



## OPINION

on the dissertation for obtaining the educational and scientific degree "Doctor" in: field of higher education 5. Technical sciences, professional field 5.1. General engineering, scientific specialty "Mechanization and electrification of crop production"

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Topic of the dissertation: "COMPARATIVE STUDY OF ACTIVE DISC WORKING BODIES FOR SURFACE CULTIVATION OF SOIL"

Reviewer: Assoc. Prof. Dr. Eng. Dimitar Enev Zyapkov, lecturer at the Agrarian University - Plovdiv, habilitated in the field of higher education: 5. Technical Sciences, professional field: 5.13. Mechanization and Electrification of Agriculture, scientific specialty "Mechanization and Electrification of Plant Growing", appointed as a member of the Scientific Jury by Order No. RD16.1272.2025 of the Rector of the Agrarian University - Plovdiv.

### 1. Relevance of the problem.

The machines used for surface tillage of the soil do not always fully meet the agrotechnical requirements, especially when it comes to stable annual regeneration of its structure. From this point of view, the design of the existing working bodies of the agricultural machines used must be able to fully satisfy the requirements of modern advanced mechanized technologies. In this regard, the problem of sustainable shallow tillage in combination with an appropriate innovative technical solution is relevant and the overall efficiency of the operation of machine-tractor units for surface tillage depends on its correct solution.

### 2. Purpose, tasks, hypothesis and research methods.

The purpose of the dissertation work is a comparative study of two innovative working bodies with active drive for surface tillage of the soil, combining the kinematics of a tillage mill with a horizontal axis of rotation and horizontal displacement of the soil by a disk working body.

The tasks of the study are six and include: study of working bodies with a new profile, mounted on a tillage mill; creation of a mechano-mathematical model describing the kinematics of the movement of the new organ, allowing for simulation study of the profile of the arable soil layer, at a given

kinematic indicator; experimental study of soil fragmentation on two soil backgrounds; experimental study of mixing of ameliorant in the soil with the two new working bodies; experimental study of the stability of the working bodies to maintain a uniform depth; experimental study of the uniformity of the bottom of the furrow after specific soil cultivation.

The hypothesis of the study is to achieve optimization of the mechanized operation by creating a new type of working bodies, directly mounted on the shaft of a soil tillage machine with a horizontal axis and the subsequent regenerative soil cultivation, regarding the applicability of the model for engineering design. The expected final results of the planned study of the innovative rotary-disk working bodies will create prerequisites for optimizing the work process of the agricultural machine on which the bodies will be installed.

The research methods developed and/or used by the doctoral student include modern methods of planning, substantiation of objects, practical research and analysis of experimental data. In experimental research, the active method of conducting the experiment and the engineering principles and rules of mathematical planning are applied. The proposed and applied private methodologies and evaluation criteria are basically advanced and practically applicable. Their structure and elements are properly justified, their interconnection is logical and this allows for obtaining reliable results.

### **3. Illustration and presentation of the obtained results.**

The dissertation work is developed on a total of 129 pages and is illustrated with 66 figures and 25 tables. It contains an introduction, five main chapters, summarized conclusions, contributions and a list of used literature. The presentation in the individual sections is presented in a logical sequence, with the doctoral student convincingly proving that he is thoroughly familiar with the scientific achievements in the field of surface tillage and applied agricultural machinery, has accurately identified unresolved elements of the technology and, taking an argumentative position, clearly formulates and solves the existing problem.

Methodologically, the actual research was conducted correctly. The mathematical dependencies obtained from the regression analyses were obtained using modern tools and are illustrated with clear and specific graphs. All this presents the doctoral student as a competently prepared researcher who is able to independently discover, investigate and solve practical scientific tasks and emerging problems in the operation of agricultural aggregates.

### **4. Discussion of results and used literature.**

From the analysis of the state /review/ and based on simulation experiments, the author comes to the conclusion that there is a prerequisite for improving active soil tillage machines by creating a new

an innovative working body, combining the horizontal displacement of the soil from the set of disks with the kinematics of a tillage machine with a horizontal axis of rotation.

The newly created active disk bodies are designed for installation on the shaft of a tillage machine. This engineering solution was correctly chosen because of: the universality and stability of the machine design, the optimal distribution of loads, the possibility of adaptation and the conditions for direct comparison between the standard and newly created disk bodies.

The reliability of the material on which the doctoral student draws his conclusions is based on his overall correct approach and the competent application of the methodology of the experimental study. The information obtained was processed using the methods of mathematical statistics, which were applied accurately, and the analysis of the results was correct.

