficiently stable in terms of shape and dimensions. This condition makes it possible to standardize the receiving and guiding elements of the device during the mechanized harvesting process. At the same time, a considerably high degree of variation was observed in mass parameters. In particular, the coefficient of variation reached 29.48% for the Bostonliq variety and 22.59% for the Konsoy variety. This shows that the inertial properties of the fruit differ markedly from one another. Since inertial forces play the primary role in fruit detachment from branches during vibration-based harvesting, these differences directly affect the efficiency of the technological process.It is known that during vibration, detachment of fruit from branches occurs depending on the fruit’s mass, attachment force, and vibration parameters. While inertial forces are higher for fruit of greater mass, this force may be insufficient for fruit of small mass. As a result, effective separation of all fruit under a single vibration regime becomes difficult.

The results obtained are also consistent with regularities established by other researchers. In particular, studies conducted by Cemal Aydin and Süleyman Arslan similarly noted that the geometric characteristics of almond fruit are relatively stable, while mass characteristics exhibit high variability.

On this basis, the following important aspects must be taken into account in designing vibrating mechanisms:

the ability to adjust vibration frequency over a wide range;

applying equal impact on fruit of different masses by adjusting amplitude;

use of elastic gripping elements to prevent excessive impact and damage.

The results indicate that in selecting the optimal vibration regime, it is necessary to rely not only on mean values but also on the degree of dispersion expressed by the coefficient of variation. Otherwise, system efficiency decreases and crop losses increase.

Conclusion. In this study, the dimensional–mass parameters of almond fruit and the effect of their statistical variability on the vibration-based fruit detachment process were systematically evaluated. The results demonstrated that the geometric dimensions of fruit have relatively low dispersion, and these serve as a basis for determining the design parameters of vibrating mechanisms. Conversely, the high variability in mass leads to an uneven distribution of inertial forces, which limits the stability of the vibration-based separation process.

On this basis, it was established that selecting a single set of vibration parameters is insufficient for effective separation of the almond crop; rather, they must be defined in interval form corresponding to the statistical variability of the fruit. The scientific novelty of the study lies in the substantiation that the degree of dispersion expressed by the coefficient of variation - rather than mean values - should be used as the primary controlling factor in designing vibrating mechanisms. This approach serves to improve the efficiency of fruit detachment and reduce losses by optimizing vibration regimes.

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AGRICULTURAL ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

PHYSICAL AND MECHANICAL PROPERTIES AND DIMENSIONAL-MASS CHARACTERISTICS OF CORN COBS

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Abstract. This article presents the results of experimental studies aimed at determining the dimensional-mass characteristics, geometric dimensions, and physical-mechanical properties of corn cobs, with the purpose of developing a sorting device for selecting cobs of precise dimensions suitable for seed production. During the research, the geometric dimensions, dimensional-mass indicators, and physical-mechanical properties of corn cobs were comprehensively studied. Based on the obtained results, the main parameters affecting the efficiency of the cob sorting and separation process - specifically, the mechanical forces and constructive characteristics of working organs - were scientifically substantiated.

Keywords: corn, corn cob, dimensional-mass characteristics, physical and mechanical properties, angle of friction, cob width, cob thickness, cob length

Introduction. Today, achieving high yields in agriculture, efficient use of resources, and the preparation of quality seed materials are of paramount importance. The ever-increasing volume of corn cultivation worldwide demands the continuous improvement of seed preparation technologies. Currently, corn is grown on 200-210 million hectares globally, with an annual harvest of 1.1-1.2 billion tons [1]. The application of energy- and resource-saving technologies in processing operations while preserving seed quality is one of the most pressing scientific and practical challenges.

One of the most critical stages in obtaining seed corn kernels is the initial processing of cobs - specifically, their husking and subsequent sorting based on quality indicators. In this process, the physical-mechanical properties, geometric dimensions, structural strength, and deformation resistance of cobs and kernels play a vital role. Therefore, developing effective methods for sorting seed corn cobs and scientifically substantiating the optimal parameters of devices that carry out this process is a scientifically important task [2]. In recent years, the leading producers of corn have been the USA (31%), China (24%), Brazil (11%), EU countries (5%), Argentina (4%), and India (3%). This further reinforces the necessity of developing and implementing advanced technologies and high-performance machinery in this field [3].

In the Republic of Uzbekistan, special attention is being paid to the modernization of agriculture and the development of the seed system. In particular, Decree No. PQ-4634 of the President of the Republic of Uzbekistan, dated March 6, 2020, identifies the improvement of the system for providing grain-growing farms with certified, high-quality seed as a priority task. In our republic, high-yielding dent and flint corn hybrids - namely Uzbekistan 306 AMV, Uzbekistan 601 YESV, Vatan, Qarasuv 350 AMV, and Figaro - are widely cultivated [4].

Literature Review and Problem Statement. A review of the literature shows that extensive scientific research has been conducted worldwide on improving the processing - particularly the sorting and separation - of seed corn cobs. Studies in this area have mainly focused on increasing the efficiency of sorting cobs by quality indicators using mechanical, aerodynamic, vibrational, and optical methods.

In the development of corn processing technologies, researchers such as Miloslav Herak, A.K. Srivastava, Ajit K. Srivastava, K.D. Astanakulov, G.G. Fozilov, and others, as well as scientific foundations developed by the CIGR organization, have made significant contributions [5,6]. Their works cover the theoretical foundations of grain crop processing, the physical-mechanical properties of materials, and the general principles of separation technologies.

In recent years, particular attention has been given to the application of digital technologies in corn cob sorting. Research by Fei Gao, Yong Zhang, and Dong Liu has proposed methods with high accuracy for identifying and sorting seed materials using machine vision and artificial intelligence [7]. Furthermore, studies by Peterson D.L. and Kepner R.A. on improving mechanical sorting systems analyzed the effectiveness of conveyor systems and size- and mass-based separation mechanisms [8].

These works substantiated the influence of the geometric and mass parameters of grain and cob materials on the separation process.

At the same time, scientific research on the use of optical sensors, color-based sorting systems, and automated control devices within the framework of modern technologies for improving seed quality is also advancing rapidly [9,10]. This demonstrates the need to further improve traditional mechanical methods and integrate them with 'smart' systems.

Accordingly, the objective of this article is to develop an effective method for sorting seed corn cobs and to theoretically and experimentally substantiate the main constructive and technological parameters of the device that implements this process [5-12].

Materials and Methods. In developing an effective method for sorting seed corn cobs and substantiating the optimal parameters of the device, the physical-mechanical properties, geometric dimensions, and dimensional-mass characteristics of the cobs are of great importance. Therefore, experimental studies were conducted to determine the structure of seed corn cobs, their dimensional-mass indicators, and their physical-mechanical properties [5].

Husked seed corn cobs that had been grown and harvested were selected as the objects of study. During the experiments, the main geometric parameters of cobs — length, width, and thickness — as well as their mass were measured and statistically analyzed. Measurements were performed with high-precision instruments. To study the internal structure of corn cobs, a portion of the husked cobs was cut, and the layers, kernel arrangement, and connection characteristics of the husk with the cob were analyzed. This process provided important data for the constructive substantiation of the working organs of sorting and husking mechanisms.

In addition, during the experiments, the physical-mechanical properties of cobs — including friction angle, sliding characteristics, and resistance to external influences — were determined, and their effect on the sorting process was evaluated. Determination of the friction angle was carried out using specially designed experimental apparatus, under conditions of interaction with various surfaces. Based on the obtained results, it was possible to determine the efficiency of the seed corn cob sorting process, as well as the gap between working organs, the angle of inclination, and other constructive-parametric indicators.

Figure 1. Process of determining geometric dimensions and mass indicators of seed corn cobs.

The arithmetic mean is the simplest and most widely used measure of central tendency. It involves taking the sum of a group of numbers and then dividing this sum by the count of numbers used in the sequence:

$$\bar{x}=\frac{\sum x}{n} \tag{1}$$

Where $\bar{x}$ is the arithmetic mean, Σx is the sum of each measured value, and n is the number of experiments. Variance is a statistical term that describes the extent of distribution of expected values for a given variable. Variance can be calculated and measured using statistics such as range, dispersion, and standard deviation.

In determining variance, the arithmetic mean result is squared. Then, 1 is subtracted from the number of experiments in the denominator:

$$S^2=\frac{\sum(x-\bar{x})^2}{n-1} \tag{2}$$

Standard deviation S (or σ) is a measure of how dispersed the data is relative to the mean. A low or small standard deviation indicates that the data is closely clustered around the mean, and a high or large standard deviation indicates that the data is more spread out:

$$S=\sqrt{S^2}=\sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \tag{3}$$

The coefficient of variation (CV) is the ratio of the standard deviation to the mean. The higher the coefficient of variation, the higher the level of dispersion around the mean. It is usually expressed as a percentage:

$$V=\frac{S}{x}\times 100\% \tag{4}$$

The determined values were subjected to mathematical-statistical processing, and their minimum and maximum values, mean square deviation, and coefficient of variation were determined.

4. Results and Discussion

Table 1

Main dimensional-mass characteristics of seed corn cobs and their degree of variation.

No.	Parameter	Mean ($\bar{x}$)	±σ	V (%)
1	Seed cob mass (g)	328	60.78	18.53
2	Seed cob diameter (mm)	56.5	2.97	6.4
3	Seed cob length (mm)	290.5	37.58	12.94

Table 1 presents experimental data on the geometric and mass parameters of seed corn cobs. These data were processed by mathematical-statistical analysis, and mean values, variance indicators, and coefficients of variation were determined, serving to substantiate the important parameters of the cob sorting process.

According to the analysis results, the average mass of a seed cob was 328 g, with a standard deviation of 60.78 and a coefficient of variation of 18.53%. This high level of variation indicates a significant difference among samples, which is explained by the natural heterogeneity of biological material and limits the use of mass as the primary criterion in the sorting process. The average cob diameter was 56.5 mm, with a standard deviation of 2.97 and a coefficient of variation of 6.4%. This low coefficient of variation indicates that diameter is a highly stable parameter [11]. Therefore, diameter can be accepted as the primary criterion in designing mechanical sorting devices.

For cob length, the average value was 290.5 mm, with a standard deviation of 37.58 and a coefficient of variation of 12.94%, indicating that this parameter has a medium level of variability. Therefore, length is appropriately used as a supplementary parameter in the sorting process. Overall, the obtained results show that diameter serves as the most stable and reliable parameter for sorting seed corn cobs, while mass has the greatest variability [12]. For this reason, in developing an effective sorting technology, diameter should be considered the primary parameter, while mass and length should be considered supplementary parameters. The physical-mechanical and geometric parameters determined experimentally serve as a solid scientific foundation for substantiating the constructive and technological parameters of the proposed sorting device. Based on the obtained results, the following main design parameters can be determined:

Working Gap Width. Taking into account that the average diameter of a seed corn cob is 56.5 mm and the standard deviation is ±2.97 mm, the working gap of the sorting mechanism should be selected in the range from $\bar{d} - k\sigma$ to $\bar{d} + k\sigma$. Here, k is the constructive safety factor, usually accepted in the range of 1.5–2.0. This approach ensures that all cobs suitable for seeding are fully covered and that undersized specimens are separated. According to calculations, the working gap width should be approximately in the range of 51.7–61.0 mm.

Inclination Angle of Working Surfaces. The determined friction angle values serve as the basis for defining the minimum and maximum inclination angles of conveyor and sorting surfaces. To ensure the stable movement of cobs without sliding away or getting stuck, the inclination of working surfaces should be greater than the static friction angle but less than the dynamic limit. This ensures a continuous and stable flow of material in the sorting zone [6].

Substantiation of Mechanical Force Parameters. Experiments on the resistance of seed corn cobs to compression and impact loads show that forces exerted by working organs must not exceed the threshold that leads to kernel detachment or structural damage to the cob. This requirement is of great importance in preserving the quality and germination capacity of seed material, and these results are consistent with scientific conclusions obtained by Brandini [6] and Fozilov et al. [4].

Overall, integrating experimentally determined parameters into the design process of the sorting device enables the creation of a mechanically sophisticated device that meets agrotechnical requirements, ensures high-precision sorting, and minimizes damage to the material. This approach serves to improve corn cob processing technologies and contributes to the scientific-technical progress in this field, consistent with the 2020–2030 agricultural mechanization strategy of the Republic of Uzbekistan [4].

Conclusion. As a result of the conducted research, the main geometric (length, diameter) and mass characteristics of seed corn cobs were experimentally determined and analyzed using mathematical-statistical methods. The results showed a significant degree of variability among cobs, with mass having the greatest and diameter having the least variation.

The analyses demonstrated that the low coefficient of variation of diameter makes it possible to use it as the primary criterion in the sorting process, while mass and length are appropriate as supplementary parameters. Based on experimental data, the important constructive and technological parameters of the sorting device - specifically, the working gap width, the inclination angle of working surfaces, and the mechanical force parameters - were scientifically substantiated. As a result, the proposed approach forms the necessary scientific foundation for creating a device that enables effective sorting of seed corn cobs, minimizes damage to the material, and ensures high-precision processing. These results serve to improve agricultural mechanization processes, enhance seed material quality, and promote efficient use of resources [1-12].

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AGRICULTURAL ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

DEVELOPMENT OF ORGANIC FERTILIZER SPREADING DEVICES: A BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS AND SPREADING MECHANISMS

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Abstract. The development of efficient devices for spreading organic fertilizers is a key factor in improving agricultural productivity and sustainability. However, a systematic understanding of research trends, particularly in spreading mechanisms, remains insufficient. This study presents a bibliometric analysis of scientific publications focused on organic fertilizer spreading technologies. The analysis was conducted using data from Scopus covering the period 2001–2024. A total of 139 relevant publications were selected and analyzed using VOSviewer. The study evaluates publication trends, keyword co-occurrence, and research clusters, with particular emphasis on the analysis of spreading mechanisms.

