THE REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

DEVELOPMENT AND SUBJECTION OF PRIMARY PROCESSING OF SUNFLOWER SEEDS IN AZERBAIJAN BASED ON NEW TECHNOLOGY

Specialty: **3102.01- Agro engineer**

Field of science: **Technical sciences**

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GENERAL PROVISIONS

Relevancy and actuality of the dissertation. The technology of post-harvest processing of sunflower seeds is a complex functional system, which comprehensively affects the quality of the obtained material. Insufficient quality of seeds leads to a significant reduction in the productivity of crops (products) and a large waste of sowing material while reducing the competitiveness of commodity products.

The agro-techniques of production, the method of harvesting, and the material of the seed manifest themselves in one way or another physically until they become the object of post-harvest processing. In most cases, post-harvest methods of treatment of seeds are primarily aimed at weakening or neutralizing the previous conditions of influence. Traditional grain cleaning technology involves the principle of the sequential passage of all processed material through a complex of cleaning machines, in each of which one or another particle is separated. The principle of minimal impact on seeds should lay the foundation for the improvement of mechanization, ie the number of operations should be kept to a minimum, and the length of the process line should be minimized, first of all, by reducing the number of transport organs.

To achieve this goal, it is necessary to address the following issues:

1. Development of a mathematical model of the technological process of sorting and fractionation (separation) of sunflower seeds in seed cleaning machines.
2. To analyze the quality of seed sorting in different operating conditions in the grain cleaning and sorting machine (air-cooled and experimental pneumatic separator TPS).
3. Construction of a regression equation describing the implementation of separate technological operations with grain cleaning and sorting machines (air-suction and PS).
4. Carrying out structural optimization of technological process and flowline and improvement of line.
5. Conducting comparative functional testing and economic evaluation of different technological schemes of grain cleaning units.

The purpose of the study is to increase the yield and improve the quality of conditioned sunflower seeds based on the structural synthesis of the subsystems of grain cleaning machines, to clarify the regularity of the main action (activity) in performing a new sequence of individual operations in the cleaning of sunflower mixture.

Research methods. The laws of classical mechanics, mathematical statistics, mathematical modeling, and multidimensional system analysis methods were used in the research.

The main provisions of the defense:

- Model of technological process of separation of sunflower seed mixture in grain cleaning and sorting machines and units;
- regression equation describing the density of grain passage of different components in different fractions and a pneumatic sorter according to different schemes;
- results of multidimensional analysis of the operation process of the grain cleaning and sorting machine in different technological schemes;
- structural optimization of the process of rational cleaning and sorting technology of sunflower seeds;
- The results of the economic performance of machines and units for cleaning and sorting various technological seeds.

Approbation and application of research. The main provisions of the dissertation were presented at the Department of Agricultural Engineering of the Azerbaijan State Agrarian University (October 2014), at the International Scientific-Practical Conference "Sustainable Development and Technological Innovations" at the Azerbaijan University of Technology (June 2014), at the Azerbaijan University of Technology teaching and application of industrial technologies. International scientific-practical conference "Technological innovations and expertise in the food industry" (2015), International scientific-practical conference "Main problems of quality assurance of university-industrial relations" dedicated to the 50th anniversary of the Azerbaijan University of Technology (2020), International Conference "Non-postclassical science: inter-disciplinary, problem-oriented and applied nature" in St. Petersburg Reported at the scientific-practical conference (2021).

The practical significance of the research The experimental device developed based on the researches were applied in the enterprise “Roasting and packing of sunflower seeds” located in the Institute settlement of Samukh region and its economic efficiency was estimated at 2000 manats. Name of the organization where the dissertation work is performed. The research was carried out at the Department of "Agricultural Technology" at the Azerbaijan State Agrarian University.

