

FARM MACHINERY AND TECHNOLOGIES

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STUDY OF POWER CHARACTERISTICS OF THE DIGGING SHARE OF A MACHINE FOR ROOT-CROP AND ONION HARVESTING

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The authors have conducted studies to determine the traction efforts of the digging share of a machine for harvesting root crops and onions based on its technological parameters – speed and digging depth. The paper presents a design scheme and general view of the offered laboratory installation for determining the supply of a heap of onion sets to the digging share. The paper describes a methodology for conducting traction studies of the digging share of an onion harvesting machine and describes the operating principle of the digging tool of a harvesting machine, which ensures high-quality harvesting of root crops and onions with minimal energy consumption. As a result of the studies, the response function values of the digging share's tractive effort have been obtained taking into account the varying speed and digging depth. When processing the results of a two-factor experiment, a first-order regression equation was obtained to describe the relationship between the traction resistance of the digging share of a machine for harvesting root crops and onions and its technological parameters $R_{II} = f(v, h)$, and the main statistical characteristics of the experiment. It has been established that in order to ensure the quality of bulb extraction from the soil (minimal damage and loss of bulbs) as well as high performance of the harvesting machine, the digging share speed should amount to 0.8...1.2 m/s and the digging depth should equal 3...5 cm.

Key words: digging share, traction effort, root crops, onions, harvesting machine, tillage bin, multifactor experiment.

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THEORETICAL STUDIES OF A DESIGN OF MANURE SPRAYING IMPLEMENT FOR LOCAL MANURE APPLICATION UNDER GOURDS

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The paper outlines a rational method of introducing manure under gourds. The authors carried out theoretical studies with modeling the movement of a manure particle from a manure spreader to the soil surface taking into account the technological features of the application process and the physicommechanical properties of manure. Based on the study results it has been recommended to localize the introduced manure in three rows using a special extension to the manure spreader. The authors provide indicators for a more uniform manure application: rational combination of the installation angle and the length of dividers, as well as the location and installation angle of trays. The paper contains a relationship between the linear speed of the conveyor belt and technological characteristics. It has been established that the travel speed of manure mass along the body lags behind the speed of the manure spreader conveyor, therefore, when calculating the performance, a correction factor $K_o = 0.5...0.6$ should be introduced. Its lower value corresponds to the minimum feed, and the upper limit – to the maximum. To divide the manure stream into three equal parts, it is necessary to install the fasteners of the lower edge of dividers at a height of 0.64 m and maintain the belt conveyor speed within 0.25...0.44 m/s.

Key words: theoretical studies, manure particles, fertilizer, manure spreader, technological process, belt, application, adaptation, determination, parameter, mode.

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PARAMETERS AND OPERATION MODES OF ROTARY TILLAGE WITH SERRATED KNIVES

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The authors have studied some ways of improving the technology of pre-planting tillage of lumpy soils using milling cutters with serrated profiles of the knife surface. This technology is certain to improve the cultivation quality and increase the agrotechnical indicators of soil cultivation. The study focused on the influence of the soil cultivation depth, the number of knives, the speed of the tiller rotor and the unit travel speed on the operation quality of a rotary tiller. The unit travel speed is characterized by the specific energy consumption of rotary tillage, the average size of lumps left on the field after rotary tillage and the degree of soil crushing. The study applied the theory of experimental design. Taking into account the shape and size of a tuber bunch as applied to the actual conditions of potato cultivation, the authors have proposed methodological principles for optimizing the parameters of formed ridges. When two cutters with a serrated blade are installed on the tiller rotor, an increase in the travel speed from 2.1 to 3.2 m/s results in a 2.5% increase in specific traction resistance, while that in the range between 3.2 and 4.3 m/s ensures a 3.0% increase. At an angular speed of the tiller rotor of 30 rad/s, when the depth of soil layer tillage increases from 100 to 120 mm, specific traction resistance increases by 2.0%, in case of an increase from 120 to 140 mm – by 2.5%. The study has proved the feasibility of using knives with serrated curved blades, as it ensures a reduction in the energy intensity of soil tillage and an increase in potato productivity by 20% as compared to the soil cultivation with the ФН-1.2 serial rotary tiller.

Key words: rotary tiller, pre-planting tillage, cultivation depth, degree of crumbling, serrated blade knife of a rotary tiller.

