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Ukrainian Black Sea Region Agrarian Science
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Alternative sources of funding for the development of united territorial communities

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Abstract. The article proves that it is important to strengthen financial capacity of united territorial communities through different financial and socio-economic mechanisms in the modern conditions of communities' decentralization and further development. The article analyzes the current trends in financing the development of united territorial communities, reveals the benefits and opportunities for attracting alternative sources of funding. An algorithm for attracting grant funds for the development of UTC and other proposals that will increase the financial capacity of UTC in the long term and the implementation of local development initiatives are proposed

Keywords: alternative sources of financing, united territorial communities, grant funds, projects, financial capacity

Formulation of the problem. One of the main tasks of local governments in most countries is to organize the search for extra-budgetary sources of funding and to establish cooperation with various funds and grant programs. The important area of activity for local communities in Ukraine should be the search for alternative sources of funding and attracting grant funds to address local development needs because they have limited budgetary resources. Therefore, the study of the content and forms of promising areas of financing for the development of united territorial communities (hereandafter – UTC) is relevant today.

Analysis of recent research and publications. The theoretical and practical aspects of attracting various sources of financing for local development are studied by the Ukrainian and foreign scientists such as M. Buryak [1], N. Vasilieva, N. Hrynchuk, T. Derun, V. Kuybida [2], A. Poltorak [3], N. Spasiv [4] and others. They reveal the features of attracting financial resources for local development, identify their advantages and disadvantages, describe the modern paradigm of finance of united territorial communities and more. At the same time, today the directions of attracting alternative sources for financing UTC need a more fundamental study, taking into account current trends in socio-economic development.

Formulation of research goals. *The purpose of the study* is to assess the status and justification of promising areas of financing the development of UTC through alternative sources to improve their efficiency.

Presentation of the main research material. Today the main aspect of the integral system of local government is that the Constitution of Ukraine determines the right of a territorial community to independently resolve issues of local importance, and the Law of Ukraine "On Local Self-Government in Ukraine" [5] stipulates that a territorial community is the residents united by permanent residence within a village, settlement, city, that are independent administrative-territorial units, or a voluntary association of residents of several villages, have the ability to independently resolve issues of local importance through the particular local government departments.

At the same time, changes to the Budget Code

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have become a key impetus for territorial communities to unite because in the case of unification, they are endowed with resources and powers as in cities of regional importance. As a result of the process of financial decentralization there is a distribution of responsibilities, powers, functions, financial resources between the central, regional and subregional levels of government [1].

The process of unification of territorial communities began in mid-2015, at the end of which 159 UTCs were established. At the same time, their number has been growing rapidly every year and in 2019 increased more than 6 times. By September 10, 2020, 983 UTCs have been established in Ukraine.

The results of financial decentralization indicate at the annual increase in local budgets' own revenues.

Thus, during 2018, incomes of own revenues to the general fund of local budgets of Ukraine amounted to UAH 234.1 billion, which is UAH 41.4 billion or 21.5% more than in the previous year (Fig. 1). During five years of financial decentralization, local budget revenues are expected to quadruple and will be UAH 267 billion (in January-November 2019, it was UAH 250.5 billion).

The increase in own revenues was achieved mainly due to the growth of tax revenues. After all, during 2014-2019, the role of local taxes and fees in the formation of relevant budgets increased.

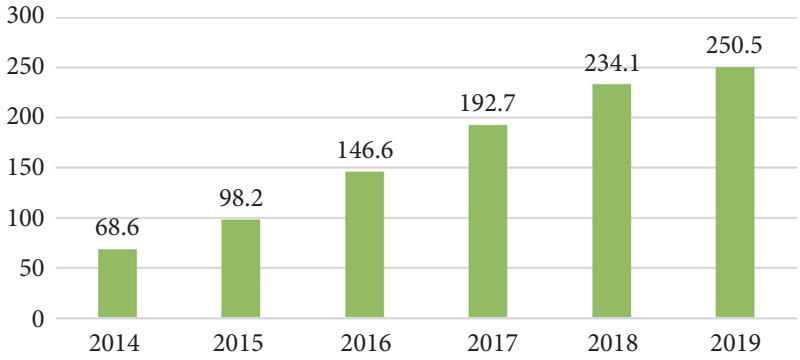

***Figure 1**. Private revenues of the general fund of local budgets, 2014-2019, UAH billion*
***Source**: made by the authors according to [6], * 2019 (January-November)*

Analysis of the implementation of own revenues of local budgets shows a steady trend of their pace growth. Thus, if in January-November 2016 own income for per inhabitant became 3385.5 UAH, for the same period in 2019 their volume almost doubled and was to 6763.6 hryvnias. At the same time, positive growth rates are typical both for the amount of personal tax income (PIT) per capita and for local taxes and fees per capita. The size of these indicators in January-November 2019 increased by 25.8% and 26.7%, respectively, comparing to the same period last year (Fig. 2).