The total volume of the dissertation with a sign, indicating the volume of the structural units of the dissertation separately. The dissertation consists of an introduction, four chapters, results, a list of 122 references, and appendices. There are 45 pictures, 23 tables, 12 appendices. The introduction to the content of the dissertation is 7 pages with 12321 characters, the first chapter is 27 pages with 50489 characters, the second chapter is 41 pages with 55021 characters, the third chapter is 22 pages with 31039 characters, the fourth chapter is 33 pages with 36387 characters, the results are 3 pages Recommendations for production are 1 page and consist of 649 characters and 122 references are 13 pages and 22186 characters and appendices are 26 pages and 5089 characters. The volume of the dissertation consists of 174 pages of the computer writing and the total volume is 224072 characters (196550 characters excluding the list of used literature and appendices).

MAIN CONTENT OF THE RESEARCH

The introduction gives the actuality and relevance of the selected topic and the general nature of the dissertation.

The first chapter is mainly devoted to the study of the problem, the purpose and objectives of the study, where the importance of sunflower among cereals and oilseeds, anatomical and morphological features of sunflower, the main hybrids and varieties, criticism of post-harvest processing technologies of sunflower seeds analysis, critical analysis of technological schemes in existing sunflower seed processing enterprises and analysis of methodology for evaluation of seed-commodity production technologies of seeds.

At the end of the chapter, the main results of the problem analysis, the goals, and the objectives of the research are presented.

In traditional seed cleaning technology, the principle is that the entire processed material passes through a complex of grain cleaning machines in sequence so that one or another particle can be separated in each of them. However, the seeds of the main plant are repeatedly exposed to the effects of the working organs (feeding, separating, and transporting devices).

Thus, the post-harvest processing technologies of sunflower seeds described above, whether multi-stage, flow, or two-stage, the application seems attractive for our country. The known placement schemes of grain cleaning machines are technically and economically unsuitable for operation on farms in our country in the current conditions. The reason for this situation is the limited production of the latest sunflower seeds in the country and the repeated repetition of operations in post-harvest processing technology, which leads to a sharp increase in energy and material capacity of the technology, increasing damage to seed coatings. Taking into account the above, it is necessary to develop post-harvest processing technology of sunflower seeds based on the existing economic conditions in the country.

The second chapter is entitled "Substantiation of theoretical considerations for post-harvest processing of sunflower seeds." Here the modeling of the process of pneumatic separation of sunflower seeds in the air stream, the generalized mathematical model of technological processes of post-harvest processing of sunflower seeds, the substantiation of the process of sorting (separation) of sunflower seeds in the air-conditioning machine, the main process of pneumatic sorting of sunflower seeds. Cleaning the seed with successive sorting at the required level for the grain is the main operation that ensures the production of high-quality seeds for sowing. The application of aerodynamic cleaning methods only allows the removal of up to 50% or more of the particles in the mixture.

Separation of the mixture of sunflower seeds into fractions in the air stream allows the separation of fractions of seeds with a large specific mass, which can retain their biological full value, higher productivity characteristics for a long time. There is no technology and technical means for post-harvest processing of superelite, elite, and first reproduction sunflower seeds in small batches in Azerbaijan.

To solve this problem, technology and an experimental device for post-harvest processing of seeds and commercial sunflower seeds have been developed. An important piece of equipment in the proposed technology is a pneumatic separator. The first and second cleaning (sorting) of seeds is carried out with a pneumoperator. The mixture (tum mixture) consists of mineral and organic parts. Particle sizes vary widely. One of the ways to clean seeds from various unwanted particles is to process them in a stream of air.

In air-blowing, the mixture is affected by the adhesion force $\bar{F}_{ad}$, the weight of the particles $\bar{G}$, the aerodynamic force $\bar{R}$ (air reaction) and the lifting force $\bar{F}_q$. For small particles, when $F_{ad} > G$ and the air reaction is greater than the lifting force, ie $R > \bar{F}_q$, the separation process occurs under the following conditions:

$$R > \mu F_{ad} \qquad (1)$$

Here $\bar{F}_{ad}$ – adhesion force; $\bar{R}$, the aerodynamic force, act as a force of influence; $\bar{F}_q$ – is lifting force;μ - is the coefficient of friction.

The effect of airflow on the separation of particles in the air stream can be determined by the following formula:

$$R = c_x \rho S_m \bar{u}_n^2/2 \qquad (2)$$

here C_x- is the coefficient of aerodynamic resistance of particles; ρ- is the density of air; S_m- is the cross-sectional area of the particles;$\bar{U}_n$ is the relative velocity of the particles in the air stream.