The results show increasing research interest in improving distribution uniformity, particle flow behavior, and spreading efficiency. Recent studies focus on simulation-based methods and precision agriculture technologies. The findings also identify gaps in performance evaluation and real-time monitoring of fertilizer distribution. This study provides a clear overview of research developments and supports the design and optimization of advanced organic fertilizer spreading devices.

Keywords. Organic fertilizer spreading; Spreading mechanism; Fertilizer spreader; Bibliometric analysis; Scopus; VOSviewer; Precision agriculture; Particle flow; Distribution uniformity; Agricultural machinery

Introduction. The application of organic fertilizers plays a vital role in improving soil fertility, crop productivity, and environmental sustainability in modern agricultural systems [1]. However, efficient and uniform distribution of organic fertilizers remains a significant engineering challenge [2], particularly due to the heterogeneous physical and mechanical properties of organic materials [3]. Mechanical spreading devices have therefore become an essential component in ensuring effective fertilizer application and reducing labor dependency [4].

Early studies by Grift, T. E. et al [5].Demonstrated that the performance of fertilizer spreaders is highly dependent on distribution uniformity and machine design parameters [6]. Further investigations by Cool, S. et al. Highlighted the importance of spreading pattern analysis for optimizing application efficiency [7]. In addition, Van Liedekerke, P. et al. Introduced advanced modelling approaches using discrete element methods (DEM), enabling detailed analysis of particle flow behaviour during the spreading process[8].

Recent studies have increasingly focused on simulation-based approaches. Hijazi, B. et al. and Coetzee, C. J. et al. emphasized the importance of accurate calibration and modelling of granular materials to improve prediction accuracy in spreading systems[9]. Furthermore, Shen, J. et al. Demonstrated the growing role of precision agriculture technologies in enhancing fertilizer application efficiency, while Zhang, X. et al [10]. Highlighted the integration of automation and intelligent control systems in modern agricultural machinery [11].

Despite these advancements, the research landscape related to organic fertilizer spreading devices remains fragmented [12]. Most studies focus on specific machine components or simulation techniques, with limited attention given to comprehensive analysis of global research trends and technological evolution. In particular, the spreading mechanism, being the core functional element of fertilizer application systems, has not been sufficiently analyzed from a bibliometric perspective.

The novelty of this study lies in conducting a comprehensive bibliometric analysis of global research on organic fertilizer spreading technologies, with a specific focus on spreading mechanisms. Unlike previous studies, this work integrates publication trends, collaboration networks, and keyword evolution to provide a systematic understanding of the research field and identify emerging technological directions.

In this context, the present study aims to analyze global research trends and technological developments in organic fertilizer spreading systems. Using data retrieved from the Scopus database for the period 2001–2024, this study evaluates publication trends, collaboration patterns, and thematic evolution based on 139 selected publications analyzed using VOSviewer.

Materials and Methods. Data Source and Search Strategy. The data used in this study were retrieved from the Scopus database, which is recognized as one of the most comprehensive sources of peer-reviewed scientific publications.

To ensure the relevance and accuracy of the dataset, a structured search query was developed focusing specifically on organic fertilizer spreading technologies and their core functional components. The search query applied in this study was formulated as follows:

TITLE-ABS-KEY((spreader OR spreading) AND ((organic fertilizer OR mineral fertilizer)) AND (machine OR equipment))

The search was refined using the following criteria:

Document type: Articles and review papers

Language: English

Time span: 2001–2024

The initial search yielded a large number of publications. After removing duplicate records and excluding irrelevant studies through title and abstract screening, a total of 139 publications were selected for further bibliometric analysis. Particular attention was given to studies addressing the spreading mechanism, which represents the key functional element of fertilizer application systems

Publication Trends Over Time. The temporal distribution of publications related to organic fertilizer spreading technologies is illustrated in Figure 1. The results reveal a gradual but consistent increase in scientific output over the period 2001-2024, indicating the growing research interest in this field.

During the initial stage (2001-2010), the number of publications remained relatively low, typically ranging from 1 to 3 articles per year. This period can be characterized as the early development phase, where research was mainly focused on basic design concepts and traditional fertilizer spreading methods.

A moderate growth phase (2011-2014) is observed, with publications increasing to 3–8 articles per year. This growth reflects the transition toward more systematic research, including the introduction of modeling approaches and improvements in spreading mechanisms.

The most significant expansion occurred during 2015-2017, when the number of publications reached a peak of 14 articles in 2017. This rapid growth can be attributed to the increasing adoption of simulation techniques, particularly the use of the Discrete Element Method (DEM), as well as the rising demand for improving distribution uniformity and efficiency of spreading devices.

A temporary decline is observed in 2018–2019, where the number of publications decreased to 5-7 articles. This fluctuation may be associated with shifts in research priorities or data indexing delays. However, this decline was followed by a strong recovery.

From 2020 onwards, a renewed and stable growth trend is evident, with publications ranging between 8 and 12 articles per year, peaking again in 2023. This recent increase highlights the growing importance of precision agriculture, automation, and smart control systems in fertilizer application technologies.

The lower number of publications in 2024 may be due to incomplete indexing of recent publications at the time of data collection.

Overall, the results demonstrate a clear transition from conventional mechanical approaches toward advanced, simulation-based, and intelligent fertilizer spreading systems. This trend confirms the increasing scientific and technological importance of optimizing spreading mechanisms for efficient and sustainable agricultural practices.

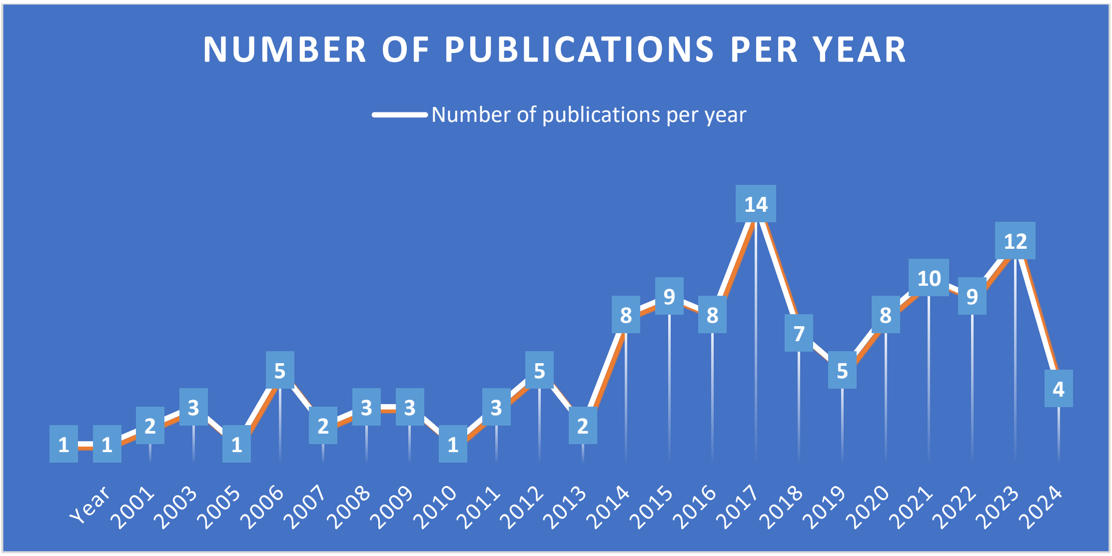

Figure 1. Annual number of publications on organic fertilizer spreading technologies indexed in the Scopus database (2001–2024).

Country Collaboration Network. The international collaboration network of countries involved in research on organic fertilizer spreading technologies is presented in Figure 2. The analysis demonstrates that the research field is supported by a diverse group of countries, indicating a growing level of global scientific cooperation.

The United States occupies a central position in the network, reflecting its leading role in both publication output and international collaboration. Its strong links with multiple countries highlight its influence in advancing research related to fertilizer spreading systems, particularly in areas such as precision agriculture and simulation-based modelling.

China is identified as another key contributor, showing a high level of research activity and strong collaboration connections, especially with the United States and other developing regions. This indicates the rapid growth of research capacity in fertilizer application technologies and agricultural machinery.

Among European countries, the United Kingdom, Belgium, Italy, and Spain demonstrate notable participation. These countries are closely connected within the network, suggesting active regional collaboration, particularly in the development and optimization of agricultural equipment and spreading mechanisms.

The presence of countries such as the Russian Federation, Ukraine, and Turkey reflects the expansion of research activities into emerging regions, where agricultural mechanization and efficient fertilizer application are becoming increasingly important.

Additionally, smaller nodes such as Malaysia and Nigeria indicate the initial involvement of developing countries in this research field, although their collaboration networks remain relatively limited.

Overall, the structure of the collaboration network reveals a multi- centered but interconnected system, where leading countries such as the United States and China act as major hubs. The strength of the links between countries indicates an increasing trend toward international cooperation, which plays a crucial role in accelerating technological development, knowledge exchange, and innovation in organic fertilizer spreading systems.

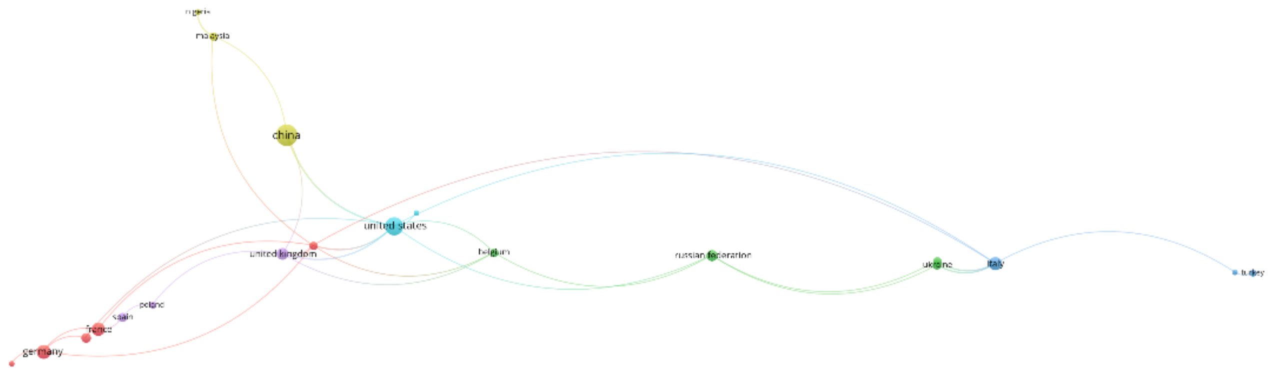

Figure 2. International collaboration network of countries in organic fertilizer spreading research based on co-authorship analysis.

Keyword Co-occurrence Analysis. The keyword co-occurrence network presented in Figure 3 reveals the main research themes in organic fertilizer spreading technologies. The analysis identifies several distinct clusters, reflecting the multidisciplinary structure of the field.

The primary cluster is associated with agricultural engineering aspects, including *"organic fertilizers," "fertilizer application,"* and *"spreader,"* indicating a strong focus on the design and optimization of spreading systems. Another cluster relates to environmental and process factors, such as *"water," "moisture,"* and *"environmental impact,"* highlighting the influence of operating conditions on spreading performance.

Additionally, a cluster linked to material and particle properties, including *"particle size"* and *"surface properties,"* emphasizes the importance of physical characteristics in determining distribution efficiency. The presence of other interconnected clusters reflects the integration of simulation, material science, and analytical approaches.

Overall, the strong interconnections between clusters indicate that research in this field is increasingly interdisciplinary, with growing emphasis on improving spreading efficiency through combined mechanical and analytical methods.

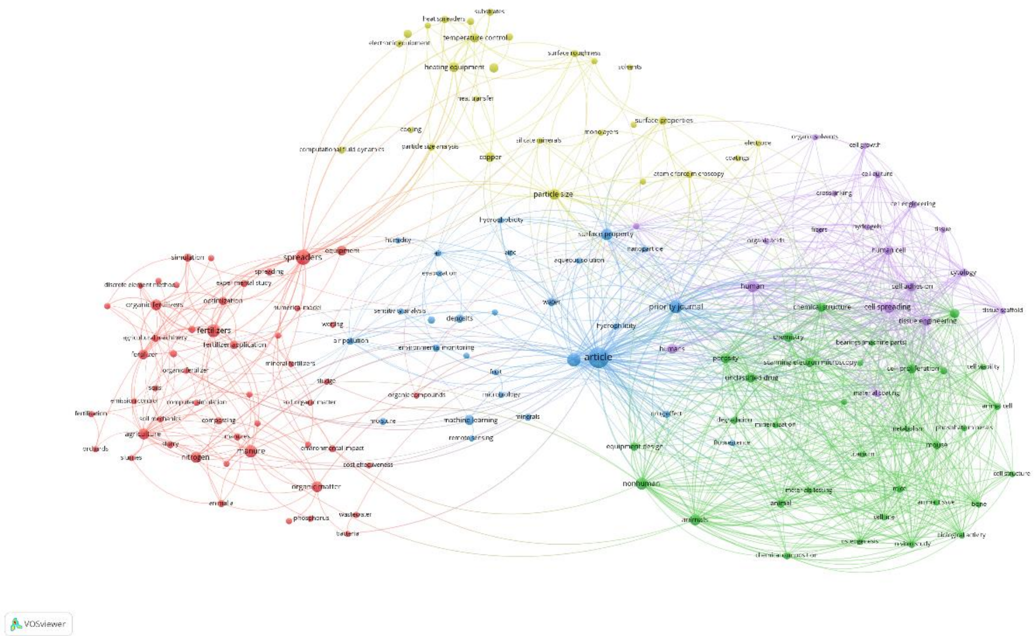

Figure 3. Keyword co-occurrence network in organic fertilizer spreading research based on Scopus data.