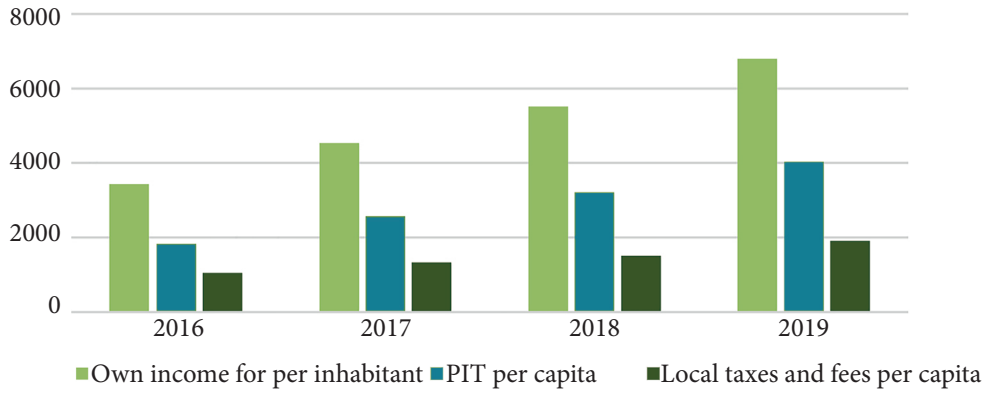

***Figure 2**. Growth of revenues of the general fund of local budgets per 1 inhabitant in January-November 2016-2019, UAH*
***Source**: made by the authors according to data [6]*

In the period from 2014 to 2019 there is a significant increase in the state support for local communities. It should be noted that since 2017, support has been provided for the construction of sports facilities, financing of sectoral regional authorities, UTC infrastructure. The activity of the State Fund for Regional Development (hereinafter – SFRD) is important in strengthening the financial base of the united territorial communities, which provides funding for regional development projects on a competitive basis and in accordance with regional development strategies and action plans for their implementation. During 2015-2019,

the amount of funding from the State Fund for Rural Development has a steady upward trend, in 2019, UAH 7.7 billion was allocated for the needs of regional development. (or 28.3% more than in 2018).

Pointing at the important role of budget resources in the development of UTC, it should be noted that at the local level there is a number of unresolved issues that are too much for the community budget, but can be successfully addressed with other resources, including alternative (grant). Today they are represented by: fundraising; common cost (crowdfunding platforms); donor programs and opportunities in the context of decentralization reform (grants from the European Union, grants from the United States Agency for International Development (USAID), financial assistance from international projects, etc.).

In addition, most UTCs have a number of problems in public financial management. Thus, based on the results of the state financial audits of UTCs in various oblasts, which were completed in 2019, the problems of inefficient management of revenues and expenditures of the community budget and others were identified and systematized. In particular, the typical problems of inefficient UTC budget revenue management are:

1) the use of low land tax and rent rates;

2) the presence of arrears of land tax and rent for land;

3) the incomplete realization of the fiscal potential of the property tax, other than land, due to lack of access to the State Register of Real Rights;

4) the loss of PIT revenues due to two main reasons (informal employment and PIT payment at the place of registration of the parent company, and not at the place of actual location of business entities which are divisions / branches of other companies and operate in the UTC) [7].

In addition, a number of key aspects of inefficient management of UTC budget expenditures have been identified [7]:

1) spending of resources to pay for utilities of individual entities;

2) constant subsidization of utilities and failure to take measures to achieve at least a break-even point, which does not contribute to improve the financial condition of utilities and quality service;

3) irrational spending in connection with the non-optimized network of educational and cultural institutions. These spending are primarily related to wages and maintenance of institutions with significant underutilization of their capacity;

4) insufficient amount of budget funding for social institutions, which does not allow to improve the condition of the premises, purchase computer equipment, etc.;

5) impossibility for various reasons to master the funds of intergovernmental transfers, which leads to their inefficient spending and the need to return some unused transfers to the state budget.

In the future, determining the alternative areas of financing the development of UTC, it is necessary to analyze the results of an express survey of UTC chairmen, which was conducted by the UTC

Association by a survey through an online service. The purpose of this questionnaire was to find out what priorities the UTC chairmen set for themselves in terms of the main sources of funds for development and in terms of key areas in which funds should be invested in order to develop the community as soon as possible. At the same time, among the most important areas for community development, roads were identified as the first priority (90% of respondents), medicine as the second one (75%), and education as the third priority (73%) (Fig. 3).