We adopt the law of surface distribution of airflow along the cross-section of the channel. In this regard, $0 \le x \le b_o$ the velocity diagram of the airflow in the fragment is described by the following equation.

$$V = V_{max}\left(\frac{x}{b_0}\right)^{1/7}\bar{\imath} \qquad (3)$$

here b_0 is the distance from the axis of the channel to the conventional cover; $\bar{\iota}$ - У is the unit vector of the axis.

In such a law of velocity distribution, a gradient of air flux $grad_y$ V is formed, which leads to the formation of side forces acting on the nuclei. To choose the right direction of the forces acting, it is necessary to look together at the plan of the speed of the particles and the scheme of the forces acting. A diagram of the forces acting on the nuclei in both halves of the pneumo-separation channel and a plan of velocities are presented in Figure 1, a, and Figure 1,b.

Here $\bar{V}$ - is the velocity of the airflow, $\bar{U}$- is the speed of the sunflower seed, və U_x, U_y – are its projections on the coordinate axes, t-t^n – touches the flight trajectory of the seed at the point under consideration.

The resistance force of the airflow (the reaction force of the air) is directed in the opposite direction of the relative velocity of the particles, and the side forces are perpendicular to the direction of the relative velocity, as shown in Figure 1, a and Figure 1., b. In the $0 \leq x \leq b_0$ section of the sunflower seeds, we find the relative velocity in the airflow from the right triangle of the velocity plan (Figure 1):

$$U_n = \sqrt{(V \pm U_x)^2 + U_y^2} \qquad (4)$$

When the speed of rotation of the seeds is greater than the speed of the airflow, the seeds (filled - valuable seeds) fall early (along the separation front) and U_x is preceded by a "+", otherwise "-". Because sunflower seeds are far from symmetry, their rotational frequency is greater than the rotational frequency of spherical particles. Therefore, the kinematics and dynamics of motion of the nuclei are different from those of cylindrical and spherical particles in the air stream. Therefore, when deriving a system of equations of motion, we look at sunflower seeds with specific geometric and aerodynamic characteristics. Figure 2. shows a diagram of a sunflower seed, S_x, S_y, S_z mid-cross sections on orthogonal planes, and the main dimensions obtained by measuring three types of seeds. (Pioneer, Armavir - 9343, Flagship) (Figure 2.)

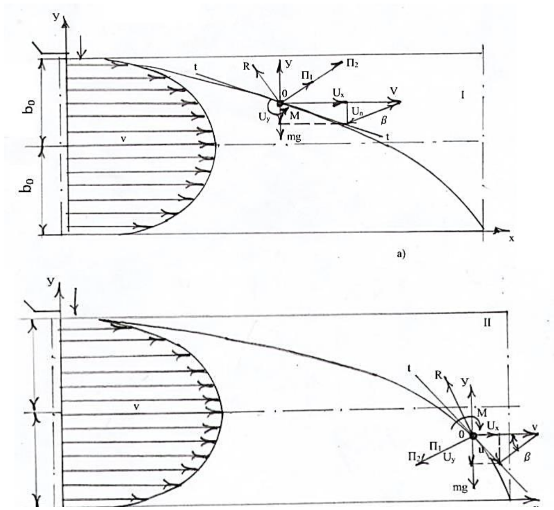


Figure 1. Scheme of the plan of forces and velocities acting on sunflower seeds: a - on the first half of the separation channel (front); b - on the second half of the separation channel (front).

As a result of the influence of side forces in the airflow, the seeds cannot hold a stable and definite position in the flow relative to the direction of its movement. In describing the aerodynamic properties of sunflower seeds, it is preferable to choose the sailing factor before the aerodynamic drag coefficient, as this indicator is more common in seed survey materials. Therefore, we determine the resistance force from the following ratio.

$$R = mK_y U_n^2 \quad (5)$$

Here K_y is the sailing factor, which is determined experimentally for sunflower seeds.