Author Collaboration Network. The co-authorship network shown in Figure 5 reveals the presence of several distinct author clusters, indicating the formation of specialized research groups in the field of organic fertilizer spreading technologies.

Strong connections are observed within clusters, reflecting active collaboration among researchers working on similar topics. However, the links between different clusters remain relatively weak, suggesting limited interaction between research groups.

Overall, the network structure indicates a fragmented collaboration pattern, highlighting the need to strengthen inter-group and international cooperation to enhance knowledge exchange and accelerate research development.

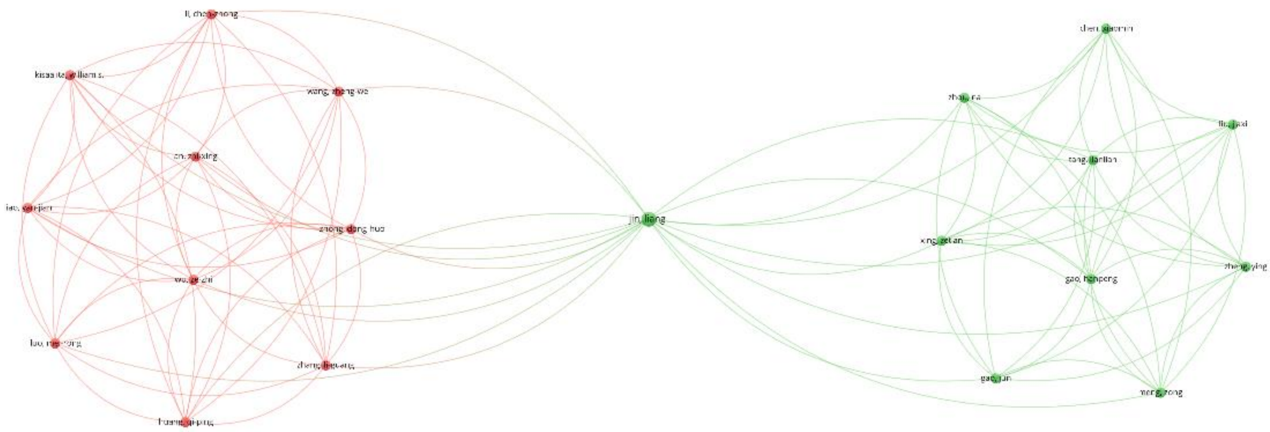

Figure 5. Co-authorship network of authors contributing to organic fertilizer spreading technologies, illustrating collaboration relationships.

Conclusion. This study provides a comprehensive bibliometric analysis of global research on organic fertilizer spreading technologies, with a particular focus on spreading mechanisms as the core functional component of fertilizer application systems. The analysis, based on 139 publications retrieved from the Scopus database for the period 2001–2024, reveals a steady growth in scientific output, reflecting the increasing importance of efficient and sustainable fertilizer application in modern agriculture. The results demonstrate a clear evolution of the research field from conventional mechanical approaches toward advanced simulation-based and precision agriculture technologies. In particular, the growing use of modeling methods, such as DEM, highlights the increasing emphasis on understanding particle flow behaviour and improving distribution uniformity.

The collaboration analysis indicates that although leading countries such as the United States and China play a central role in research development, global cooperation is still uneven and can be further strengthened. Similarly, the author collaboration network reveals the presence of well-defined research groups, but limited interaction between them, suggesting opportunities for broader knowledge exchange.

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AGRICULTURAL ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

TRAKTOR PARKIDA GAZ YORDAMIDA HAVONING IFLOSLANISHINI ANIQLASH VA TAHLIL QILISH MQ-135 DATCHIGI

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Annotatsiya: Ushbu maqolada shahar sharoitida atmosfera havosi sifatini kuzatish va tahlil qilish uchun MQ-135 gaz datchigining qo‘llanilishi ko‘rib chiqiladi. Datchikning ishlash prinsipi, uning texnik xususiyatlari, kalibrlash uslubi va Arduino mikrokontrollyori bilan integratsiyasi tavsiflangan. Turli shahar obyektlarida o‘tkazilgan eksperimental o‘lchovlar natijalari, shuningdek, ma’lumotlarni talqin qilish usullari keltirilgan. Ifloslantiruvchi moddalarning ruxsat etilgan chegaraviy konsentratsiyalari (RECHK) oshib ketganda erta ogohlantirish tizimi ishlab chiqilgan.

Kalit so‘zlar: MQ-135 gaz datchigi, havo ifloslanishi, havo sifati monitoringi, Arduino, PDK, karbonat angidrid, azot oksidlari, ekologik nazorat.

ОПРЕДЕЛЕНИЕ И АНАЛИЗ ЗАГРЯЗНЕНИЯ ВОЗДУХА В ТРАКТОРНОМ ПАРКЕ С ПОМОЩЬЮ ГАЗОВОГО ДАТЧИКА MQ-135

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Аннотация: В данной статье рассматривается применение газового датчика MQ-135 для мониторинга и анализа качества атмосферного воздуха в условиях городской среды. Описаны принцип работы датчика, его технические характеристики, методика калибровки и интеграция с микроконтроллером Arduino. Представлены результаты экспериментальных измерений на различных городских объектах, а также методы интерпретации данных. Разработана система раннего оповещения при превышении предельно допустимых концентраций (ПДК) загрязняющих веществ.

Ключевые слова: газовый датчик MQ-135, загрязнение воздуха, мониторинг качества воздуха, Arduino, ПДК, углекислый газ, оксиды азота, экологический контроль.

DETERMINATION AND ANALYSIS OF AIR POLLUTION IN THE TRACTOR PARK USING GASMQ-135 SENSOR

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Abstract: This article examines the application of the MQ-135 gas sensor for monitoring and analyzing atmospheric air quality in urban environments. The sensor's operating principle, technical

specifications, calibration methodology, and integration with the Arduino microcontroller are described. The results of experimental measurements at various urban sites, as well as methods for interpreting the data, are presented. An early warning system has been developed for exceeding the maximum permissible concentrations (MPC) of pollutants.

Keywords: MQ-135 gas sensor, air pollution, air quality monitoring, Arduino, MPC, carbon dioxide, nitrogen oxides, environmental control.

Kirish. Atmosfera havosining ifloslanishi muammosi hozirgi zamonning eng oʻtkir ekologik muammolaridan biridir. Jahon sogʻliqni saqlash tashkiloti maʼlumotlariga koʻra, ifloslangan havo har yili dunyo boʻylab 7 millionga yaqin bevaqt oʻlimga sabab boʻladi. Ayniqsa, ifloslantiruvchi moddalar konsentratsiyasi meʼyoriy qiymatlardan ancha yuqori boʻlgan yirik sanoat markazlari va megapolislar xavotir uygʻotmoqda.

Soʻnggi yillarda sezilarli moliyaviy xarajatlarsiz havo sifatini nazorat qilishning taqsimlangan tizimlarini tashkil etish imkonini beruvchi arzon yarimoʻtkazgichli gaz datchiklari keng tarqalmoqda. Ular orasida bir qator zararli gazlar, jumladan, CO_2, NH_3, NO_x, spirtlar, benzol va boshqa organik birikmalarga reaksiya qilish qobiliyatiga ega boʻlgan MQ-135 datchigi alohida oʻrin tutadi.

Ushbu ish MQ-135 datchigining metrologik imkoniyatlarini oʻrganish, uni kalibrlash usulini ishlab chiqish va avtomatlashtirilgan ekologik tizim tarkibida qoʻllashga bagʻishlangan.Принцип работы датчика mq-135

MQ-135 datchigi yarimoʻtkazgichli xemosorbsion sensorlar sinfiga kiradi. Sezgir element qizdirish elementi boʻlgan keramik taglikka surtilgan qalay oksidi (SnO_2) qatlamidan iborat. Toza havoda SnO_2 yuzasida kislorod adsorbsiyalanib, potensial toʻsiq hosil qiladi va qatlamning yuqori elektr qarshiligiga sabab boʻladi.

Qaytaruvchi yoki oksidlovchi gazlarning molekulalari bilan oʻzaro taʼsirlashganda adsorbsiyalangan kislorod bilan reaksiya sodir boʻladi, elektronlar ajralib chiqadi va sezgir elementning sirt qarshiligi kamayadi. Qarshilikning oʻzgarish miqdori atrof-muhitdagi gaz konsentratsiyasiga mutanosib boʻlib, quyidagi darajali bogʻliqlik bilan tavsiflanadi:

$$\frac{R_s}{R_0} = A \cdot C^B$$

bu yerda R_s - datchikning oʻlchangan qarshiligi, R_0 - toza havodagi qarshilik, C - gazning ppm dagi konsentratsiyasi, A va B - har bir gaz turi uchun tajribada aniqlanadigan kalibrlash koeffitsiyentlari.

Konstruksiyasi va texnik tavsiflari. MQ-135 datchigi sezgir elementni mexanik taʼsirlardan himoya qiluvchi va tahlil qilinayotgan gazning konvektiv kirishini taʼminlovchi qoʻsh toʻrli A turdagi metall korpusda ishlab chiqariladi.

Modul tarkibiga konsentratsiyaning chegaraviy qiymati oshganda diskret signal olish imkonini beruvchi analog komparator ham kiradi.

Quyida datchikning asosiy texnik xususiyatlari keltirilgan.

1-jadval

MQ-135 datchigining texnik tavsiflari

Parametr	Qiymat
Ishchi kuchlanish	5 B (DC)
Ishlash harorati	-20°C ... +70°C
CO_2 konsentratsiyasi	10 – 1000 ppm
NH_3 konsentratsiyasi	10 – 300 ppm
NO_x konsentratsiyasi	0,5 – 10 ppm
CO konsentratsiyasi	20 – 2000 ppm
Spirtlar konsentratsiyasi	10 – 300 ppm
Qizish vaqti	≥ 48 ч (первичный)
Chiqish signali	Analog (0–5 B), raqamli (TTL)

Kalibrlash uslubi va apparat qismi. MQ-135 datchigi Arduino Uno mikrokontrollyoriga A0 analog kirishi orqali ulanadi. Sezgir element +5 V shinasidan quvvat oladi. Koʻrsatkichlarning barqarorligini ta’minlash uchun datchikni birinchi marta ishlatishda kamida 48 soat va keyingi ulanishlarda kamida 3 daqiqa davomida oldindan qizdirish tavsiya etiladi.

Oʻlchov trakti sxemasi quyidagi komponentlarni oʻz ichiga oladi: MQ-135 datchigi, RL = 20 kOm yuklama qarshiligi, Arduino Uno (ATmega328P) mikrokontrollyori, I2C interfeysli 16×2 LCD displeyi, ma’lumotlarni yozish uchun SD-karta moduli hamda ma’lumotlarni serverga uzatish uchun GSM/Wi-Fi moduli.

Kalibrlash tartibi. Datchikni kalibrlash ikki bosqichda amalga oshirildi. Birinchi bosqichda R0 baza qarshiligi toza havo sharoitida 20±1°C haroratda va 65±5% nisbiy namlikda oʻlchandi. Buning uchun datchik CO2 konsentratsiyasi ma’lum boʻlgan atmosferada (400 ppm — atmosfera foni) 24 soat davomida ushlab turildi.

Ikkinchi bosqichda komponentlar tarkibi attestatsiyadan oʻtgan gaz aralashmalaridan foydalangan holda maqsadli gazlar uchun kalibrlash egri chiziqlari qurildi. Kalibrlash natijalariga koʻra, mikrokontrollerning EEPROM energiya mustaqil xotirasiga kiritilgan har bir aniqlanayotgan gaz uchun A va B koeffitsiyentlari olindi.

AROʻ koʻrsatkichlarini konsentratsiyaga (ppm) aylantirish formulasi dasturiy kodda amalga oshirilgan:

```
float getRs(int raw) {
float Vout = raw * (5.0 / 1023.0);
return (5.0 - Vout) / Vout * RL;
}
float ppm = A * pow(Rs / R0, B);
```

Tajriba natijalari. Oʻlchovlar Toshkent shahrida (Oʻzbekiston Respublikasi) bahor faslida ikki hafta davomida oʻtkazildi. Ifloslanish manbalari va intensivligi bilan farq qiluvchi toʻrtta xarakterli kuzatuv nuqtasi tanlandi: turar-joy hududi, transport yuklamasi yuqori boʻlgan avtomobil yoʻli, sanoat hududi va yopiq koʻp qavatli avtoturargoh.

Maʼlumotlar sutkasiga 24 soat davomida 5 daqiqalik davriylik bilan qayd etildi. Shu bilan birga, BME280 datchigi yordamida meteorologik koʻrsatkichlar: harorat, namlik va bosim qayd etilib, keyinchalik koʻrsatkichlar kompensatsiya qilindi.

Oʻlchangan konsentratsiyalarni tahlil qilish. Turli nuqtalarda CO_2 konsentratsiyasini oʻlchash natijalari 2-jadvalda keltirilgan. Maʼlumotlar uchta reprezentativ kuzatuv kuni uchun oʻrtachalashtirilgan.

2-jadval

CO2 konsentratsiyasini kuzatish nuqtalari boʻyicha oʻlchash natijalari

Oʻlchash joyi	CO_2, ppm (kun)	CO_2, ppm (choʻqqi)	Xavf darajasi
Turar joy hududi	350-420	450-520	Meʼyor
Avtomobil yoʻli	780-950	1200-1800	Koʻtarilgan
Sanoat zonasi	1100-1400	2100-3500	Baland
Yopiq avtoturargoh	1600-2200	3800-5200	Kritik

Olingan maʼlumotlar tahlili shuni koʻrsatdiki, aholi yashash joylarida CO_2 konsentratsiyasi meʼyoriy qiymatlardan oshmaydi. Shu bilan birga, avtomobil magistrallarida tigʻiz soatlarda JSST tomonidan tavsiya etilgan konsentratsiyalarning 2,5-3,5 barobarga oshishi kuzatilmoqda. Yopiq avtoturargohlar ayniqsa xavflidir, bu yerda shamollatishning sustligi natijasida ifloslantiruvchi moddalar konsentratsiyasi kritik qiymatlarga yetadi.