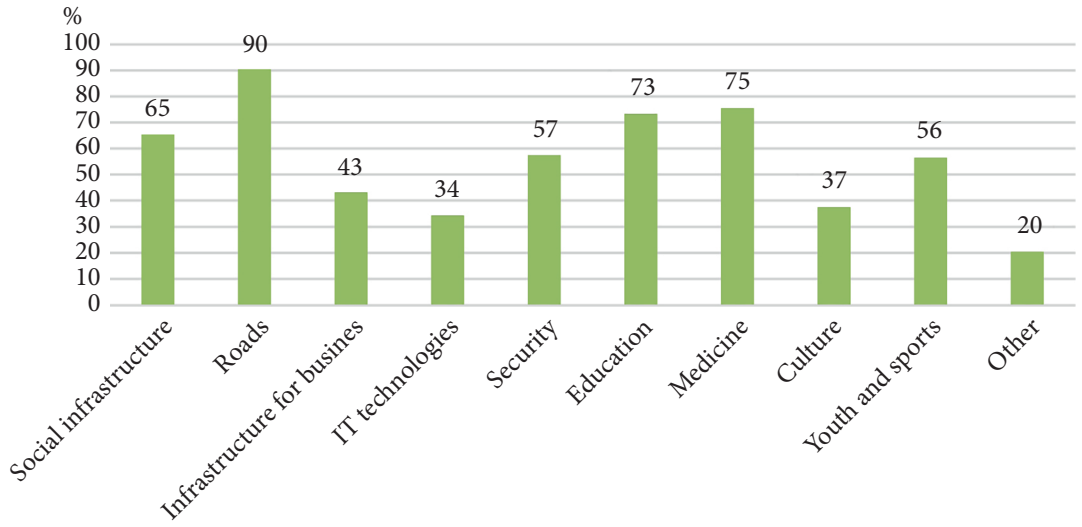

***Figure 3**. The most important areas for community development, identified by the results of the survey of UTC chairmen*
***Source**: made by the authors on the basis of data [8]*

At the same time, today the majority of UTC chairmen (93%) identify the infrastructure subvention as the most important source of funds for community development. However, after two or three years, the main source of funds, along with local budgets (67%), more than half of the heads of UTCs (55%) defined grants as international technical assistance (ITA) (Fig. 4).

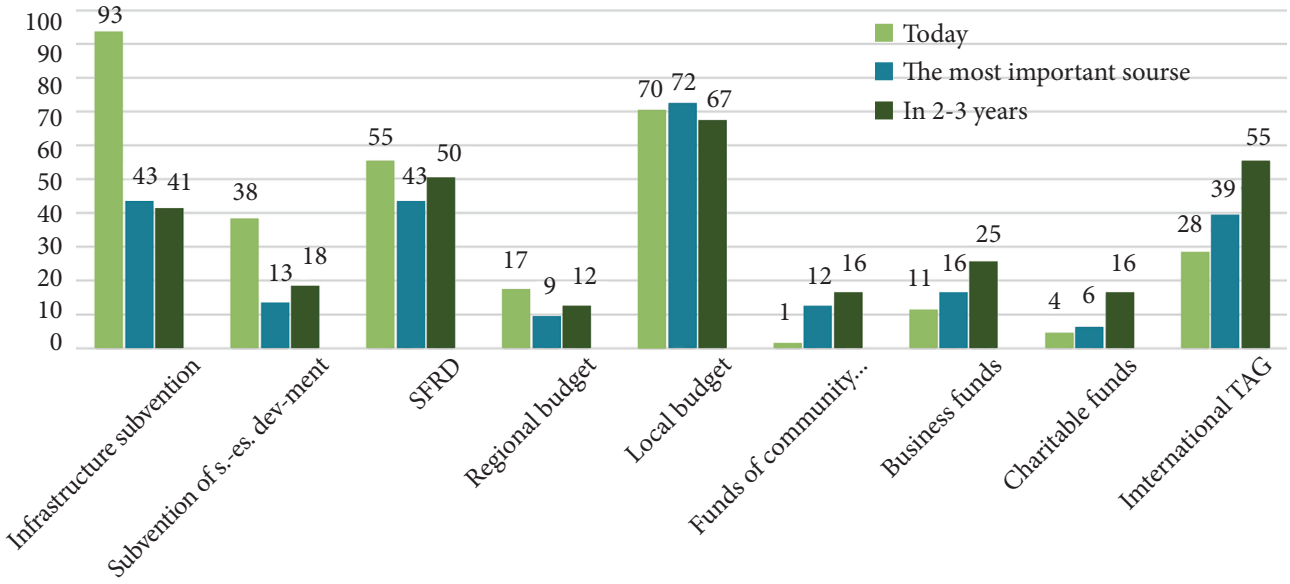

***Figure 4**. The main sources of funds for community development, identified by the survey of UTC chairmen changes*
***Source**: made by the authors on the basis of data [8]*

In-depth analysis in terms of UTC types, it should be noted that ITA grants are currently one of the four most important sources of funds for community development. Thus, more than a third of urban, township and rural UTC identified them as the main source of funding for the development of their own area – 37%, 36% and 41% respectively (Fig. 5).