R_x and R_y projections on the coordinate axes of the resistance force

$$\left.\begin{aligned} R_x = mK_y U_n cos\beta \\ R_y = mK_y U_n sin\beta \end{aligned}\right\} \quad (6)$$

The relative velocity projections of the seeds on the x and y axes are determined from the velocity plan (Figure 1), taking into account the value of the flow velocity in the expression (3):

$$\left.\begin{array}{c} u_n cos\beta = V \pm u_x = \left[V_{max}\left(\frac{x}{b_0}\right)^{1/7} \pm u_x\right] \\ u_n sin\beta = u_y \end{array}\right\} \quad (7)$$

In the inverted form, we determine the resistance force $\bar{R}$ from the ratio (2.6) by substituting the value of the relative velocity of the nuclei in the air stream. (2.4)

$$K = mK_y\left\{\left[V_{max}\left(\frac{x}{b_0}\right)^{1/7} \pm u_x\right]^2 + u_y^2\right\} \quad (8)$$

Therefore, according to N.E. Zhukovsky's theorem, the force of resistance is determined from the ratio of the quantities of side forces, in proportion to the velocity of the advancing flow U and the circulation Q, ie

$$\overline{\Pi} = \rho\bar{U}_n Q \quad (9)$$

Here ρ - - is the density of air.

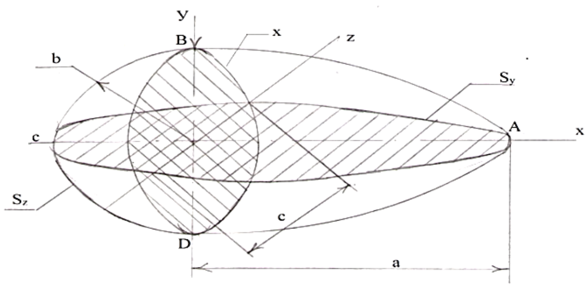


Figure 2. Scheme of sunflower seeds

The object of modeling is the various processes of grain cleaning machines to bring the final fraction of seed material to a high-quality condition with a one-time cleaning of a mixture of sunflower seeds. For the TPS construction we adopted (Figure 5), the separation $E_{\Phi\Pi C}$ criterion and objective function is written as follows:

$$\varepsilon_{\Phi\Pi C} = 100 - \frac{\sum_{j=2}^{c} a_{\Pi j}\varepsilon_{\Pi j}}{\sum_{j=2}^{c} a_{\Pi j}} \rightarrow \max \qquad (16)$$

Here $\varepsilon_{\Pi bj}$ – is the output density of the j-th components (j = 1,2, ..., c) separated from the seed fraction. Output of j components in the material from the i-th fraction (i = 1 - light particles, i = 2 - purified seeds (purified seeds and intermediate fraction), i = 3 - heavy particles) (Figure 3):

$$q_{\Pi bij} = Q_{\Pi} a_{\Pi j} \varepsilon_{ij} \qquad (17)$$

Here ε_{ij} – is the output density of the j-component from the i-th fraction.

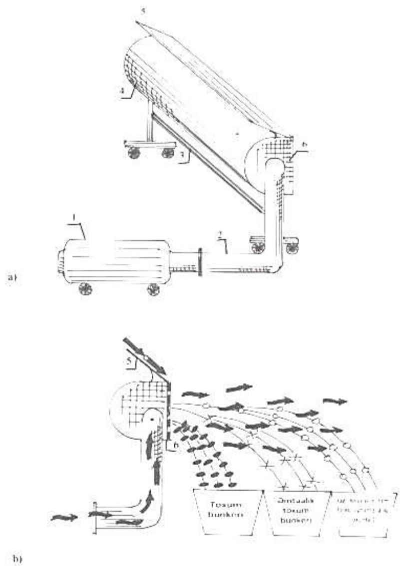


Figure 3. TPS - general view (a) and functional scheme (b) of the experimental pneumatic separator: 1 - electric pneumonia pumps; 2 - air supply pipe; 3 - wheelchair; 4 - air blowing window; 5 - seed (mixed) transmitter board; 6 - air - nozzle window;
air flood; fatty particles; cleaned seeds;
initially cleaned seeds (or mixture).