Konsentratsiyalarning sutkalik dinamikasi ertalabki (07:00–09:00) va kechki (17:00–20:00) transport faolligining eng yuqori soatlariga mos keladigan oʻziga xos ikki oʻrkachli profilga ega. Konsentratsiyaning tungi minimumlari soat 03:00–05:00 ga toʻgʻri keladi va atmosfera fon qiymatlariga yaqin qiymatlar bilan tavsiflanadi.

Olingan maʼlumotlar asosida quyidagi funksional komponentlarni oʻz ichiga olgan havo sifatini monitoring qilishning avtomatlashtirilgan tizimi ishlab chiqildi:

MQ-135 datchigi va ESP8266 Wi-Fi moduli bilan Arduino asosidagi 12 ta avtonom oʻlchov tugunlaridan iborat tarmoq;

Raspberry Pi 4 platformasi asosida maʼlumotlarni yigʻish va saqlashning markaziy serveri;

Real vaqt rejimida maʼlumotlarni vizuallashtirish va ifloslanish xaritasini koʻrsatish uchun veb-interfeys;

Telegram Bot API orqali xabarnomalar yuborish bilan chegaraviy ogohlantirish tizimi;

Datchik koʻrsatkichlariga harorat va namlikning taʼsirini kompensatsiyalash algoritmi.

Tizim belgilangan chegaraviy qiymatlarga muvofiq uchta trevoga darajasini amalga oshiradi: "Diqqat" (REMdan 1,5 baravar oshib ketish), "Xavf" (3 baravar oshib ketish) va "Kritik vaziyat" (5 baravardan ortiq oshib ketish). Chegaraviy qiymatga yetganda, avtomatik ravishda ogohlantirish generatsiya qilinadi va 1 daqiqalik davriylik bilan maʼlumotlarni kuchaytirilgan roʻyxatga olish boshlanadi.

Muhokama va cheklovlar. O‘tkazilgan tadqiqotlar MQ-135 datchigining atmosfera havosi ifloslanishini nisbiy monitoring qilish vazifalari uchun qo‘llanilishini tasdiqladi. Shu bilan birga, amaliyotda qo‘llashda hisobga olinishi kerak bo‘lgan bir qator muhim cheklovlarni ta’kidlash zarur.

Birinchidan, datchik ma’lum bir gazga nisbatan selektiv emas, uning signali bir nechta komponentlarning umumiy ta’sirini aks ettiradi. Alohida gazlarning ulushlarini ajratish uchun xemometriya usullarini qo‘llash yoki boshqa turdagi datchiklar bilan kombinatsiyalash talab etiladi. Ikkinchidan, sezgir elementning eskirishi natijasida ko‘rsatkichlarning uzoq muddatli barqarorligi pasayadi, shuning uchun har 6 oyda kamida bir marta qayta kalibrlash tavsiya etiladi.

Uchinchidan, ko‘rsatkichlarga atrof-muhit harorati va namligi katta ta’sir ko‘rsatadi. Ishlab chiqilgan harorat-namlik kompensatsiyasi algoritmi ushbu omillar ta’siridagi xatolikni ishchi sharoit oralig‘ida ±25% dan ±8% gacha kamaytirish imkonini berdi.

Xulosa. O‘tkazilgan tadqiqotlar natijasida havo sifatini monitoring qilishning avtomatlashtirilgan tizimlari tarkibida MQ-135 gaz datchigini qo‘llash samaradorligi ko‘rsatilgan. Ifloslantiruvchi moddalar konsentratsiyasi haqida 50-5000 ppm oralig‘ida ±12% dan ko‘p bo‘lmagan xatolik bilan ishonchli ma’lumotlar olish imkonini beruvchi datchikni kalibrlash usuli ishlab chiqildi va sinovdan o‘tkazildi.

Turli shahar hududlarini qamrab olgan 12 ta o‘lchov markazini o‘z ichiga olgan faoliyat yurituvchi monitoring tarmog‘i yaratildi. O‘lchov natijalari transport yuklamasi yuqori bo‘lgan hududlarda va yopiq joylarda ifloslantiruvchi moddalarning me’yoriy konsentratsiyasi sezilarli darajada oshganini ko‘rsatdi.

Tadqiqotning keyingi rivojlanishi ifloslanish epizodlarini bashorat qilish uchun mashinali o‘rganishni integratsiyalash va fuqarolarni havo sifati haqida real vaqt rejimida xabardor qilish uchun mobil ilova ishlab chiqishni o‘z ichiga oladi.

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AGRICULTURAL ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

KORPUSLARI QO‘SHIMCHA AG‘DARGICHLAR BILAN JIHOZLANGAN DISKLI PLUGNI TAYANCH TEKISLIGIDAN UNING OSISH QURULMASINING PASTKI TAQISH NUQTALARIGACHA BO‘LGAN TIK MASOFANI HAYDOV CHUQURLIGIGA TA’SIRI BO‘YICHA O‘TKAZILGAN TAJRIBA NATIJALARI

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Annotatsiya: Ushbu maqolada qo‘shimcha ag‘dargich bilan jihozlangan korpusli diskli plug osish qurilmasining yuqori va pastki taqish nuqtalari orasidagi H_2 masofa 610 mm qabul qilinib, plug tayanch tekisligidan osish qurilmasining pastki taqish nuqtalarigacha bo‘lgan H_1 tik masofa har 50 mm oraliqda 560 mm dan 710 mm gacha o‘zgarishi plug haydov chuqurligiga ta’siri bo‘yicha o‘tkazilgan dala tajriba natijalari keltirilgan.

Tayanch so‘zlar: diskli plug, plug korpusi, qo‘shimch ag‘dargich, osish qurilmasi, plug tayanch tekisligidan osish qurilmasining pastki taqish nuqtasigacha bo‘lgan tik masofa, transport tirqishi, plugning tortishga solishtirma qarshiligi, ish tezliklar.

РЕЗУЛЬТАТЫ ЭКСПЕРИМЕНТОВ, ПРОВЕДЕННЫХ ПО ВЛИЯНИЮ ВЕРТИКАЛЬНОГО РАССТОЯНИЯ ОТ ОПОРНОЙ ПЛОСКОСТИ ДИСКОВОГО ПЛУГА, КОРПУСЫ КОТОРОГО ОБОРУДОВАНЫ ДОПОЛНИТЕЛЬНЫМИ ОТВЕРЖКАМИ, ДО НИЖНИХ ТОЧЕК НАКРЫТИЯ ЕГО ВЕСОЧНОГО УСТРОЙСТВА НА ГЛУБИНУ ПАХОТЫ

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Аннотация: В данной статье приведены результаты полевых опытов по влиянию изменения вертикального расстояния H_1 от опорной плоскости плуга до нижних точек навески навесного устройства от 560 мм до 710 мм на глубину вспашки плуга при расстоянии H_2 между верхней и нижней точками навески корпусного дискового плужного устройства, оснащенного дополнительным отвалом, принятом равным 610 мм.

Ключевые слова: дисковый плуг, корпус плуга, дополнительный отвал, навесное устройство, вертикальное расстояние от опорной плоскости плуга до нижней точки крепления навесного устройства, транспортный зазор, удельное тяговое сопротивление плуга, рабочие скорости.

RESULTS OF EXPERIMENTS ON THE EFFECT OF THE VERTICAL DISTANCE FROM THE REFERENCE PLANE OF A DISC PLOW, THE BODIES OF WHICH ARE EQUIPPED WITH ADDITIONAL MOULDBOARDS, TO THE LOWER COVERAGE POINTS OF ITS WEIGHTING DEVICE ON THE PLOWING DEPTH

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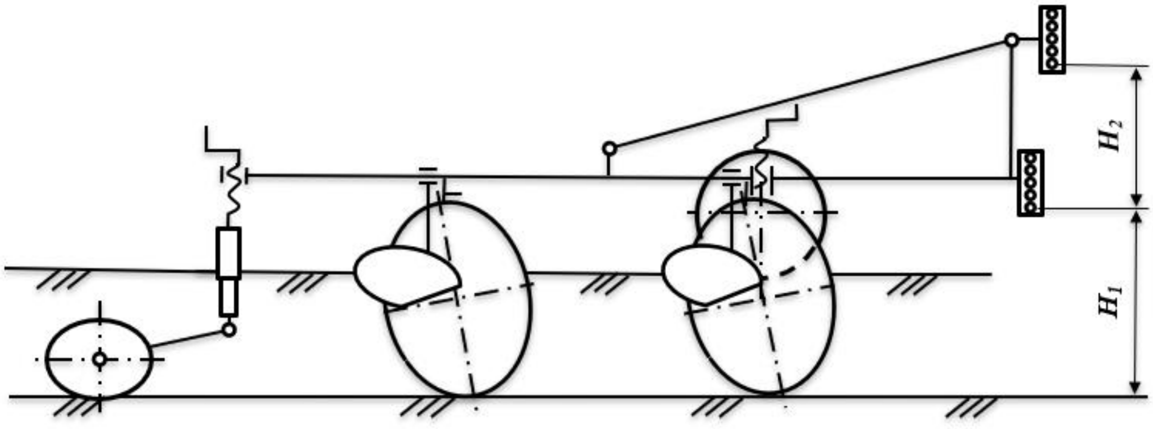
Abstract: This paper presents the results of field experiments investigating the effect of varying the vertical distance H_1 from the reference plane of the plow to the lower attachment points of the mounted linkage system, within the range of 560 mm to 710 mm, on the plowing depth. The study was conducted under the condition that the distance H_2 between the upper and lower attachment points of the disc plow body equipped with an additional mouldboard was maintained at 610 mm.

Keywords: disc plow, plow body, additional mouldboard, mounted linkage system, vertical distance from the plow reference plane to the lower attachment point of the linkage system, transport clearance, specific draft resistance of the plow, operating speeds.

Kirish: Keyingi yillarda qishloq xo‘jaligida energiya-resurstejamkor texnologiyalar va texnika vositalari keng joriy etilishi munosabati bilan yerlarga asosiy ishlov berish(shudgorlash)da diskli, ya’ni ish organi sferik disk ko‘rinishida bo‘lgan pluglarni qo‘llash muhim ahamiyat kasb etmoqda. Chunki ular ag‘dargichli pluglarga nisbatan tortishga kam qarshilik ko‘rsatadi, ish unumi yuqori, o‘simlik qoldiqlari va begona o‘tlarga tiqilmasdan ishlaydi[1].

Masalaning quyilishi:

Tajribalarda qo‘shimcha ag‘dargich bilan jihozlangan korpusli diskli plug osish qurilmasining yuqori va pastki taqish nuqtalari orasidagi H_2 masofa 610 mm qabul qilinib [2], plug tayanch tekisligidan osish qurilmasining pastki taqish nuqtalarigacha bo‘lgan H_1 tik masofa har 50 mm oraliqda 560 mm dan 710 mm gacha o‘zgartirildi (1-rasm). Bunda plug osish qurilmasi barmoqlarini uning kranshteyn teshiklarida o‘zgartirish yo‘li bilan amalga oshirildi.



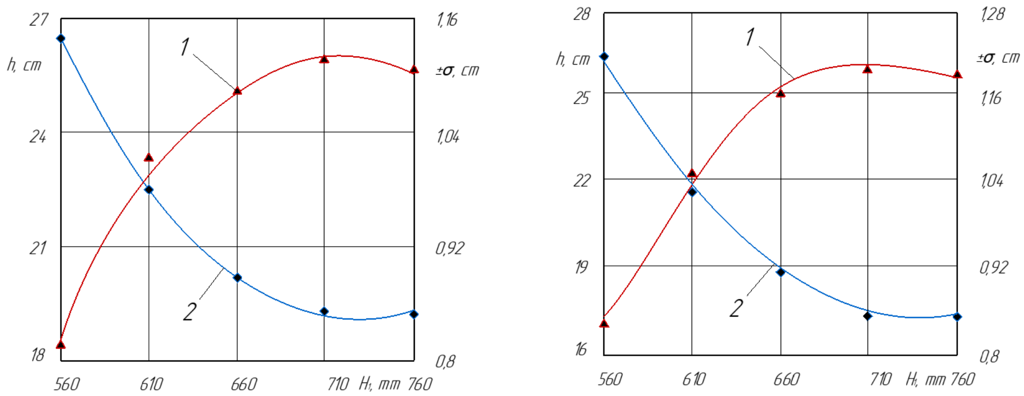
1-rasm. 1,4 -2,0 klassdagi traktorlar bilan agregatlanadigan qo‘shimcha ag‘dargich bilan jihozlangan korpusli diskli plugning sxemasi

Tajribalarni o‘tkazishda qo‘shimcha ag‘dargich bilan jihozlangan diskli plug New Holland TD5.110 traktori bilan agregatlandi va bunda agregatning ish tezligi $V=6$ va 9 km/soat va plugning ishlov berish chuqurligi 25 sm etib qabul qilindi.

Baholash mezoni sifatida plugning haydov chuqurligi va uning o‘rtacha kvadratik chetlanishi qabul qilindi.

Tajribalarning natijalari grafik ko‘rinishda 2-rasmda tasvirlangan. Ulardan ko‘rinib turibdiki, har ikkala harakat tezligida ham diskli plugning tayanch tekisligidan uning osish qurilmasining pastki taqish nuqtalarigacha bo‘lgan tik masofa 560 mm dan 660 mm har 50 mm oraliq bilan o‘zgarganda plugning haydov chuqurligi (*h*) ortgan, uning o‘rtacha kvadratik chetlanishiga (±σ) esa kamaygan, ya’ni plugning haydov chuqurligining barqarorligi yaxshilangan.