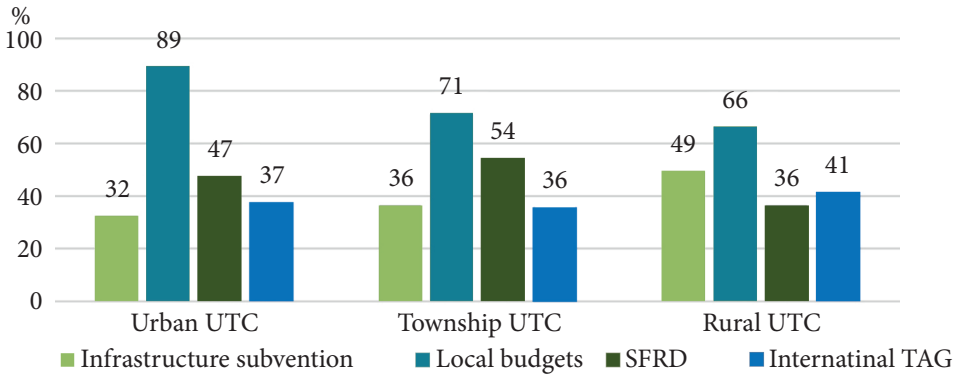

***Figure 5**. Four main sources of funds for community development,identified by the survey of UTC chairmen*
***Source**: made by the authors on the basis of data [8]*

It should be noted that today there is a number of promising funds like "Vidrodzhennia", "Dobre" (Decentralization Offering Better Resultsand Efficiency – DOBRE), "Support to Decentralization in Ukraine" (DESPRO), etc., which provide funds for the implementation of those projects that convince in their long-term existence and usefulness for the population and the economic infrastructure of Ukraine in general. Such funds are formed mainly not only at the expense of domestic contributions, but also a significant share belongs to foreign development funds [9]. As a result, competition and incentives for self-financing appear between UTCs, social responsibility is formed and the consciousness of the population changes.

Mykolayiv region is also an active participant in the formation of UTC and increasing their selffinancing opportunities for the economic prosperity of the region. As of the end of 2019, 30 UTCs have been established in the region. At the same time, the level of subsidization of their budgets (the share of the basic/reverse subsidy in revenues) ranges from 24.2% to 38.6%. Thus, in Bashtanska UTC with a population of 22.6 thousand people, the level of subsidies is only 3.4 percent. This indicator is facilitated by the active position of the chairman and members of the UTC in the socio-economic development and development of projects financed from alternative sources.

Halytsynivska UTC is a successfully developed, financially viable community, which is one of the few that currently pays reverse to the state (the level of budget subsidies is 24.2 percent). Throughout the period of the community's existence, it is nonsubsidized, the reverse dotation in 2017 was UAH 12 million, in 2018 was UAH 16 million, in 2019 was UAH 23 million, in 2020 (plan)

is UAH 26 million. Thanks to cooperation with public associations, the community cooperates with international donors, embassies and ministries of the EU and the USA: USAID DOBRE; Representation of DVV International in Ukraine; USAID Pact; Kyiv Dialogue Project; German Ministry of Foreign Affairs; Federal Ministry for Economic Cooperation and Development of Germany (BMZ). During this cooperation, 17 small and large projects were implemented.

Thus, such examples prove that increasing the level of self-financing capacity, attracting funds for promising projects, will contribute to further effective financial support for the development of UTC. This will create positive conditions for unloading the budget of Ukraine and provide an opportunity to direct these funds to other important social needs that are currently relevant for the country [9].

In order to increase the number of UTCs that will actively use alternative sources of funding, we have suggested an algorithm for attracting grant funds for the development of UTCs. It contains the defining features of attracting resources for grant programs (Fig. 6).