Chapter 3 analyses "Program and methodology of experimental research. The research program, core methods of experimental research, description of technological processes of post-harvest processing of sunflower seeds and devices for their implementation, measurement-mass characteristics of sunflower, and measurement characteristics of oily sunflower hybrid seeds are reflected here.

The program of experimental research envisages conducting experiments on four technological schemes. The aim is to make a comparative analysis of the results obtained for each technological scheme. It is planned to compare the results obtained after the implementation of these technological schemes, as well as to analyze the material and energy capacity of the best quality cleaned seeds. Grain-and-seed cleaning machines included in the technological line are adjusted under the operating rules before the researches are carried out and put into operation for at least 4-5 hours to determine the stability of the technological process. Before sampling, the machine is set to the optimal mode by setting the appropriate solution.

Structure of pneumatic sorting separator.

The window is installed at a certain angle, the flow regulator allows air to flow to the window at a certain speed for the processed material. The seed mixture enters the window, where it spreads under the influence of directed displacements and increased airflow, forming a layer of seed mixture in different directions: light particles - in the direction of the displacement line, the main outlet is transported between them (light and heavy particles).

The main technological features of the mixture of sunflower seeds are their size, sail, shape, surface properties, density, weight, elasticity, and color. All this, to one degree or another, is variable, so it is necessary to take into account the development of technological schemes for cleaning and sorting seed mixtures. Their measurement characteristics serve as indicators of the variability of any size of seeds. The variability of the particle size of the separated mixture can be given in the form of a sequence of variations or variation curves. To construct a series of variations or curves, it is necessary to make 300 ... 500 measurements on the selected parameter (thickness, width, and length) and distribute the obtained measurements by class. For sunflower seeds, the interval of classes on their thickness, width, and length λ is 0.2, respectively; 0.3 and 0.4 mm are accepted. The total number of classes is determined by the dimensions of the maximum l_{max} and minimum l_{min} and by dividing their difference (l_{max}-l_{min}) by the interval of classes (λ). Usually, they are in the range of 5 ... 10.

The division of seeds into classes by thickness and width can be done not only by measuring but also by releasing a mass of 50 ... 100 g of seeds taken from a separating tube equipped with sockets equal to the size of the class intervals. Each class is characterized by boundary and average values. Sunflower is one of the most widespread oilseeds in our country and abroad. The area under sunflower in Azerbaijan occupies more than 75% of the area under all oilseeds. Sowing is an important operation of production technology, achieving a high yield of sunflowers. Therefore, the main condition for obtaining high-quality seeds is to ensure their compliance with agro-technical requirements as a sowing material. At the same time, the total productivity of sunflowers, as in other row crops, is determined by their even distribution in the field and plant density, which, if ensured, can increase its quantity by up to 30%.

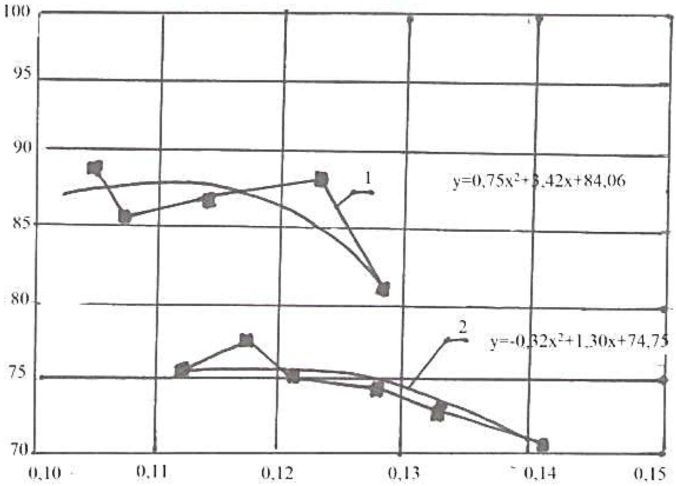
In the study of the physical and mechanical properties of sunflower seeds, the number of seeds involved in the measurement was determined by the method of division (cross-section) in the period until the average sample size of 250 seeds. A rod with a measuring accuracy of 0.1 mm was used to determine the size of the seeds. The obtained results were recorded in a special table and then processed by the method of mathematical statistics using the computer program MarthCad.