Ushbu masofa 660 mm dan 710 mm gacha ortishi diskli plug haydov chuqurligi va uning o‘rtacha kvadratik chetlanishi sezilarli ta’sir ko‘rsatmagan. Yana shuni aytish lozimki, diskli plug tayanch tekisligidan uning osish qurilmasining pastki taqish nuqtalarigacha bo‘lgan tik masofa 710 mm dan katta bo‘lganda diskli plugning me’yoriy hujjatlarda talab etiladigan transport tirqishi ta’minlanmadi.



a) *b*)

1. $h = f(H_1)$ 2. $\pm\sigma = f(H_1)$ 1. $h = f(H_1)$ 2. $\pm\sigma = f(H_1)$

a - 6 km/soat tezlikda *b* - 9 km/soat tezlikda

2-rasm. Qo‘shimcha ag‘dargich bilan jihozlangan diskli plugning tayanch tekisligidan uning osish qurilmasining pastki taqish nuqtalarigacha bo‘lgan tik masofani plugning haydov chuqurligi (*h*) va uning o‘rtacha kvadratik chetlanishi (±*σ*) ga ta’siri

Tadqiqot usuli: Sinovlar QXMITI tajriba uchastkasining bug‘doydan bo‘shagan va nam suvi berilgan dalalarida o‘tkazildi.

Tajribalarni o‘tkazishda qurilmaning tortishga solishtirma qarshiligi O’zDSt 3193:2017 «Qishloq xo‘jaligi texnikasini sinash. Mashinalarni energetik baholash usuli» bo‘yicha tenzometrik barmoqlar qo‘llanilib, agrotexnik ko‘rsatkichlari esa O‘zDSt 3355:2018 “Qishloq xo‘jaligi texnikasini sinash. Tuproqqa chuqur ishlov beruvchi mashinalar va qurollar. Sinov dasturi va usullari” bo‘yicha aniqlandi [3-5.].

Xulosa. Demak, qo‘shimcha ag‘dargich bilan jihozlangan diskli plug tuproqqa yetarli botishi va plugning haydov chuqurligi barqaror bo‘lishi va talab etiladigan transport tirqishi ta’minlanishi uchun uning tayanch tekisligidan plug osish qurilmasining pastki taqish nuqtalarigacha bo‘lgan tik masofa 660-710 mm oralig‘ida bo‘lishi kerak ekan.

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AGRICULTURAL
ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

KORPUSLARI QO‘SHIMCHA AGDARGICHLAR BILAN JIHOZLANGAN DISKLI PLUG PARAMETRLARINI MAQBULLASHTIRISH BO‘YICHA O‘TKAZILGAN KO‘P OMILLI EKSPERIMENTLARNING NATIJALARI

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Annotatsiya: Ushbu maqolada Y_1 mezon tuproqning uvalanish darajasi 80 % dan, Y_2 mezon o‘simlik qoldiqlarining ko‘milish chuqurligi 10 cm dan kam bo‘lmasligi, Y_3 mezon shudgor yuzasidagi notekisliklar balandligi 5 cm oshmasligi va Y_4 plugning tortishga solishtirma qarshiligi ushbu mezon minimal qiymatga ega bo‘lishi shartlaridan yechilib va ish tezligi 6-9 km/h oralig‘ida bo‘lganda korpuslari qo‘shimcha ag‘dargichlar bilan jihozlangan diskli plug quyidagi maqbul parametrlarga ega bo‘lganligi bo‘yicha olib borilgan ko‘p omilli eksperimentlarning natijalari keltirilgan.

Tayanch so‘zlar: diskli plug, qo‘shimcha ag‘dargich, ishchi sirtining egrilik radiusi, qo‘shimcha ag‘dargichning gorizontga nisbatan o‘rnatilish burchagi, qo‘shimcha ag‘dargichning korpus aylanish markaziga nisbatan o‘rnatilish balandligi, agregatning harakat tezligi, tuproqning uvalanish darajasi, o‘simlik qoldiqlarining ko‘milish chuqurligi, shudgor yuzasidagi notekisliklar balandligi, plugning tortishga solishtirma qarshiligi.

РЕЗУЛЬТАТЫ ПРОВЕДЕННЫХ МНОГОФАКТОРНЫХ ЭКСПЕРИМЕНТОВ ПО ОПТИМИЗАЦИИ ПАРАМЕТРОВ ДИСКОВОГО ПЛУГА С ОБОРУДОВАННЫМИ ДОПОЛНИТЕЛЬНЫМИ ОБРАЩАТЕЛЯМИ В КОРПУСАХ

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Аннотация: В данной статье приведены результаты многофакторных экспериментов, проведенных при условии, что критерий Y_1 - степень крошения почвы не менее 80%, критерий Y_2 - глубина заделки растительных остатков не менее 10 cm, критерий Y_3 - высота неровностей поверхности пашни не превышает 5 cm, а критерий Y_4 - удельное тяговое сопротивление плуга имеет минимальное значение, и при скорости работы в диапазоне 6-9 km/h дисковый плуг с корпусами, оснащенными дополнительными отвалами, имеет следующие оптимальные параметры.

Ключевые слова: дисковый плуг, дополнительный отвал, радиус кривизны рабочей поверхности, угол установки дополнительного отвала относительно горизонта, высота установки дополнительного отвала относительно центра вращения корпуса, скорость движения агрегата, степень крошения почвы, глубина заделки растительных остатков, высота неровностей поверхности пашни, удельное тяговое сопротивление плуга.

RESULTS OF MULTIFACTORIAL EXPERIMENTS ON THE OPTIMIZATION OF PARAMETERS OF A DISC PLOW EQUIPPED WITH ADDITIONAL MOULDBOARDS IN THE BODIES

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Abstract: This paper presents the results of multifactorial experiments carried out under the following constraints: criterion Y_1 - the soil fragmentation degree is not less than 80%; criterion Y_2 - the burial depth of plant residues is not less than 10 cm; criterion Y_3 - the height of surface irregularities of the plowed field does not exceed 5 cm; and criterion Y_4 - the specific draft resistance of the plow is minimized. Under these conditions, and within an operating speed range of 6–9 km/h, the disc plow with bodies equipped with additional mouldboards exhibits the following optimal parameters.

Keywords: disc plow, additional mouldboard, radius of curvature of the working surface, installation angle of the additional mouldboard relative to the horizontal plane, installation height of the additional mouldboard relative to the body rotation center, arperate travel speed, soil fragmentation degree, burial depth of plant residues, surface irregularity height of the plowed field, specific draft resistance of the plow.

Kirish: Keyingi yillarda qishloq xo‘jaligida energiya-resurstejamkor texnologiyalar va texnika vositalari keng joriy etilishi munosabati bilan yerlarga asosiy ishlov berish(shudgorlash)da diskli, ya’ni ish organi sferik disk ko‘rinishida bo‘lgan pluglarni qo‘llash muhim ahamiyat kasb etmoqda. Chunki ular ag‘dargichli pluglarga nisbatan tortishga kam qarshilik ko‘rsatadi, ish unumi yuqori, o‘simlik qoldiqlari va begona o‘tlarga tiqilmasdan ishlaydi [1].

Masalaning quyilishi:

Qo‘shimcha ag‘dargich bilan jihozlangan diskli plugni uning ish ko‘rsatkichlariga birgalikdagi ta’sirlarini o‘rganish hamda ularning maqbul qiymatlarini aniqlash maqsadida Xartli-4 rejasi bo‘yicha ko‘p omilli eksperementlar tajribalar o‘tkazildi [2;3].

1-jadvalda omillar, ularning shartli belgilanishi, o‘zgarish oraliqlari va sathlari keltirilgan.

1-jadval

Omillarning o‘zgarish oraliqlari va sathlari

Omillar va ularning o‘lchov birligi	**Omillar**				
	Kodlan-gan belgilanishi	**o‘zgarish oralig‘i**	**sathlari**		
			quyi (-1)	**asosiy (0)**	**yuqori (+1)**
1. Qo‘shimcha ag‘dargich ishchi sirtining egrilik radiusi, cm	X_1	7,5	25	32,5	40
2. Qo‘shimcha ag‘dargichning gorizontga nisbatan o‘rnatilish burchagi, °	X_2	5	10	15	20
3. Qo‘shimcha ag‘dargichning korpus aylanish markaziga nisbatan o‘rnatilish balandligi, cm	X_3	7,5	0	7.5	15
4. Agregatning harakat tezligi, km/h	X_4	1,5	6,0	7,5	9,0

Ular o‘tkazilgan nazariy hamda bir omilli tajribaviy tadqiqotlar natijalaridan kelib chiqqan holda tanlandi.

Ko‘p omilli eksperimentlarni o‘tkazishda baholash mezoni sifatida o‘simlik qoldiqlarining ko‘milish to‘liqligi (Y_1,%), o‘simlik qoldiqlarining ko‘milish chuqurligi (Y_2,*cm*), shudgor yuzasidagi notekisliklar balandligi (Y_3,*cm*) hamda plugning tortishga solishtirma qarshiligi (Y_4, *kN/m*) qabul qilindi.

Tuproqning fizik-mexanik xossalari hamda dala yuzasida mavjud bo‘lgan notekisliklarning baholash mezonlariga ta’sirini kamaytirish maqsadida tajribalarni o‘tkazish tartibi tasodifiy sonlar jadvalidan foydalanib belgilandi.

Bundan tashqari barcha variantlar uchun ishlov berish chuqurligi bir xil va 25 cm etib belgilandi.

Tajribalarda olingan ma’lumotlarga ishlov berishda dispersiyaning bir xilligi Koxren, regressiya koeffitsientlarining qiymati Student, regression modellarning adekvatligi Fisher kriteriyalari bo‘yicha baholandi [2].

Tajriba natijalariga Qishloq xo‘jaligini mexanizatsiyalash ilmiy-tadqiqot institutida PK uchun ishlab chiqilgan “Ko‘p omilli faol eksperiment natijalari bo‘yicha ikkinchi darajali regression modellarini hamda ular asosida 3D grafiklarini qurish” dasturi bo‘yicha ishlov berilib, baholash mezonlarini adekvat ifodalovchi quyidagi regressiya tenglamalari olindi:

Tuproqning uvalanish darajasi bo‘yicha (%)

$$Y_1 = 88{,}553991+3{,}623333\,X_1 - 1{,}350000\,X_4 - 1{,}886150\,X_1^2 - 0{,}704167X_1X_2 - -1{,}737500X_1X_3 + 1{,}620833\,X_1X_4 + 1{,}463850\,X_2^2 + 1{,}320833\,X_2X_3 + 1{,}245833X_2X_4 + 1{,}579167X_3X_4 - 1{,}602817X_4^2; \quad (1)$$

O‘simlik qoldiqlarining ko‘milish chuqurligi bo‘yicha (cm)

$$Y_2 = 13{,}094340+0{,}946667X_1+1{,}633333X_4+1{,}412500X_1X_2 - 0{,}662500X_1X_4 - 3{,}546855X_2^2 - 1{,}345833X_2X_3+1{,}079167X_3X_4+1{,}786478X_4^2; \quad (2)$$

Shudgor yuzasidagi notekisliklar balandligi (cm) bo‘yicha

$$Y_3 = 5{,}028571 - 0{,}716667\,X_1 + 0{,}166667\,X_2 + 1{,}416667\,X_3 - 0{,}633333\,X_4 - 0{,}258333\,X_1X_2 + 0{,}316667\,X_2X_3 - 0{,}416667\,X_2X_4 + 0{,}541429\,X_3^2; \quad (3)$$

Plugning tortishga solishtirma qarshiligi bo‘yicha (kN/m)

$$Y_4=5{,}357277-0{,}226667X_1-0{,}450000X_2-0{,}283333X_3+0{,}123333X_4+ +0{,}183099X_2^2+0{,}237500X_2X_4+0{,}216432X_3^2+0{,}312500X_3X_4-0{,}200235-X_4^2; \quad (4)$$

Ushbu olingan regressiya tenglamalarini tahlil etib, quyidagilarni ta’kidlash mumkin:

– qo‘shimcha ag‘dargich ishchi sirtining egrilik radiusining kichik bo‘lishi o‘simlik qoldiqlarining ko‘milish to‘liqligi va chuqurligining kamayishiga, hamda shudgor yuzasidagi notekisliklar balanligi va plugning tortishga solishtirma qarshiligining ortishiga olib kelgan;

- qo‘shimcha ag‘dargichning gorizontalga nisbatan o‘rnatilish burchagining kichik bo‘lishi o‘simlik qoldiqlarining ko‘milish to‘liqligi va chuqurligi hamda shudgor yuzasidagi notekisliklar balanligi kamayishiga va plugning tortishga solishtirma qarshiligining ortishiga olib kelgan;

- qo‘shimcha ag‘dargichning korpus aylanish markaziga nisbatan o‘rnatilish balandligi kichik bo‘lishi o‘simlik qoldiqlarining ko‘milish to‘liqligi va chuqurligining, shudgor yuzasidagi notekisliklar balanligi kamayishiga va plugning tortishga solishtirma qarshiligining ortishiga olib kelgan;

- haydov tezligi ortishi plugning barcha agrotexnik ko‘rsatkichlariga ta’sir qilgan, ya’ni o‘simlik qoldiqlarining ko‘milish to‘liqligi va chuqurligi, plugning tortishga solishtirma qarshiligining ortishiga hamda shudgor yuzasidagi notekisliklar balanligi kamayishiga olib kelgan.

(1)-(4) regressiya tenglamalari Y_1 mezon tuproqning uvalanish darajasi 80 % dan, Y_2 mezon o‘simlik qoldiqlarining ko‘milish chuqurligi 10 cm dan kam bo‘lmasligi, Y_3 mezon shudgor yuzasidagi notekisliklar balandligi 5 cm dan oshmasligi va Y_4 plugning tortishga solishtirma qarshiligi mezoni minimal qiymatga ega bo‘lishi shartlaridan yechildi.