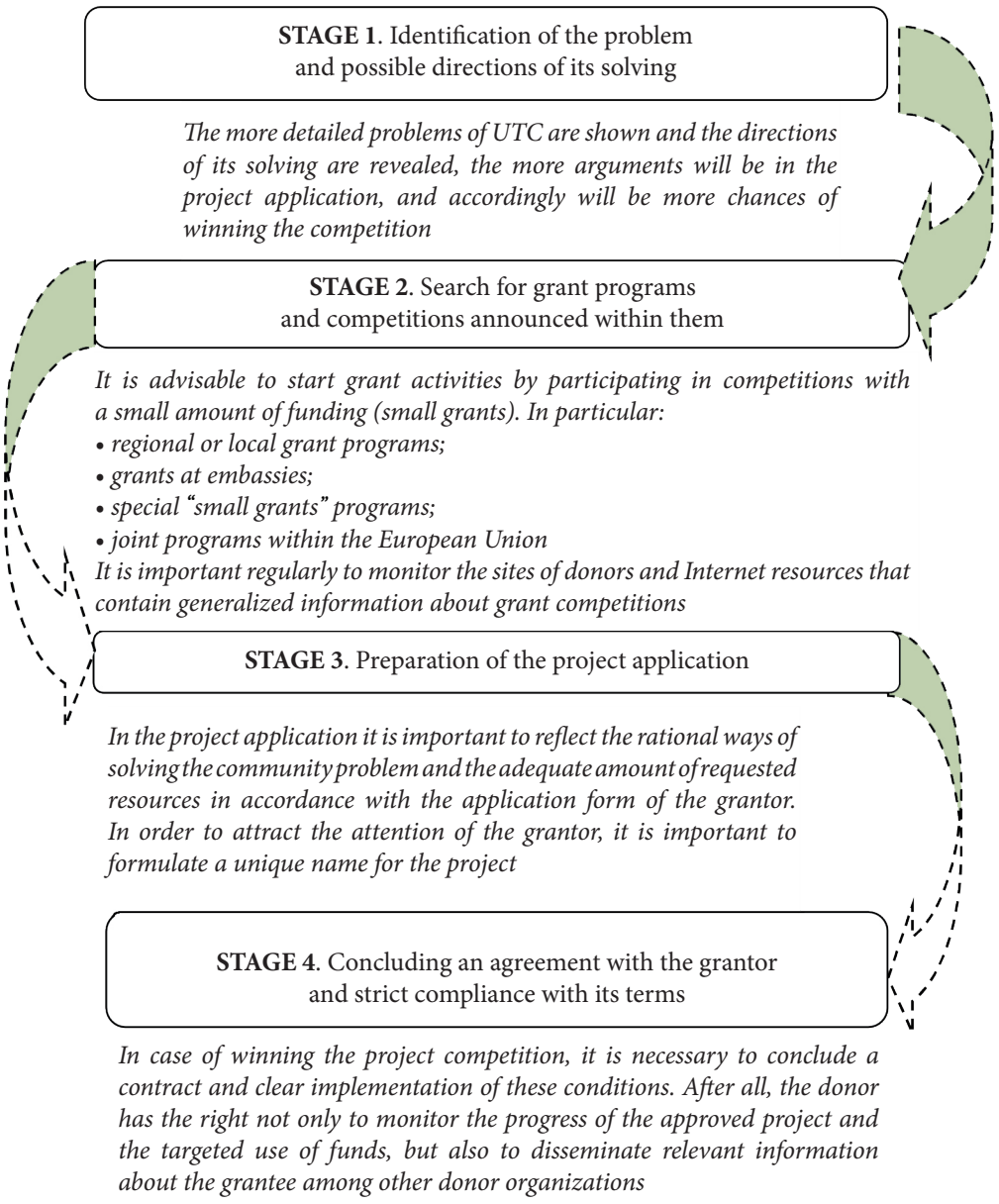

***Figure 6**. The algorithm for attracting grant funds for the development of UTC*
***Source**: summarized and supplemented by the authors [10]*

At the same time, it is important regularly to monitor the official websites of donor organizations and Internet resources that contain generalized information about grant competitions. In particular, the followings are quite informative and relevant: the resource center "Gurt"; the information portal of nonprofit organizations of Ukraine "Public space"; the crowdfunding platform "Big Idea"; the Ukrainian Association of township and rural Councils; the official portal "Decentralization"; the SwissUkrainian project "Support to Decentralization in Ukraine" (DESPRO); the International Foundation "Renesans"; Facebook group "Grants, competitions, scholarships" (https://www.facebook.com/groups/prograntS/); the directory of donors (http://foundations.org); the International Association of Public and Corporate Donors "European Foundation Center (EFC)"; the international portal for non-profit organizations and others.

As the successful UTC experience shows, in order to increase the chances of receiving grant support, community members should participate in trainings, which are often conducted by donor organizations for potential participants in the future competition in the relevant area. In addition, it is important to ensure that the project application is in line with the strategic development plan of the community or region. After all, donor organizations usually prefer those socioeconomic development projects which prove viability at the stage after the completion of grant funding.

Conclusions. Conducted research has shown that the main task of budget decentralization is to find a sufficient amount of financial resources that will be able to provide full independence and autonomy of local budgets in the structure of the budget system of Ukraine. It is substantiated that along with the budget, investment and credit resources, the decisive role in financing local socio-economic development projects belongs to alternative sources in the form of grant funds. Implementation of the suggested promising projects through alternative sources of funding, consistent with the Community Development Strategy, will contribute to the formation of a favorable business environment and the implementation of social programs in UTC, increase financial capacity in the long run. Adherence to the algorithm suggested in the article and the development of skills to raise funds from alternative sources will be a determining factor in the success of local development of initiatives of the territorial communities of Ukraine.