The fourth chapter is entitled "The results of experimental research, which substantiates the economic efficiency of research." In this chapter, the study of the dependence of the transmission density of the components of the mixture of sunflower seeds on air on different technological schemes, the study of the dependence of the components of the mixture of sunflower seeds on the airflow, the structural optimization of seed cleaning machines, the results of comparative testing In the processing technological scheme, the economic efficiency of the research results and the report of the main economic indicators are reflected here.

Thus, based on the results of experimental studies of the technological work process on the cleaning schemes of grain cleaning machines, the change of quality indicators depending on the functional scheme of the air-cleaning system (Air Conditioning System Cleaning Machine) was analyzed.

Based on the experimental data obtained using a computer and known patterns from MS Excel, describe the density of the jth (j = 1,2, .. 5) component in the i-th fraction ("seeds", "sub-system pass") for the ACSCM machine. Figure 4-6 for seeds is given in the appendices for the remaining components. During the operation of the ACSCM air purifier in the initial cleaning mode (Figure 4), it was determined that the yield was 0.911 kg / s on the 1st and 2nd technological schemes, the seed yield was 87.98%, while the 3- At the rate of 0.138 kg / s of productivity under the scheme, this figure makes up 76.06%.

During the operation of the ACSCM air purifier in the second cleaning mode (Figure 5), it was determined that the seed yield was significantly increased from 90.6 to 86, increasing the productivity to 0.10 ... 0.15 kg / s., Up to 00% (for scheme №1), but more intensive for scheme №4 - from 84.41% to 62.95%. For the pneumatic sorting device ACSCM, the productivity dependence of the seed output is shown in Figure 6. The analysis of the obtained data shows that with the increase of productivity, the amount of decrease in seed yield decreases insignificantly (from 94.8% to 90.4%, to 4.8%)

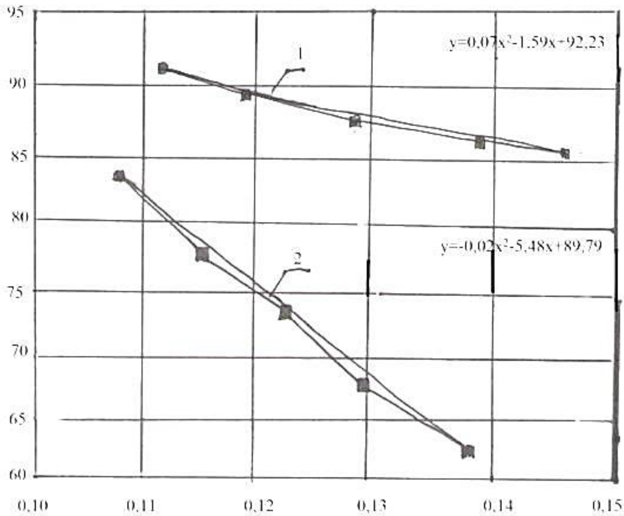


kg/s

Figure 4. Graph of dependence on the total yield (density) of conditioned seeds obtained from the common material during the initial technological cleaning mode

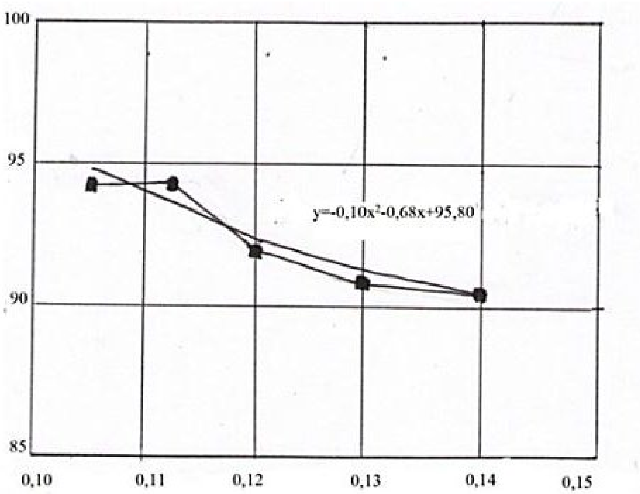
According to the results of experimental studies of the technological work process of the cleaning machine on the scheme № 1-4, it is clear from the analysis of changes in the parameters of TPS activity in its cleaning system that MS Excel computer program and known regularities based on the experimental data obtained using the i-th fraction (i = 1 - light, i = 2 - purified seeds, i = 3 - heavy) j-components (j = 1,2, ..., 5) a regression equation describing the transition density has been constructed.