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WEAR PATTERNS OF SOIL CUTTING BLADES

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The paper presents the results of laboratory tests of the wear of soil tillage blades. The authors have developed an experimental unit with a linear-moving sample blade when interacting with an abrasive medium imitating the real soil. Physical properties of the abrasive medium can be changed by incorporating into the composition quartz particles, paraffin, ceresin, pulverized cement and other materials. The installation reproduces the operation of a blade shearing off soil particles of a loamy soil. The authors have obtained relationships between the inclination angle, the blade wear land width and length and the cutting path. As the depth of cutting increases, the wear rate increases in a parabolic manner. Due to the wavy irregularities of the furrow bottom, the wear rate decreases by 10...15%. It is caused by a load decrease of treated abrasive medium regardless of the blade material (steel or aluminum alloy). With the hardness of medium increases to more than 2 MPa, the blade wear rate increases, but the wear land angle to the furrow bottom decreases due to a changed wear mechanism. As fine dust particles concentration in abrasive medium increases, a facet formed on the blade edge contributes to its rapid blunting. As the cutting speed increases from 0.3 to 0.6 m/s, the blade wear rate increases by 25...30% due to raising soil resistance and the specific energy spent on soil deformation and destruction.

Key words: tillage tool, abrasive soil model, blade wear rate.

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CHOOSING OPTIMAL ARRANGEMENT OF KNIVES ON ROTOR-TYPE MACHINES FOR FEED GRINDING

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The paper considers three arrangement options for knives on a rotor machine for feed grinding: with a vertical blade, with a blade inclined forward, and with a blade inclined back. The authors proved that for a rotor-type machine, it is preferable to arrange the knife blade inclined forward, as this reduces the cutting force and hence the energy consumption required for cutting. In addition, this option of knife arrangement will ensure tight press of the grinded material to the rotor, which is necessary for effective cutting. The authors show the effect of knife wear on the cutting process proving that the blunting of knives reduces the grinding efficiency. The paper presents an improved structural design of the grinder, according to which the rotor rotates not only in the horizontal plane, but also vertically, which reduces the cutting angle of the material and the cutting force. Based on experimental studies, the authors recommend that the knives be set at an angle of 30 degrees, at which the “chopping-type” cutting transforms into cutting with moving or sliding effects.

Key words: knives, grinded material, blades, geometric parameters, arrangement, grinder

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THE ANGLE OF STATIC LATERAL STABILITY FOR SELF-PROPELLED AGRICULTURAL MACHINES

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One of the safety criteria for self-propelled agricultural machinery is the angle of lateral static stability. The authors have analyzed the methods for determining the angle of static lateral stability for self-propelled agricultural vehicles, a significant part of which is equipped with a balancer suspension of the steering axle. The study has revealed a significant deviation of the experimental values of the indicated angle from the calculated value determined according to GOST 33691-2015. Using large-scale models of agricultural machines (Claas Jaguar forage harvester, Claas Axion and John Deere tractors), the authors have evaluated the effect of the balancing suspension on the value of the angle of lateral stability and compared the obtained data with the calculation results for the considered relationships. It has been established that when using balancing suspension of the steering axle in machines, the lateral stability angle depends not only on the height of their gravity center, but also on its longitudinal displacement. Thus, in order to obtain the actual calculated data for the considered angle, it is necessary to use methods that take into account the influence of the balancing suspension.

Key words: tipping axis, lateral stability, balanced steering axle.

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STUDY OF FACTORS THAT AFFECT THE STABILITY OF THE BUCKET CANAL CLEANER ON RIGID GUIDES

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The research aim is to determine the stability of a bucket canal cleaner on rigid guides PP303 depending on the change in the boom extension (handling radius), the operating length of the bucket during soil withdrawal, and the counterweight arm. The working equipment of the canal planer is installed as a side hitch on the caterpillar tractor ДТ-75. In this case, the fuel tank acts as an additional counterweight. It is also possible to use the BTK-90ТГ crawler tractor as a

base. The main elements of the working equipment of the canal cleaner are a telescopic composite boom, rigid guides with a bucket mounted on the boom, and a counterweight with a variable reach. Changing the characteristics of structural elements affects the machine stability during operation. The canal cleaner stability was determined with a three-factor research method, which allows to assess the value of the most significant factor. The results of experimental studies were processed using statistical analysis methods. It has been shown that the presented mathematical model fairly correctly describes the values of the stability coefficient of the canal cleaner. It has been established that the greatest influence on stability during operation of the PP-303 canal cleaner is exerted by a change in the counterweight offset. A significant influence of the boom extension (operating radius) and the position of the working element on the rigid guides is observed when they are jointly considered. The authors conclude that during the modernization of the working equipment of the PP-303 canal cleaner, one should take into account the counterweight size and location.