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Аспекти формування продовольчої безпеки в контексті епідеміологічних обмежень у США

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Анотація. У статті доведено, що у сучасних умовах проведення децентралізації і подальшого розвитку об'єднаних територіальних громад важливим є посилення їх фінансової спроможності через різні фінансові та соціально-економічні механізми. Проаналізовано сучасні тенденції фінансування розвитку об'єднаних територіальних громад, розкрито переваги і можливості залучення альтернативних джерел фінансування. Запропоновано алгоритм залучення грантових коштів для розвитку ОТГ та інші пропозиції, що сприятимуть підвищенню фінансової спроможності ОТГ на довгострокову перспективу та реалізації ініціатив місцевого розвитку

Ключові слова: альтернативні джерела фінансування, об'єднані територіальні громади, грантові кошти, проєкти, фінансова спроможність

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Globalization challenges and competitiveness of the company's personnel

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Abstract. The efficiency indicator of personnel management in many aspects determines the success of innovative activities of every modern enterprise. At the same time, the social aspect of personnel development plays an important role in the successful functioning of each specific enterprise in the face of globalization challenges. Agricultural enterprises form the basis of the country's food security, and the study of issues related to the development of personnel, especially in terms of its social direction, has both a theoretical and an applied nature. Currently, the creation of products in the agricultural sector of the state requires not only quantitative indicators of personnel, but also depends on its qualitative factors, among which priority is given to the ability to create innovations. The problem of transferring enterprises of the agro-industrial complex to an innovative model of development is one of the important and priority ones, and requires special attention. Thus, the purpose of the article is to interpret the essence of the social component of personnel under the circumstances of innovative changes in the economy as a condition of personnel competitiveness. The article examines certain aspects of the social component of the staff in the conditions of innovative development of the enterprise, the strengthening of globalization challenges facing the economy of Ukraine. It is substantiated that in the modern conditions of the enterprise's activity, the problem of staff stability has matured. The possibility of considering this issue through such components as motivational, managerial and social is determined. It was determined that the competitiveness of personnel is a significant factor in the formation of competitive advantages of any enterprise. It has been proven that education and professional development of personnel become dominant factors in the formation of competitive advantages of enterprises of the agro-industrial complex

Keywords: development, social component, enterprise, personnel, innovation, competitiveness, globalization, potential

INTRODUCTION

The level of efficiency of personnel management largely determines the success of innovative activities of a modern enterprise. To ensure stable priorities in the market, the enterprise must be competitive both from the standpoint of its structural organization and from the standpoint of the ability to adapt to the effects of environmental factors, in particular, globalization challenges in the process of functioning. In order to increase the efficiency of the business entity's operation, eliminate costly methods of activity, each enterprise should realistically assess the amount of its own costs for production, the personnel and financial situation, and the positions of potential partners. Natural resources, demographic and environmental conditions, in terms of their quantity, quality and importance, significantly affect the solution of the tasks of ensuring the competitiveness of the enterprise. It is impossible without knowledge, innovations, a new philosophy and ethical principles of management, which is directly related to the human factor, which is the driving force of any process. Only a person is capable of building a system of goals and developing specific measures aimed at ensuring competitive advantages in achieving effective solutions for the innovative development of the enterprise. There-

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fore, along with the economic component, which provides competitive advantages of the enterprise, an important role belongs to the development of personnel, which is an internal factor of its innovative development.

Accumulation of problems related to the formation, development, use and reproduction of human resources has led scientists to be seriously interested in them. Many researches of economist scientists were reflected in works dedicated to revealing the essence of the human factor, its personnel and intellectual potentials, their role in the development of the economy of the state, region and enterprise, characteristics and components, ways of their qualitative formation and effective use in the process of labor activity. This problem was actively studied by the following scientists: V. Antonyuk [1], V. Bezsmertna [2], S. Hrynkevich [3], V. Kutsenko [4], L. Smolyar [5], O. Dovhal [6] and others . In particular, R. Skrynkovsky [7] in his research claims that the main integral structural components of assessing the competitiveness of enterprises on the market are: the efficiency of the enterprise and the competitiveness of the personnel. A. Kucher [8] studied the assessment of the impact of personnel on the competitiveness of enterprises in Ukraine. The general hypothesis of the study is based on the assumption of existing positive relationships between the quality of personnel and the competitiveness of enterprises. V. Mohonko [9] considered certain aspects of ensuring the competitiveness of enterprises and established that the competitiveness of the enterprise directly depends on qualified personnel. Y. Yaxu [10] proposed a model for assessing the competitiveness of an enterprise through the prism of personnel potential. The research results proved that the constructed model is suitable for a comprehensive assessment of the competitiveness of enterprises. E. Pankratov [11], considering the analytical approach of forecasting the competitiveness of industrial enterprises, singled out three components, namely: motivation, effective personnel management and innovations. G. Dovlatova [12] offers an institutional approach to assessing and ensuring the competitiveness of enterprises through the formation and implementation of an innovative development model, which is based on highly competitive personnel. Today, in the conditions when the innovative development of the enterprise is its competitive advantage in the conditions of the increasing influence of globalization on the economy of the state, the role of knowledge and the ability to create innovations are becoming dominant. At the same time, the social vector of personnel development, their creative abilities, creative thinking and satisfaction with the content of work is of particular importance.