The analysis of the presented data shows that the increase in yield leads to a decrease in the seed yield density from 86.5% to 61.9% from the main outlet (cleaned seeds) and at the same time, light and heavy fractions increase from 6.3% to 27.5% and from 7.2% to 10.7%, respectively. The main loss of the main plant seeds occurs due to their falling into a light fraction.



kg/s

Figure 5. Graph of dependence on the total yield of conditioned seeds obtained during the initial technological cleaning mode



kg/s

Figure 6. Graph of dependence of conditioned seeds from the pneumatic sorting device on total yield

It was determined that the aggregates according to the functional schemes №2 and № 3 provide the production of 1st class (purity over 99%) seeds in the yield range of the mixture considered in the aggregate. Seeds of the second class are obtained in the operation of unit № 1 scheme and the limited feed range (0.110 ... 0.150 kg / s) - s 4 scheme). However, the share of 1st class seeds is provided in the work on the scheme № 2 of the unit (61.4 ... 62.5%) and in the work on the scheme № 3 of the unit (61.8%). Access to waste is high in the operation of the unit on the scheme № 3, it constitutes 18.1 ... 29.6%, and when using the scheme №2 is 14.2 ... 19.8%.

The largest output of feed waste was in the scheme №1, which varies in the range of 25.3 ... 26.6% against 23.1 ... 24.5% in the scheme № 2. At the same time, the largest waste output is in the scheme №4, which varies from 18.1 to 29.6%, depending on the yield. Production test of local hybrid sunflower seeds was carried out following OCT 70.10.2-84. The seeds included in the cleaning were collected in the field by a combine (Sampo 2045) (baskets are cut by hand, thrown into the inclined conveyor of the combine, and separated from the basket in the beating machine, and then transferred to the decontamination unit). In total, 2.5 tons of local sunflower seeds were processed. The purity of the raw material changed in the range of 73.31 ... 89.17%, including the number of organic impurities (particles) - 17.02 ... 6.07%, crushed seeds 0.39 ... 2, 24%, and weak seeds - in the range of 2.37 ... 4.85%.

It was determined that the seed yield from the raw material as a whole is 62.0% and 65.9%, respectively. The purity of the obtained seeds is 98.87% and 99.48%, the amount of sown seeds is 0.45% and 0.24%. The weight of 1000 seeds obtained by the new technology was 82.66 g and 85.94 g, respectively. These data were obtained at the optimal productivity of each scheme, ie for the scheme №1 - 432 kg / h, for the scheme №2 - ~ 468 kg / h. When it is not possible to separate the mixture by one trait, a combination of two or three traits is used and a correlation table is drawn up, based on which the variance curves are constructed, using the relationship between the divisions of the traits selected as a whole.

Thus, the correlation table compiled on three characteristics (length, width, and thickness of the seeds) is 4.0 ... 4.5 mm or allows the width of the elongated slots to be taken in the range of 2.0 ... 2.3 mm. At this stage, the mixture of sunflower seeds consisting of hollow - weak, broken and peeled fractions, basket elements, etc. becomes partially separated. Therefore, to fully sort the sunflower seeds in the seed-commodity direction, their separation in the air stream is included in the technological flow line. The advantage of air-sorting is explained by the fact that in conventional seed cleaning units, repeated transmission of seeds by seed causes their damage and, consequently, weakens the protection of seeds and, consequently, weakens the protection of seeds and reduces the quality of output. Similarly, a combined correlation table covering other traits can be constructed, thus achieving a higher amount of complete mixture sorting.