Tadqiqot usuli: Sinovlar QXMITI tajriba uchastkasining bug‘doydan bo‘shagan va nam suvi berilgan dalalarida o‘tkazildi.

Tajribalarni o‘tkazishda qurilmaning tortishga solishtirma qarshiligi O’zDSt 3193:2017 «Qishloq xo‘jaligi texnikasini sinash. Mashinalarni energetik baholash usuli» bo‘yicha tenzometrik barmoqlar qo‘llanilib, agrotexnik ko‘rsatkichlari esa O‘zDSt 3355:2018 “Qishloq xo‘jaligi texnikasini sinash. Tuproqqa chuqur ishlov beruvchi mashinalar va qurollar. Sinov dasturi va usullari” bo‘yicha aniqlandi [4;5.].

Xulosa. Ko‘p omilli tajribalar natijalariga ko‘ra agregat harakat tezliklari 6-9 km/h oralig‘ida bo‘lganda qo‘shimcha ag‘dargich ishchi sirtining egrilik radiusi 30-35 cm, qo‘shimcha ag‘dargichning gorizontga nisbatan o‘rnatilish burchagi 10-20° va qo‘shimcha ag‘dargichning korpus aylanish markaziga nisbatan o‘rnatilish balandligi 10-15 cm bo‘lganda, plug kam energiya sarflagan holda tuproqqa talab darajasida ishlov berishini ta’minlaydi.

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AGRICULTURAL ENGINEERING SOLUTIONS
ISSN: 2181-399X Volume 2, Issue 14, 2026

G‘O‘ZA QATOR ORALARINING TUPROG‘INI QATLAMLAB YUMSHATISH VOSITASI BILAN AGREGATLANADIGAN TRAKTOR TANLASH

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Annotatsiya. Ushbu maqolada g‘o‘za qator oralarining tuprog‘ini qatlamlab yumshatish uchun mo‘ljallangan texnik vosita bilan agregatlanadigan traktorni tanlash masalasi ko‘rib chiqilgan. Traktor va qishloq xo‘jaligi mashinasi parametrlarini o‘zaro moslashtirish asosida maqbul agregatni shakllantirish, uning ish rejimini aniqlash hamda energiya samaradorligini oshirish usullari ishlab chiqilgan. Tadqiqot natijalari asosida optimal traktor modeli tanlangan va uning samaradorligi asoslangan.

Kalit so‘zlar: qishloq xo‘jaligi mashinasi, traktor, agregat, quvvat, yonilg‘i sarfi, tortishga qarshilik, unumdorlik, tezlik rejimi, energiya samaradorligi.

ВЫБОР ТРАКТОРА, АГРЕГАТИРУЕМОГО С ОРУДИЕМ ДЛЯ ПОСЛОЙНОГО РЫХЛЕНИЯ ПОЧВЫ В МЕЖДУРЯДЬЯХ ХЛОПЧАТНИКА

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Аннотация. В статье рассмотрена задача выбора трактора для агрегатирования с техническим средством, предназначенным для послойного рыхления междурядий хлопчатника. Предложен метод формирования оптимального агрегата на основе согласования параметров трактора и сельскохозяйственной машины. Разработаны подходы к определению рационального режима работы и повышению энергетической эффективности. На основе результатов исследований обоснован выбор оптимальной модели трактора.

Ключевые слова: сельскохозяйственная машина, трактор, агрегат, мощность, расход топлива, тяговое сопротивление, производительность, скоростной режим, энергоэффективность.

SELECTION OF A TRACTOR AГРЕГATED WITH A TOOL FOR LAYER-BY-LAYER SOIL LOOSENING IN COTTON ROW SPACING

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Annotation. This article addresses the problem of selecting a tractor for aggregation with a machine designed for layered soil loosening in cotton row spacing. A method for forming an optimal aggregate based on matching the parameters of the tractor and agricultural machinery is proposed. Approaches for determining optimal operating modes and improving energy efficiency are developed. Based on the research results, an optimal tractor model is justified.

Keywords: agricultural machinery, tractor, aggregate, power, fuel consumption, traction resistance, productivity, speed mode, energy efficiency.

Kirish. Qishloq xo‘jaligida yangi ishlab chiqilgan yoki foydalanishga qabul qilingan qishloq xo‘jalik mashinalariga traktor tanlashda g‘ildirakli traktor dvigatelining samarali quvvati to‘la yuklanmasligi (o‘rtacha yuklanish 45..50 %), energiyaning katta qismi samarasiz sarflanishiga, natijada agregatdan foydalanishda yonilg‘i sarfining me’yordan ortiq sarflanishiga yo‘l qo‘yilmoqda [1, 2, 3].

Masalaning qo‘yilishi. Hozirgi davrda qishloq xo‘jaligi zamonaviy traktorlar va qishloq xo‘jaligi mashinalari bilan ta’minlangan. Shu bilan birga olimlar tomonidan mahalliy, samarali konstruksiyalari yaratilmoqda, ishlab chiqarishga tavsiya etilmoqda [4]. Ammo, qishloq xo‘jalik mashinalariga mos va maqbul keladigan traktorlarni tanlash usulining yo‘qligi traktorlardan tuzilgan agregatlar dvigatellarining quvvati (ilmoqdagi quvvati) bo‘yicha to‘la yuklanishda ishlatilmasligi yoki aksincha traktor quvvatining yetishmasligi oqibatida texnologik operasiyani bajarishga qo‘yiladigan agrotexnik tezlik rejimidan chiqib ketishi, imkoniyatlardan to‘liq foydalanilmaslik oqibatida yonilg‘i sarfining me’yordan ortiq sarflanishi kuzatilmoqda [5, 6].

Tadqiqot uslubi. Masalani xal etish uchun mavjud hamda yangi yaratilgan qishloq xo‘jalik mashinalariga maqbul traktor tanlash, agregat tuzish, tarkibini oldindan modellashtirish, maqbul tezlik rejimini aniqlash va tahlil qilish usuli taqdim etilgan [7, 8]. Buning uchun qishloq xo‘jalik mashinasiga mos tanlanadigan traktorning foydalanish xususiyatlarini, ya’ni: dvigatelining samarali quvvati N_e^n; solishtirma yonilg‘i sarfi q; foydalanish og‘irligi G_t; transmissiyasining foydali ish koeffisienti, η_t; g‘ildiraklarining ruxsat etilgan shataksirashi, δ; g‘ildiraklarining tuproq bilan ilashish koeffisienti μ, dumalanishiga qarshilik koeffisienti f qiymatlarini, ikkinchi tomondan qishloq xo‘jalik mashinasining foydalanish xususiyatlarini, ya’ni: qamrov kengligi V_m; foydalanish og‘irligi G_m; tuproqning solishtirma qarshiligi K; texnologik jarayon bajariladigan dala maydonining ehtimoliy qiyaligi i, texnologik jarayonni bajarishga mos keladigan agrotexnik ruxsat etilgan tezliklarining oraliq ($\upsilon_{\min} - \upsilon_{\max}$) qiymatlari bo‘yicha tahlil qilish asosida maqbul agregatni tuzish, uning ish rejimi va unumi hamda yonilg‘i sarfi bo‘yicha baholash usuli tavsiya etilgan [9, 10].

Masalaning yechimi:

G‘o‘za qator oralarining tuprog‘ini qatlamlab yumshatadigan texnik vositaning tortishga (sudrashga) qarshiligi quyidagi formula bo‘yicha aniqlanadi

$$R_{qxm} = B_{qxm} \cdot K_s \pm G_{qxm} \frac{i}{100} \text{ , N} \tag{1}$$

bunda B_{qxm} – texnik vositaning qamrov kengligi, m; K_s – solishtirma qarshilik, N/m; G_{qxm} – texnik vositaning og‘irligi, N.

Agrotexnik jihatdan ruxsat etilgan tezliklarning oraliq ($\upsilon_{\min}-\ \upsilon_{\max}$) qiymatlarida talab etiladigan agregatni tortishga kerak bo‘ladigan traktor quvvati quyidagi formulalar bo‘yicha aniqlandi:

$$N_{ag}^{\min}=\frac{R_{qxm}\cdot\upsilon_{\min}}{3,6},\ \text{kW} \quad (2)$$

$$N_{ag}^{\max}=\frac{R_{qxm}\cdot\upsilon_{\max}}{3,6},\ \text{kW} \quad (3)$$

Agrotexnik jihatdan ruxsat etilgan tezliklarining oraliq ($\upsilon_{\min}-\ \upsilon_{\max}$) qiymatlarida talab etiladigan traktor dvigatelining quvvati quyidagi formulalar bo‘yicha aniqlandi:

$$N_{s}^{\min}=\frac{N_{ag}^{\min}}{\eta_t(1-\frac{\delta}{100}-\frac{f\pm\frac{i}{100}}{\lambda\cdot\mu}},\ \text{kW} \quad (4)$$

$$N_{s}^{\max}=\frac{N_{ag}^{\max}}{\eta_t(1-\frac{\delta}{100}-\frac{f\pm\frac{i}{100}}{\lambda\cdot\mu}},\ \text{kW} \quad (5)$$

bunda η_t– traktor transmissiyasining foydali ish koeffitsienti; δ - traktor g‘ldiraklarning ruxsat etilgan shataksirashi,%; f – traktor yurish qismining dumalanishiga qarshilik koeffitsienti; i – agregat ishlaydigan dala maydonining qiyaligi, %; μ – traktor g‘ildiraklarining agrofondagi tuproq bilan ilashish koeffitsienti; λ – traktorning yurish qismlariga to‘g‘ri keladigan foydalanish og‘irligi. (4x4 sxemali traktor uchun λ =1).

G‘o‘za qatorlari orasining tuprog‘i bilan yetarlicha ilashish hossasini ta’minlaydigan traktorning foydalanish G_t og‘irligi quyidagi formulalar bo‘yicha aniqlandi:

$$G_t^{\min}=\frac{3,6\cdot N_s^{\min}\cdot\eta_t}{\upsilon_{\max}\cdot\lambda\cdot\mu},\ \text{kN} \quad (7)$$

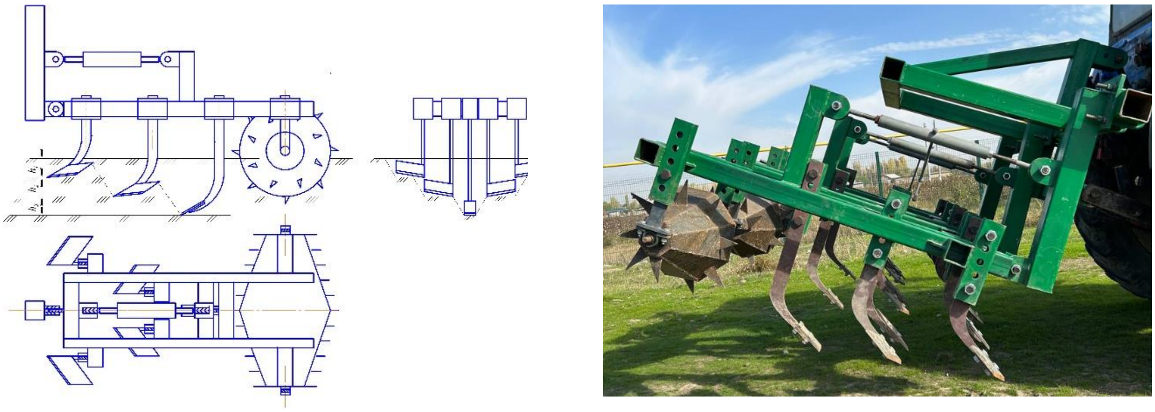
$$G_t^{\max}=\frac{3,6\cdot N_s^{\max}\cdot\eta_t}{\upsilon_{\min}\cdot\lambda\cdot\mu},\ \text{kN} \quad (8)$$

Hisob natijalari bo‘yicha ikkita me’zon ko‘rsatkichlar asosida texnik vositaga mos keladigan traktor tanlanadi:

$$G_t^{\min}:\ \upsilon_{\max}\ \text{va}\ N_s^{\min} \quad (9)$$

$$G_t^{\max}:\ \upsilon_{\min}\ \text{va}\ N_s^{\max} \quad (10)$$

Natijalar va muhokamalar. Eksperimental tadqiqotlarni oʻtkazish uchun gʻoʻza qator oralarining tuprogʻini qatlamlab yumshatadigan texnik vositaning konstruksiyasi ishlab chiqildi va uning tajriba nusxasi tayyorlandi (1-rasm).



1-rasm. Gʻoʻza qator oralarining tuprogʻini qatlamlab yumshatadigan texnik vositaning konstruksiyasi va tajribaviy nusxasi

Tadqiqot dasturida belgilangan vazifa boʻyicha dala sinovlarida agregatning tortishga qarshiligi tadqiq etildi. Agregatning tortishga (sudrashga) qarshiligini dinamometr yordamida aniqlashda texnik vositaning bitta seksiyasi traktorga tirkalib 7 va 8 km/s harakatlanish tezliklarida sinovlar oʻtkazildi.

Dala sinovlari bir seksiyali agregatning ish jarayoni va transport holatidagi tortishga qarshiliklarini borib-kelishlar boʻyicha 3 marta takrorlanishda amalga oshirildi va natijalar olindi (1-jadval).

1-jadval

Bir seksiyali agregatning tortishga qarshilik koʻrsatkichlari natijalari

Texnologik jarayon		Oʻtishlar	Qarshilik, N	
			hisobiy	oʻrtacha
1	Gʻoʻza qator oralari tuprogʻini yumshatish	borish	5765	5653
		kelish	5541	
2	Ochiq maydon tuprogʻini yumshatish	borish	5810	5786
		kelish	5763	
3	Agregatning transport holatida	borish	2795	2819
		kelish	2843	

Dala sinovlari gʻoʻza qator oralarining tuprogʻini yumshatish, paxtasi terib olingan qator oralarining tuprogʻini yumshatish va ochiq maydon tuprogʻini yumshatish boʻyicha texnologik jarayonlar boʻyicha amalga oshirildi. Natijalar ochiq maydon tuprogʻini yumshatishda tortishga qarshilik 4-5 % ga yuqori boʻlishini koʻrsatdi.