The relevance of the study is due to the significant role played by the social aspect of personnel development in the activities of each specific enterprise in the context of globalization challenges, which determined the importance of considering this issue. Since agro-industrial complex enterprises form the basis of the country's food security, the study of issues related to personnel development, especially in the part of its social vector, is not only theoretical, but also applied in nature. Today, the creation of products in the agricultural sector of the state requires not only quantitative indicators of personnel, but also depends on its qualitative characteristics, among which priority is given to the ability to create innovations. The problem of transferring enterprises of the agro-industrial complex to an innovative development model is one of the most urgent and priority ones, which requires special attention.

The main goal of the article is to reveal the essence of the social component of the staff in the conditions of innovative changes in the economy as a condition for the competitiveness of the staff. Despite the fact that issues related to the effectiveness of personnel and labor potential have been studied by many Ukrainian and foreign scientists at different hierarchical levels, a comprehensive diagnosis of the social component of personnel at the macro level needs to be supplemented. This requires further research in the personnel management system.

THE SOCIAL FACTOR OF INNOVATIVE DEVELOPMENT OF THE ENTERPRISE

Today, in the period of Ukraine's transition to a new model of development - post-industrial, when the main resource of wealth is knowledge, intelligence and creative creativity, the question of new approaches to the formation of skills and abilities of personnel has arisen acutely before business entities. An important place in ensuring the innovative development of the country is occupied by the agro-industrial complex (AIC), the work of which largely depends on the state of the industry in general, the development and stability of the functioning of its components in the conditions of increasing globalization challenges in the world. In the conditions of political and military instability in Ukraine, the role of personnel and sensitivity to threats to the agricultural industry is increasing. Along with other components of economic security, food security forms the basis of economic relations, creating conditions for the production of gross domestic product (GDP). Currently, the problem of increasing food security, in particular the availability of food products for daily consumption, is becoming actualized not only in Ukraine, but also in the world.

Modern world processes require the ability of an enterprise to quickly adapt to global competition, which becomes the most important condition for its successful activity. For the development of agriculture in Ukraine, innovation is an important factor that depends on the competitiveness of the industry, its development and efficiency of operation. The innovative activity of agro-industrial complex enterprises is accompanied by risks, which are determined by the combined influence of factors of the external and internal environment of each enterprise. At the current stage, the effective development of agricultural enterprises is possible on the

condition that innovations and new technical and technological developments are introduced into production activities, which will ensure the overcoming of pressing problems (production, resource, environmental, technological, material and technical, organizational-management and social) and contribute to their solution.

The aggravation of the energy crisis and the increase in its scale, the strengthening of the coronavirus pandemic accelerate the need to change the paradigm of social development, transition to a new technological system, and improve organizational forms of management. The problem of change, improvement of the concept of the enterprise and its personnel strategy is becoming more and more urgent.

The social component of the innovative development of the enterprise can be considered in the context of sustainable development of the personnel, which includes, in our opinion, two interrelated elements: the needs of the enterprise team (observance of legally established guarantees for the employed, which is regulated by the normative legal acts of Ukraine); limitations due to the technical and technological level of production and labor organization (manifested in the ability of the environment to meet the current and future needs of the company's employees). The situation in which restrictions do not allow the realization of the company's needs in personnel development causes the emergence of contradictions in the sustainable development of personnel. The main reasons for such a situation can be considered [13]: excessive requirements for employees who do not have an appropriate base from the point of view of socio-economic justification of their necessity for the performance of professional duties stipulated in job instructions; non-compliance with the provisions of normative legal acts of Ukraine regulating relations in the sphere of management of hired labor; organizational-economic, technical-technological limitations of the enterprise in meeting the needs of employees in their development; low level of motivation of personnel in raising the professional level, expanding the area of competences, responsibility, career growth.

ANALYSIS OF THE SOCIAL COMPONENT AS A CONDITION FOR THE COMPETITIVENESS OF THE COMPANY'S PERSONNEL

Globalization in the labor market and the development of agro-industrial complex enterprises require the disclosure and use of all types of enterprise potential. At the same time, the role of potential, which is concentrated in the social factors of the enterprise, cannot be underestimated. Therefore, today in scientific circles, considerable attention is paid to the labor potential of a person, enterprises, which are closely related to the concept of personnel competitiveness.

For the labor market, competitiveness is a relative concept, since it is heterogeneous, and its segmental structure affects the degree of market demand for the quality of the workforce and consumer demand for it. The main property of human capital is competitiveness in the labor market. It determines the satisfaction of market demand for labor. The term "staff competitiveness" began to appear in economic literature at the end of the 20th century.

Enterprise competitiveness is one of the most important categories of the market economy. It characterizes the possibility of effective adaptation to the conditions of a changing competitive environment through the rational use of the company's available resources [14].

The competitiveness of personnel is a complex economic category that determines the ability of employees to generate ideas, develop and implement innovations faster than competitors, as the best compliance with the requirements of employers in terms of knowledge, abilities, skills, the ability to best apply personal, professional and business qualities and to fully implement one's own potential, as well as the ability to effectively perform managerial functions and make timely decisions [15].

In general, the competitiveness of personnel is real and potential abilities, business and professional competence, initiative, ingenuity, sense of responsibility, which are significantly different from other employees and allow them to withstand competition in the market [15].