The main economic indicators of the activity of various structures of grain cleaning units were determined using certain costs of operation of grain cleaning units in the cleaning of sunflower seeds. It was determined that the average cost of income from the operation of the unit operating on the scheme №3 in the range of yield of sunflower seed mixture to various units is ~ 709.94 manat, and in the operation of unit №2 - ~ 582,433 manat. During the agro-technical period (200 hours) the income of the aggregates was 35447.06 AZN and 29121.650 AZN respectively.

CONCLUSIONS

1. Analysis of the activity of various technologies and technical means for the preparation of sunflower seeds for seed and food in the agricultural sector shows that the need for seed cleaning of the required quality, as a rule, 2-3 times cleaning of seeds in existing grain cleaning units or separate grain cleaning machines This, in turn, leads to a significant increase in their damage (up to 30%) and an increase in processing costs by 1.5 ... 2.0 times.

2. A topological model has been constructed, which defines the various functional schemes (scheme 4) of the cleaning units,

describes the matrix of free paths, forms the subsets of special operations in the form of a closed graph, due to which in the input effects given in modeling and the performance indicators of the process provide an assessment of the various functional schemes of these units.

3. Adequate multidimensional mathematical model of its technological process based on modeling of special operations forming the subgroup of operations of the grain cleaning unit, as well as the introduction of subsystems of special operation variant F $\vec{}$, control effects $\vec{A}$ and a model of the process of separating the output characteristics $\vec{B}$ vectors with the given arguments.

4. Evaluation of the technological process of the grain cleaning unit was carried out in different subgroups of special technological operations. It was determined that the maximum yield was 87.98% when the ACSCM - grain cleaning machine was operating in the initial cleaning mode according to schemes 1, 2, and 4, while the seed yield was 0.15 kg / s, and the yield was 76.06% according to the №3 scheme. It is provided with a productivity of 0.14 kg / h.

5. In modeling the operation of the grain cleaning unit with different technological schemes, it was determined that the functional scheme units (№2 and №3) provide the production of first-class seeds (purity over 99%) in the yield range of the material under consideration. However, the share of conditioned seeds under Scheme 2 varied from 61.4 to 62.5%, while under Scheme 3 it increased from 49.7 to 61.8%. According to the first and second technological schemes, the total operating costs of the technological equipment, energy capacity, material capacity, and labor costs for its cleaning significantly exceed the corresponding indicators in schemes 3 and 4. The minimum cost of refined seeds in the considered trading range (0.8 ... 2.2 kg/sec) is №2 according to the technological scheme - from 2.02 to 2.08 AZN/kg.

6. Based on the results of production testing of technological schemes 1 and 2, the effective technological process of scheme 2 (ACSCM-1 + TPS + ACSCM-2) was determined, which is confirmed by the results of modeling. Based on the compared schemes, the yield of conditioned seeds in all raw materials is 62.0%

and 65.9% respectively, the purity of the obtained seeds is 98.67% and 99.48%, separately, the productivity increase for the 2nd scheme constitutes 37.3%.

7. It was determined that in the use of the grain cleaning unit according to the 3rd scheme in the productivity range considered in practically the same operating costs, each ton of processed seeds provides the highest income (798,936 AZN) compared to the 1st scheme (692.95 AZN) and the 2nd scheme (582,433 AZN) In the interval of delivery of the mixture of sunflower seeds to the grain cleaning unit according to the 3rd technological scheme, it provides 39946,800 maximum income compared to the 1st scheme (34647.68) and the 2nd scheme. (29121.65) In the application of the new technology, the annual production volume is 122,167 manat at 50 tons. The payback period of the investment is 0.83.

8. It is recommended to add the developed device to the technological scheme of machines to improve the quality of preparation of sunflower seeds for seed and food production.

RECOMMENDATIONS

New technology and structure of grain cleaning machines and units have been developed for cleaning and sorting of sunflower seeds.

The newly developed device added to the technological scheme of the machines has led to a significant increase in productivity and quality.

The schematic diagram of the proposed device can be utilized in design bureaus that design grain treatment plants and by enterprises that manufacture these units.

It is recommended to add the developed device to the technological scheme of machines to improve the quality of preparation of sunflower seeds for seed and food production.

The main provisions of the dissertation are reflected in the following scientific articles published:

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