To achieve the set goal, the doctoral student reviewed and analyzed 101 literary sources in Cyrillic, working mainly with new scientific information on the problem. This is evident from the fact that over 80% of the sources used were issued or published in reputable scientific journals after 2000.

The comprehensive literature review, the scientific approaches analyzed in the dissertation, the innovative working bodies developed, the experimental studies conducted with them, the derived mathematical models of the processes and the correct analysis and argumentation of the obtained results show a thorough knowledge of the state of the problems related to surface tillage.

## **5. Contributions of the dissertation work.**

The dissertation work represents a complex /simulation and field/ scientific study of surface tillage with newly created working bodies for a tiller, and the results obtained, the conclusions made and proposals correspond to modern achievements and contain significant scientific-applied and applied contributions to theory and practice.

### *Scientific and applied contributions*

1. Two innovative active working bodies have been developed, which combine the kinematics of a soil tillage machine with a horizontal axis of rotation and horizontal displacement of the soil by means of a disk working body.
2. A new approach to the design of surface treatment machines has been proposed, ensuring simultaneous crushing and displacement of the soil layer.
3. A mechano-mathematical model of motion has been created, describing the trajectory of an actively driven disk working body mounted on a horizontal shaft at an angle to its axis. The model allows for analytical study of the interaction between the disk and the soil, taking into account the geometric and kinematic parameters of the system.

4. A methodology has been created for conducting numerical experiments at the design stage, through which the optimal values of the mounting angle and the diameter of the disk can be determined.

5. A methodology has been developed for simulation modeling of the process of interaction of the working body with the deformable volume of soil.

### ***Applied***

1. Two sets of actively driven new working bodies for surface tillage of the soil have been designed. The results obtained prove their functional suitability and efficiency under different agrotechnical conditions.

2. Two prototypes of disk working bodies with different profiles for surface tillage of the soil have been developed and tested.

3. Mathematical dependencies of the kinematic indicator on the stability for maintaining a given depth of tillage have been established.

4. The operating modes of the created working bodies have been determined, which provide the maximum percentage of agronomically valuable soil structure in the range of 1–25 mm.

5. Speed ranges for mixing the ameliorant have been experimentally established, at which optimal incorporation into the soil is achieved.

6. The degree of influence of the forward speed on the stability and quality of operation of the machine, equipped with the two newly created discs, has been established.

### **6. Critical notes and questions.**

1. The analysis of the condition is too explanatory, which for some of the reviewed machines leads to inconclusiveness. It is possible that p.1.2 and p.1.3. be reduced by analyzing only working bodies and technical solutions related primarily to the upcoming goal and tasks that will help to achieve it;

2. There are some contradictions in the conclusions of the review /p.27/, concerning the advantages and disadvantages in the implementation of the work operation;

3. There is no numbering of the formulas and regression equations, some of the figures do not have a text explanation /Fig. 4, 5 and from 17 to 20/ and there are some visible inaccuracies in some of the tabular designations;

4. It would be correct to protect the design parameters of the new working bodies such as: overall dimensions, location on the shaft, sharpening angle and some others, since they directly affect the impact of the entire machine on the cultivated soil.;

5. Not all conclusions are formulated in the most convincing way or are presented as findings /without the 4th, 6th, 9th and 10th/, which should be paid attention to.

**Questions:**

1. What basic agrotechnical requirements are met when surface tillage of the soil with the working body developed by the doctoral student?
2. Have steps been taken to patent it and is there interest from agricultural machinery manufacturers?
3. What is the working width of the tiller with the new working bodies and what is the criterion for overlapping during the next work stroke of the MTA in order to guarantee continuity of the cultivated area?

**7. Published articles and citations.**

I am convinced that the doctoral dissertation and the contributions are the personal work of the doctoral student, asst. eng. Petya Genkova, which is also confirmed by the fact that in three of her publications, two were independently developed, and in one she is the lead co-author. The publications presented on the dissertation are in English, and both were published in reputable scientific journals with Impact factor.

The abstract is prepared in accordance with the requirements of the Agricultural University and reflects the main part of the dissertation research, while the printed scientific works reflect the influential main results and contributions of the developed work.

**CONCLUSION:**

Based on the modern methodologies and research methods learned and applied by the doctoral student, the correctly conducted experiments, the analyses, summaries and conclusions, I believe that the presented dissertation work meets the requirements of the Law on Agricultural Research and Development of the Republic of Bulgaria and the regulations of the Agricultural University-Plovdiv for its application, which gives me reason to evaluate it **POSITIVELY**.

I would like to propose that the esteemed Scientific Jury also vote positively and award Asst. Eng. Petya Angelova Genkova the educational and scientific degree of "doctor" in the scientific specialty Mechanization and electrification of crop production.

Подписите в този документ са заличени

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