Dala sinovlari natijalari agregatning harakatlanish tezligining 7 km/s dan va 8 km/s gacha ortishi tortishga (sudrashga) qarshilikning ortishini koʻrsatdi. Buni ishchi qismlarning gʻoʻza qator oralarining tuprogʻi bilan oʻzaro taʼsirlanish jarayonining jadallashuvi natijasida tortishga (sudrashga) qarshilikning ortishi kuzatilgan deb izoxlash mumkin.

Dala sinovlari natijalari asosida agregatning 7 va 8 km/s harakatlanish tezliklarda texnologik jarayonni bajarish uchun talab etiladigan quvvat koʻrsatkichlari ham aniqlandi (2-jadval).

2-jadval

Texnologik jarayonni bajarish uchun talab etiladigan quvvat ko‘rsatkichlar

№	Talab etilgan quvvat N, kW:			
1	G‘o‘za qator oralari tuprog‘ini yumshatishga	7 km/s	10,99	11,55
		8 km/s	12,56	
2	Ochiq maydon tuprog‘ini yumshatishga	7 km/s	11,25	12,05
		8 km/s	12,85	

Bunda ham sinov natijalari ochiq maydon tuprog‘ini yumshatishda talab etiladigan quvvat ko‘pi bilan 15 – 17 % ga yuqori bo‘lishini ko‘rsatdi.

Yaratilgan g‘o‘za qator oralarining tuprog‘ini qatlamlab yumshatadigan texnik vositaga mos traktor tanlash, agregat tuzish, maqbul tezlik rejimini aniqlash va tahlil qilish uchun yuqoridagi (1)-(10) formulalar ishlab chiqildi va quyidagi natijalar olindi (3-jadval)

Ikkita (9) va (10) me’zon ko‘rsatkichlar dvigateli quvvati va uning g‘o‘za qatorlari orasining tuprog‘i bilan yetarlicha ilashish hossasini ta’minlaydigan foydalanish og‘irligi bo‘yicha traktor tanlash imkonini berdi.

3-jadval

Agrotexnik jihatdan ruxsat etilgan tezliklarning oraliq (υ_{min} – υ_{max}) qiymatlari chegarasida hisoblangan qarshilik, quvvat va og‘irlik ko‘rsatkichlar

№	Ko‘rsatkichlar	Agrotexnik jihatdan ruxsat etilgan tezliklarning qiymati	
		υ_{min}=6 km/h	υ_{max} =9 km/h
1.	Texnik vositaning tortishga (sudrashga) qarshiligi, R_{qxm}, *N*	16959	
2.	Agregatni tortishga kerak bo‘ladigan traktor quvvati, N_{ag}, *kW*	28,26	42,39
3.	Talab etiladigan traktor dvigatelining quvvati, N_s, *kW*	40,95	62,17
4.	Tuproq bilan yetarlicha ilashish hossasini ta’minlaydigan traktorning foydalanish og‘irligi, G_t, *kN*	18,37	41,85
5.	Tanlab olingan MTZ-80X rusumli traktorning ilmoqdagi eng katta quvvati, N_{il}^{max} , *kW*	40,8	
6.	Tanlangan traktordan tuzilgan agregatining ilmoqdagi eng katta quvvati bilan amalga oshirish imkoni bo‘lgan foydali (tortish) quvvat chegarasidagi maqbul harakatlanish tezligi, υ_{maq}, *km/h*	6,7	
7.	Amalga oshirish imkoni bo‘lgan foydali (tortish) quvvat bilan texnik vositaning qarshilik quvvati	8,27	

	chegarasidagi maqbul harakatlanish tezligi, υ_{maq}, *km/h*		
8.	Agregat maqbul harakatlanish tezligida ishlashi uchun traktor dvigatelining quvvati, N_{ag}^{k}, *kW*	31,56	38,95
9.	Agregatda amalga oshirish imkoni bo‘lgan foydali (tortish) quvvat, N_{f}^{dv}, *kW*	41,18	38,30
10.	Traktorning ilashish xususiyatlari bilan belgilanadigan ilmoqdagi tortish quvvat, N_{il}^{μ}, *kW*	35,58	57,53

Texnik tavsifi bo‘yicha D-243 dvigatelli, 60 kW (82 o.k.) 18 pog‘ona uzatmali, solishtirma yonilg‘i sarfi 220 g/kW.s, foydalanish og‘irligi 36,3 kN, MTZ-80X rusumli paxtachilikda foydalaniladigan traktor tanlandi.

Ko‘rilayotgan sharoit uchun tanlab olingan MTZ-80X rusumli traktorning ilmoqdagi eng katta quvvati quyidagi formula bo‘yicha hisoblandi

$$N_{il}^{\max} = N_s^n \cdot \eta_t (1 - \frac{\delta}{100} - \frac{f \mp \frac{i}{100}}{\lambda \cdot \mu}) \text{, kW} \quad (11)$$

Tanlangan traktordan tuzilgan agregatining maqbul harakatlanish tezligi quyidagi formula bo‘yicha hisoblandi

$$\upsilon_{maq} = \frac{3{,}6 \cdot N_s^n \cdot \eta_t (1 - \frac{\delta}{100})}{16{,}959 + 36{,}3(f \pm \frac{i}{100})} \text{, km/h} \quad (12)$$

G‘o‘za qator oralari tuprog‘iga ishlov beradigan agregat maqbul harakatlanish tezligida ishlashi uchun traktor dvigatelining quvvati quyidagi formula bo‘yicha hisoblandi

$$N_{ag}^{k} = \frac{R_{ag}^{k} \cdot \upsilon_{maq}}{3{,}6} \text{, kW} \quad (13)$$

Tanlangan traktor bilan tuzilgan agregatda amalga oshirish imkoni bo‘lgan foydali (tortish) quvvat quyidagi ifodalar yordamida hisoblandi:

$$N_{f}^{dv} = N_s^n \cdot \eta_t (1 - \frac{\delta}{100}) - \frac{G_t \cdot \upsilon_{\min} (f \pm \frac{i}{100})}{3{,}6} \text{, kW} \quad (14)$$

$$N_f^{dv} = N_s^n \cdot \eta_t (1 - \frac{\delta}{100}) - \frac{G_t \cdot \upsilon_{\max} (f \pm \frac{i}{100})}{3{,}6}, \text{ kW} \quad (15)$$

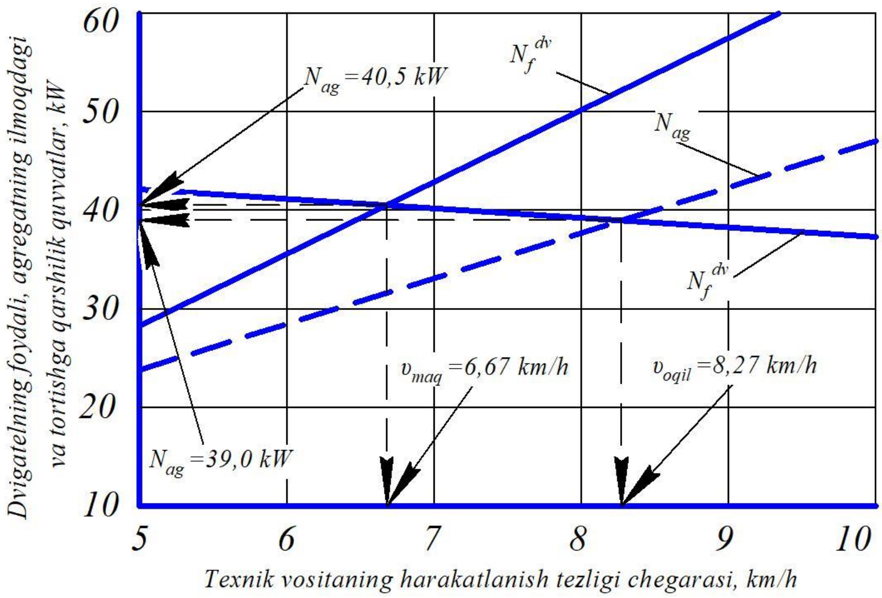
Shataksirash (sirpanish), o‘zini-o‘zi harakatga keltirish va qiyalik bo‘yicha ko‘tarilishni yengib o‘tishga quvvatlarning yo‘qotilishini hisobga olgan holda tanlangan traktorning ilashish xususiyatlari bilan belgilanadigan ilmoqdagi tortish quvvati quyidagi formulalar bo‘yicha hisoblandi:

$$N_{il}^{\mu} = \frac{G_t \cdot \upsilon_{\min} \left[\lambda \cdot \mu - (f \pm \frac{i}{100}) \right]}{3{,}6} - N_s^n \cdot \eta_t \frac{\delta}{100}, \text{ kW} \quad (16)$$

$$N_{il}^{\mu} = \frac{G_t \cdot \upsilon_{\max} \left[\lambda \cdot \mu - (f \pm \frac{i}{100}) \right]}{3{,}6} - N_s^n \cdot \eta_t \frac{\delta}{100}, \text{ kW} \quad (17)$$

Hisoblangan natijalar tahlil qilish uchun 3-jadvalga kiritildi

Masalaning yechimini grafo-analitik usul bilan tekshirib ko‘rish mumkin bo‘ladi



2-rasm. Texnik vositaning maqbul harakatlanish tezligini aniqlashning grafo-analitik usuli

Tanlangan traktor dvigatelining quvvatidan foydalanish koeffitsienti $\upsilon_{maq} = 6{,}67$ *km/h va* $\upsilon_{oqil.} = 8{,}27$ km/h harakatlanish tezliklarida quyidagi qiymatlarga ega bo‘ldi

$$\eta_{q.f.}^{maq.} = \frac{N_{ag}}{N_{il}^{\max}} = \frac{40{,}05}{40{,}8} = 0{,}98 \quad \eta_{q.f.}^{oqil.} = \frac{N_{ag}}{N_{il}^{\max}} = \frac{39{,}0}{40{,}8} = 0{,}95 \quad (18)$$

Xulosalar.

1. G‘o‘za qator oralariga ishlov berishda texnik vosita va traktor parametrlarini mos tanlash energiya samaradorligini oshiradi.
2. Taklif etilgan modellash usuli agregatning maqbul tezligi va quvvatini aniqlash imkonini beradi.
3. Agrotexnik jihatdan ruxsat etilgan tezliklarning $(\upsilon_{min};\upsilon_{max})$ qiymatlarida tanlab olingan traktor dvigatelining ilmoqdagi quvvati to‘la yuklanishida ishlashi aniqlandi.
4. Tezlik oshishi bilan tortishga qarshilik va quvvat talabi ortishi aniqlangan.
5. MTZ-80X traktori optimal variant sifatida tanlangan.
6. Yondashuv amaliyotda qo‘llash uchun samarali hisoblanadi.

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AGRICULTURAL ENGINEERING SOLUTIONS

ISSN: 2181-399X Volume 2, Issue 14, 2026

TAKOMILLASHTIRILGAN MOLA-TEKISLAGICH G‘ALTAKMOLASI PONASIMON QISMINING O‘TKIRLANISH BURCHAGI VA BALANDLIGINI UNING ISH KO‘RSATKICHLARIGA TA’SIRINI O‘RGANISH BO‘YICHA TAJRIBAVIY TADQIQOTLARNING NATIJALARI

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Annotatsiya: Maqolada g‘altakmolasi ponasimon ishchi sirtga ega bo‘lgan g‘altakmolali mola-tekislagich ishlab chiqilgani keltirilgan hamda uning g‘altakmolasi ponasimon qismining o‘tkirlanish burchagi va balandligini maqbul qiymatlarini aniqlash bo‘yicha o‘tkazilgan tajribaviy tadqiqotlarning natijalari bayon etilgan va ular bo‘yicha ishlab chiqilgan takomillashtirilgan mola-tekislagich talablar darajasidagi ish sifatini kam energiya sarflagan holda ta’minlash uchun uning g‘altakmolasi ponasimon qismining o‘tkirlanish burchagi va balandligi mos ravishda 60° va 50 mm bo‘lishi lozimligi aniqlangan.

Tayanch so‘zlar: takomillashtirilgan g‘altakmolali mola-tekislagich, tekislagich, ponasimon g‘altakmola, tajribaviy tadqiqotlar, tuproqning uvalanish sifati, tuproqning zichligi, tortiishga solishtirma qarshilik, laboratoriya dala qurilmasi, harakat tezligi, g‘altakmola ponasimon qismining o‘tkirlanish burchagi va balandligi, ish ko‘rsatkichlarining o‘zgarish qonuniyatlari.

РЕЗУЛЬТАТЫ ЭКСПЕРИМЕНТАЛЬНЫХ ИССЛЕДОВАНИЙ ПО ИЗУЧЕНИЮ ВЛИЯНИЯ УГЛА ЗАТОЧКИ И ВЫСОТЫ КЛИНОВИДНОЙ ЧАСТИ КАТКА УСОВЕРШЕНСТВОВАННОГО МАЛА-ВЫРАВНИВАТЕЛЯ НА ПОКАЗАТЕЛИ ЕГО РАБОТЫ

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Аннотация: В статье отмечается, что разработан мала-выравнивателя с катком с клинообразной рабочей поверхностью, а также изложены результаты экспериментальных исследований по определению оптимальных значений угла заточки и высоты клинообразной части его катка, по которым установлено, что для обеспечения требуемого качества работы разработанного усовершенствованного мала-выравнивателя с минимальными затратами энергии угол заточки и высота клиновидной части его катка должны быть соответственно 60° и 50 мм.