Key words: canal cleaner stability, stability coefficient, three-factor experiment, optimization parameter, response function; factors affecting the objective function.

POWER SUPPLY AND AUTOMATION OF AGRICULTURAL PRODUCTION

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EXPERIMENTAL MODELING OF THE VAPORIZATION OF LIQUID SOLUTIONS UNDER VACUUM AND MICROWAVE FIELD CONDITIONS

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The paper provides a comparative analysis of traditional methods of concentrating food solutions. The author identifies the main problem of classical evaporators, which is associated with the impossibility of obtaining high concentrations of the finished product due to a sharp increase in its viscosity and temperature caused by the formation of a boundary layer. He puts forward a scientific and technical hypothesis offering a possible solution to this problem by providing a considerable supply of energy directly to the product moisture. The paper outlines thermophysical and physical schemes of evaporation processes based on traditional and innovative methods. Their fundamental differences are highlighted and the relevance of the development of an innovative evaporation method is proved. The author presents a scheme of an innovative evaporator, which allows to obtain the finished product in the solid phase with a final concentration of up to 90°brix. The author reports on the experiments conducted with apple juice to study the effect of pressure and power of the electromagnetic field on the steam output of the evaporator. As a result, he established relationships that indicate a constant evaporation rate throughout the entire process, up to a concentration of 80...85°brix. The product temperature did not exceed 35...40°C, which may indicate its high nutritional value. The above data confirm the formulated hypothesis about a possibility of transition from the boundary conditions of the 3rd type to the boundary conditions of the 2nd type by using microwave energy in the process of evaporation. On the basis of the obtained results, a model in the criterial form was obtained, which makes it possible to accurately calculate the performance of a microwave vacuum evaporator in certain ranges of the energy deposition number and the obtained dimensionless group.

Key words: energy management, food production, energy efficiency, drying, cryoconcentration, microwave field, dehydration, food concentrates.

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METHOD FOR DETERMINING THE MATURITY OF TOMATOES BASED ON THE CONTROL OF THEIR CHLOROPHYLL FLUORESCENCE INDUCTION

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Conventional methods of tomato sorting are based on the external attributes of fruits, such as color, size, hardness, or other textural features. These methods do not take into account the internal qualities and texture of fruits, which therefore affects the sorting quality. The proposed method for sorting tomatoes based on the control of their induction of chlorophyll fluorescence takes into account the internal structure and quality of tomatoes. During the experiment, the botanical Alcazar variety of tomatoes with various stages of maturity was used: green; dairy (light green); brown; pink, and red. For the considered tomato variety, a general pattern was revealed: as the fruit ripens, the magnitude of maximum fluorescence induction decreases and the variability of this indicator increases. Immature fruits are characterized by high

values of the maximum fluorescence induction of chlorophyll with its low variability. The full-maturity stage of tomatoes is characterized by low values of maximum fluorescence and the variability of this indicator. The proposed method is less time-consuming than the method for determining the maturity of tomatoes by their colour; it ensures better quality separation of tomatoes by maturity, taking into account their internal structure. The method can be applied for an integrated maturity assessment of large batches of vegetables, as well as of each individual fruit.