Ключевые слова: усовершенствованный мала-выравниватель с катком, выравниватель, клинообразный каток, экспериментальные исследования, качество крошения почвы, плотность почвы, удельное тяговое сопротивление, лабораторно-полевая установка, скорость движения, угол заточки и высота клинообразной части катка, закономерности изменения показателей работы.

RESULTS OF EXPERIMENTAL STUDIES ON THE EFFECT OF THE SHARPENING ANGLE AND THE HEIGHT OF THE WEDGE-SHAPED PART OF THE ROLLER OF THE IMPROVED LEVELER ON ITS PERFORMANCE INDICATORS

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Abstract: The article highlights the development of a land leveler (mala-leveler) equipped with a roller featuring a wedge-shaped working surface. It presents the results of experimental studies aimed at determining the optimal sharpening angle and height for the wedge-shaped part of the roller. The findings indicate that to ensure the required quality of operation for the improved leveler with minimal energy consumption, the sharpening angle and the height of the wedge-shaped part of the roller should be 60° and 50 mm, respectively.

Keywords: improved land leveler with a roller, leveler, wedge-shaped roller, experimental studies, soil crumbling quality, soil density, specific traction resistance, laboratory-field installation, movement speed, sharpening angle and height of the wedge-shaped part of the roller, patterns of change in performance indicators.

Kirish. Mavjud g‘altakmolali mola-tekislagichlarda tuproqni zichlash uchun tekis silindrik sirtli g‘altakmolalar qo‘llanilgan [1,2]. Ammo ular tuproqni pastki qatlamlarini yetarli darajada zichlamaydi [3-7]. Bundan tashqari tuproqni talablar darajasida zichlash uchun tekis silindrik sirtli g‘altakmolalarga katta tik yuklanish berilishi talab etiladi va bu ularning metall-energiyahajmdorligini ortishiga olib keladi.

Ushbu ta’kidlanganlardan kelib chiqib, biz tomonimizdan takomillashtirilgan, ya’ni g‘altakmolasi ponasimon ishchi sirtga ega bo‘lgan mola-tekislagich ishlab chiqildi (rasmga qaralsin). U osish qurilmasi bilan jihozlangan rama 1 va uning old qismiga o‘rnatilgan tekislagich 2 va orqa qismiga o‘rnatilgan ishchi sirti ponasimon ko‘rinishdagi g‘altakmola (keyingi o‘rinlarda ponasimon g‘altakmola) 3 dan tashkil topgan.

Ish jarayonida takomillashtirilgan g‘altakmolali mola-tekislagichning tekislagichi dala yuzasidagi notekisliklarni tekislaydi, ponasimon g‘altakmolasi esa ushbu tekislangan yuza tuprog‘ini talablar darajasida zichlaydi va kesaklarni maydalaydi. Bunda g‘altakmolaning ponasimon qismi tuproqqa chuqur botib uning pastki qismini samarali zichlaydi. Bundan tashqari ponasimon g‘altakmolani tuproqqa botirish uchun kam tik yuklanish talab etiladi hamda u qattiq kesaklarni ponasimon qismi bilan talablar darajasida maydalaydi.

Ushbu maqolada ishlab chiqilgan takomillashtirilgan mola-tekislagich g‘altakmolasi ponasimon qismining o‘tkirlanish burchagi $2\gamma_t$ va balandligi h_t ni (rasmga qaralsin) uning ish ko‘rsatkichlariga ta’sirini o‘rganish bo‘yicha o‘tkazilgan tajribaviy tadqiqotlarning natijalari keltirilgan.

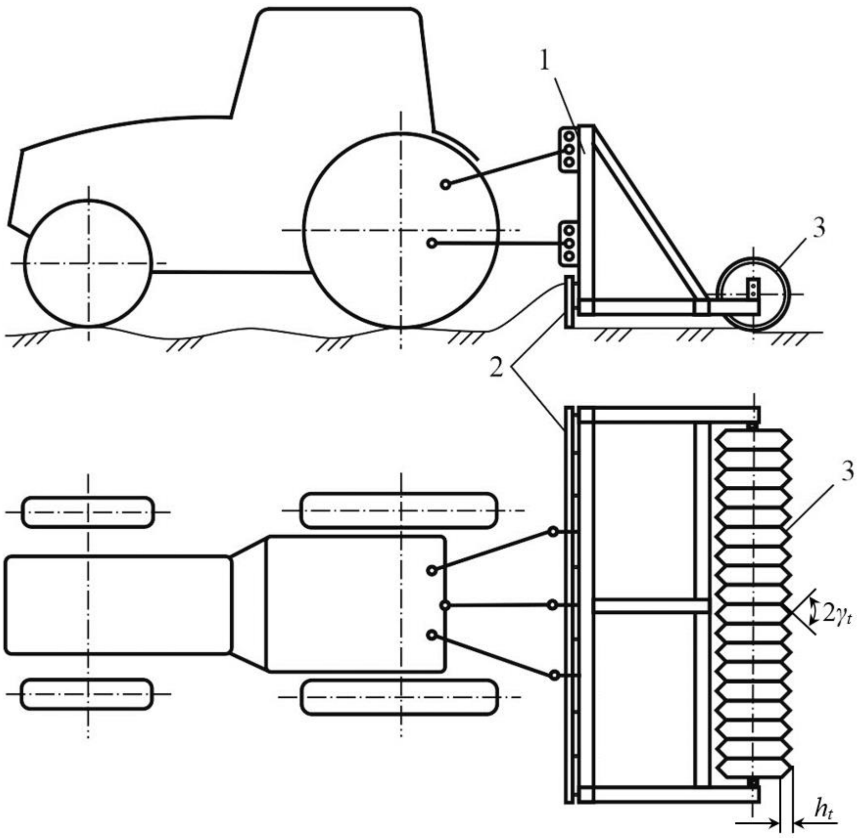
Materiallar va uslublar. Tajribaviy tadqiqotlar Qishloq xo‘jaligini mexanizatsiyalash ilmiy-tadqiqot institutining tajriba uchastkasi dalalarida bahorda yerlarni ekishga tayyorlash davrida chizellangan fonda o‘tkazildi. Tajribalarda O‘zDSt 3412:2019 “Qishloq xo‘jaligi texnikasini sinash. Tuproq yuzasiga ishlov beruvchi mashinalar va qurollar. Sinov dasturi va usullari” hamda O‘zDSt 3193:2017 “Qishloq xo‘jaligi texnikasini sinash. Mashinalarni energetik baholash usuli” me’yoriy hujjatlar bo‘yicha takomillashtirilgan mola-tekislagich g‘altakmolasi ponasimon qismining o‘tkirlanish burchagi va balandligining o‘zgarishini tuproqning uvalanish sifati, 5-15 cm qatlamdagi zichligi hamda uning solishtirma, ya’ni bir metr qamrash kengligiga to‘g‘ri keladigan tortishga solishtirma qarshiligiga ta’siri o‘rganildi.

Tajribalarni o‘tkazish uchun maxsus laboratoriya dala qurilmasi ishlab chiqildi va JINMA 9001 traktori bilan 6,0 va 9,0 km/h tezliklarda ishlatildi.

Tajribalar o‘tkazishdan oldin 0-10 va 10-20 qatlamlarda tuproqning namligi mos ravishda 12,7 va 16,4 foizni, qattiqligi 0,88 va 1,87 MPa va zichligi 0,97 va1,06 g/cm^3 ni tashkil etdi.

Natijalar va ularning tahlili. Tajribalarda olingan natijalar 1 va 2-jadvallarda keltirilgan.

1-jadvalda keltirilgan ma’lumotlarning tahlili shuni ko‘rsatadiki, har ikkala harakat tezliklarida ham takomillashtirilgan mola-tekislagich g‘altakmolasi ponasimon qismining o‘tkirlanish burchagi 50° dan 60° ortganda tuproqning uvalanish sifati yaxshilangan, ya’ni unda o‘lchami 50 mm dan katta fraksiyalar miqdori kamaygan va o‘lchami 25 mm dan katta fraksiyalar miqdori ortgan, tuproqning zichligi ham ortgan. Bu burchak 60° dan 90° gacha ortganda tuproqning uvalanish sifati yomonlashgan, zichligi esa kamaygan.



Takomillashtirilgan g‘altakmolali mola-tekislagichning sxemasi

Tuproqning uvalanish sifati va zichligini g‘altakmola ponasimon qismining o‘tkirlanish burchagiga bog‘liq ravishda yuqorida ta’kidlangan qonuniyat bo‘yicha o‘zgarishini shu bilan izohlash mumkinki, g‘altakmola ponasimon qismining o‘tkirlanish burchagi 60° bo‘lganda uning ishchi sirtiga tuproqning yopishishi deyarli kuzatilmagan va natijada tuproqning uvalanish sifati hamda zichligi yuqori bo‘lgan.

Takomillashtirilgan mola-tekislagichning tortishga solishtirma qarshiligi uning g‘altakmolasi ponasimon qismining o‘tkirlash burchagi ortishi bilan har ikkala harakat tezlgiklarida ham ortgan. Bunga sabab shuki, g‘altakmola ponasimon qismining o‘tkirlanish burchagi ortishi bilan unga tuproq tomonidan ta’sir etuvchi reaksiya kuchining bo‘ylama tashkil etuvchisi ortadi.

Tajribalarda harakat tezligini 6,0 km/h dan 9,0 km/h gacha ortishi tuproqning uvalanish sifatini yaxshilanishiga, uning zichligini kamayishiga hamda tortishga qarshilikni ortishiga olib kelgan.

Yuqorida keltirilgan tahlillar asosida shuni ta’kidlash mumkinki, kam energiya sarflagan holda tuproqni talablar darajasidagi uvalanish sifati va zichligini ta’minlash uchun takomillashtirilgan mola-tekislagich g‘altakmolasi ponasimon qismining o‘tkirlanish burchagi 60° bo‘lishi maqsadga muvofiq.

1-jadval

Takomillashtirlgan g'altakmolali mola-tekislagich g'altakmolasi ponasimon qismining o'tkirlanish burchagini uning ish ko'rsatkichlariga ta'siri

G'altakmola ponasimon qismining o'tkirlanish burchagi ,°	Tuproq fraksiyalarining miqdori, %			Tuproqning zichligi, g/cm^3	Tortishga solishtirma qarshilik, kN/m
	>50 mm	50-25 mm	<25 mm		
Agregatning harakat tezligi 6 km/h					
50	4,4	7,6	86,9	1,20	2,52
60	5,1	8	88,0	1,23	2,55
70	5,5	8,4	86,1	1,16	2,58
80	5,9	8,7	85,4	1,12	2,61
90	6,2	8,9	84,9	1,09	2,64
Agregatning harakat tezligi 8 km/h					
50	3,4	7,7	88,3	1,17	2,58
60	5,3	6,4	88,9	1,20	2,61
70	6,8	5,8	87,4	1,13	2,64
80	7,1	6,2	86,7	1,10	2,65
90	7,5	6,6	85,9	1,07	2,67

2-jadval

Takomillashtirilgan g'altakmolali mola-tekislagich g'altakmolasi ponasimon qismining balandligini uning ish ko'rsatkichlariga ta'siri

G'altakmola ponasimon qismining balandligi, mm	Tuproq fraksiyalarining miqdori, %			Tuproqning zichligi, g/cm^3	Tortishga solishtirma qarshilik, kN/m
	>50 mm	50-25 mm	<25 mm		
Agregatning harakat tezligi 6 km/h					
30	6,2	8,9	84,9	1,11	2,56
40	5,8	8,1	86,1	1,16	2,63
50	5,4	7,2	87,4	1,20	2,68
60	4,9	6,4	88,7	1,26	2,75
Agregatning harakat tezligi 8 km/h					
30	5,8	8,1	86,1	1,06	2,62
40	5,5	7,1	87,4	1,11	2,68
50	5,1	6,7	88,2	1,18	2,75
60	4,6	6,3	89,1	1,24	2,82

2-jadvalda keltirilgan ma'lumotlar bo'yicha har ikkala harakat tezliklarida ham takomillashtirilgan mola-tekislagich g'altakmolasi ponasimon qismining balandligini 30 mm dan 60 mm gacha ortishi tuproqning uvalanish sifatini yaxshilanishi, uning zichligi va mola-tekislagichning tortishga solishtirma qarshiligini ortishiga olib kelgan. Ammo g'altakmola ponasimon qismining balandligi 60 mm bo'lganda u keragidan ortiq chuqurlikka botib ishlaydi va bu yerlarga ekish oldidan ishlov berishda ortiqcha energiya sarflanishiga olib keladi.

Takomillashtirilgan mola-tekislagich g'altakmolasi ponasimon qismining balandligi ortishi bilan tuproqning uvalanish sifatini yaxshilanishi, uning zichligi va tortishga solishtirma qarshilikni ortishi asosan mola-tekislagich g'altakmolasining tuproqqa botish chuqurligini ortishi hisobiga yuz beradi. Bu yerda ham yuqoridagidek harakat tezligi 6,0 km/h dan 9,0 km/h gacha ortganda tuproqning uvalanish sifati yaxshilangan, uning zichligi kamaygan, tortishga qarshilik ortgan.

O‘tkazilgan tajribalar natijalari asosida takomillashtirilgan mola-tekislagich g‘altakmolasi ponasimon qismining balandligini 50 mm qabul qilamiz.

Xulosa. O‘tkazilgan tajribaviy tadqiqotlarning natijalari bo‘yicha ishlab chiqilgan takomillashtirilgan mola-tekislagich talablar darajasidagi ish sifatini kam energiya sarflagan holda ta’minlashi uchun uning g‘altakmolasi ponasimon qismining o‘tkirlanish burchagi va balandligi mos ravishda 60° va 50 mm bo‘lishi lozim.

Foydalanilgan adabiyotlar

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