Key words: tomatoes, Alcazar variety, colour, maturity, chlorophyll fluorescence induction

THEORY AND METHODOLOGY OF PROFESSIONAL EDUCATION

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IMPROVING THE TRAINING OF ENGINEERING MASTER STUDENTS FOR PROFESSIONAL TEACHING ACTIVITIES

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The paper discusses the problem of improving the training of engineering master students for professional teaching activities. The pedagogical technology can be mastered by students in the process of studying the course of “Fundamentals of Pedagogical Activity” and acting as a teacher during pedagogical practice. The course of lectures and practical tasks in the course of “Fundamentals of Pedagogical Activity” is delivered in the author’s version. The key role in the process of mastering the subject belongs to the organization of practical classes and extracurricular independent work, during which master students perform competence-based tasks. A competence-based task is a problem situation reflected in the student’s mind and objectified in a sign model corresponding to a certain type of professional activity and the graduate’s competence. The program of pedagogical practice also includes individual competence-oriented tasks performed by master students. The study involved 90 master students. The effectiveness of using competence-based tasks in the study process was evaluated according to a comprehensive methodology that comprehensively considers subjective and objective factors. According to the research results, 76% of lecturers noted the high degree of master students’ readiness for teaching practice. The obtained empirical data allow to assess the effectiveness of psychological and pedagogical training of engineering master students and the contribution of a system of competence-based tasks to it.

Key words: professional education, professional and pedagogical training of undergraduates, pedagogical practice, competence-based tasks.

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SPECIFIC FEATURES OF STATE FINAL ASSESSMENT OF GRADUATES MAJORING IN VOCATIONAL TRAINING

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The study is based on the analysis of the structure of the content of biprofessional training of vocational training teachers and training in monoprofessional programs, as well as a comparative analysis of the State final assessment practice. The paper provides the grounds for a model for diagnosing students’ learning outcomes at the final stage of university training during the State assessment. The latter, as a rule, includes the State exam, as well as the preparation and public defense of graduation qualification project. While developing this approach, the authors took into account specific features of the content of the graduates’ training within “Vocational Training (sectoral)” major, which differs significantly from the teacher training in individual academic subjects, as well as the multifunctional nature of their future professional activities. The authors have analyzed various options for the implementation of vocational teacher training including two-stage training on the basis of sectoral basic education and training in a monospecialty form and possible ways of implementing the State final assessment with the revealed advantages and disadvantages of both forms. Based on the conducted analysis they suggest a generalized complex diagnostic model, in which the content of assessment tests should correlate isomorphically with sectoral and pedagogical components of the training content. These components should be adequately reflected in both the State exam and the graduation qualification project. The proposed model provides for the most diversified and most complete verification of the whole range of content elements of biprofessional training of future vocational teachers and the assessment of the graduates’ competencies for their ability and readiness to perform their professional functions.

Key words: State final assessment, learning outcomes, diagnostics of learning outcomes, State exam, graduation qualification project, training content, “stepwise” and “biprofessional” training of vocational training teachers.

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DUAL TRAINING ORGANIZATION AND SELF-ASSESSMENT BY STUDENTS OF THE DEVELOPMENT OF COMPETENCIES

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An analysis of the practice of introducing dual training has shown how important it is to improve the regulatory framework for its development. However, the on-going mutual convergence of enterprises and universities is also important. The paper discusses the organization of dual training at the level of “enterprise-department (laboratory)”. The objectives of the study include clarification of the principles of dual education organization at this level, development of methodological principles for the dual education organization, graduate-assisted assessment of the success of its organization and the development of universal competencies. Based on the analysis of ten distinctive features of the dual education system, the authors have clarified the principles of its organization at the level of “enterprisedepartment (laboratory)”. The possibility of their implementation by the department is considered a selection criterion for choosing seven positions. The authors have been searching for a methodological basis for successful solving organizational and managerial tasks when interacting with enterprises. The authors state that the methodological categories of modern education – “objects”, “types”, “elements”, “conditions for the implementation of professional activities” can be used to formulate methodological principles for the organization of dual training at the “enterprise-department (laboratory)” level. It is emphasized that in the context of dual education, practical training of students should provide the formation of skills to work with objects and form experience in the implementation of professional types and elements of activity in professionally significant contexts. The authors provide an example of the formulation of these categories in the professional context. Diagrams of the evaluation results of the dual training institution obtained from the university graduates have shown that it is more difficult to build this system at the department level than at the laboratory level. During the selfassessment of the development level of ten competencies made by university graduates, no respondents chose the position “competency is not developed”. However, respondents noticed the weak formation of individual competencies (from 11.1% to 44.4%, excluding communication in different languages). The study results have shown that successful development of competencies in the framework of dual training requires not only the implementation of its organization principles, but also the use of improved teaching methods.

Key words: dual training, department, enterprise, organization of dual training, principles, methodology of professional activity, professional education, competencies, self-assessment of competencies.