We believe that the study of the social component as a condition for the competitiveness of the company's personnel should be considered in the context of such components as managerial, social and motivational.

The essence of the management component as one of the components of the competitiveness of the personnel lies in the inconsistency of the organizational structure with the strategic goals of the enterprise. This is expressed due to insufficient functional division of labor; contradictions between traditional and modern labor management methods; between specialists of different generations in the field of strategy and everyday activities; problems of quality use of working time according to the qualification and experience of the employee, etc.

The essence of the social component of personnel competitiveness is manifested in personnel turnover processes; inadequacies of organizational and socio-psychological working conditions; imperfections of corporate culture; the need to ensure conditions for professional development; slow growth of the level of education and professional training of personnel; lack of innovation-oriented social policy, insufficient development of corporate social responsibility, etc.

The content of the motivational component of personnel competitiveness is expressed in the perception of the employee as an individual, a fair assessment of his actions; levels of workplace organization; equal opportunities for professional growth of employees; involving them in management, supporting their initiative; equal concern for the social development of the team, etc.

So, the social component of innovative development of the enterprise can be reduced to the concept of sustainable development of personnel. The shift of emphasis towards its sustainable development is due to the need to adapt the provisions of the lifelong learning concept to the conditions of business operations in modern Ukrainian realities. The basis of this concept is the use of educational technologies, which act as a kind of tool that ensures the level of professionalism of employees, their acquisition of new knowledge and competencies that are put forward for a specific position. As a result of the creation of a favorable environment for the growth of human intellectual abilities (ability to self-study and self-organization, opportunities for professional and career growth, etc.), the company's management produces intellectually rich products. The issue of social aspects of sustainable development was considered in 2011 in the UNDP report "Sustainable Development and Equality of Opportunities: A Better Future for All". It emphasizes the significant role of the social sphere, which becomes a priority for the development of the state, because there is a direct relationship between health, education and employment. Environmental degradation increases inequality due to adverse effects on the physical and spiritual condition of people. In turn, the inequality of human development increases ecological degradation, in particular due to the lack of formation of relevant moral and ethical guidelines in society [15; 16].

Investigating the social sphere of agro-industrial complex enterprises, features were identified that affect the competitiveness of personnel. Among them, the psychophysiological, social, and moral characteristics of employees, the organization of work, and the degree of satisfaction with its content are especially important. The influence of various factors that determine the competitiveness of personnel can be classified in different ways, in particular: external and internal, global and local (by the degree of coverage of the territory), socio-demographic, socio-psychological (by the component structure of employees), losing and winning territories (by specifics of the activities of agro-industrial complex enterprises) labor motivation factors (economic, social), etc. Among the classifications of factors that have a significant impact on the competitiveness of personnel, the most famous is the classification of I.I. Khokhlova [17]. The author divides the factors into groups depending on the environment of their occurrence. According to this criterion, three main classes are distinguished: factors of personal competitiveness, factors created at the enterprise and external factors.

In the conditions of the development of the enterprise, professional diagnostics and monitoring are important to ensure its effective personnel. Their regular conduct, both for newly hired and permanent personnel, will be a guarantee of determining the priorities of the development of employees, will make it possible to forecast and plan their careers in order to form their motivation for further development and acquisition of the necessary competencies for the enterprise. Development for the sake of development will certainly contribute to the growth of the competitiveness of the personnel.

In the modern conditions of the development of agribusiness enterprises, active attention should be paid to the partnership of business and professional education as one of the ways to increase the competitiveness of future qualified workers. In order to meet the needs of employees in their own development, the company's policy could be aimed at social investment by attracting state and non-state (private) funds. At the same time, the creation of favorable working conditions in production, increasing the motivation of employees to achieve the company's goals in order to maximize the return on the use of the labor potential of the personnel require attention.

One of the factors that influence the growth of the level of professionalism of the staff, and therefore their competitiveness, is education. Investing in education allows you to capitalize on its results both in the form of professional and personal competencies of the employee, and indirectly - as a result of intellectual activity, which is ensured by the production of intellectually rich products. In such a situation, not only the level of remuneration increases, but also the usefulness for the company and the employee himself due to the increase in the level of professional, intellectual and communicative competences. Their constant development, use, transfer, mobility lead to such a process as the capital intensity of the sustainable development of the company's personnel.

Problems related to the functioning of the educational system of Ukraine are an important problem today for all types of enterprises without exception. This is first of all. the inefficiency of the system of professional education and training, which does not sufficiently meet the real and prospective needs in personnel. According to the Law of Ukraine "On Vocational and Technical Education", the system of vocational and technical education (VTE) is intended to be the mechanism that ensures citizens the right to obtain vocational and technical education in accordance with their vocations, interests and abilities, to contribute to the implementation of state policy employment of the population, to provide the country's economy with highly qualified and competitive workers in the labor market [18].

Analysis of the regional variation of the distribution of the population by the level of education of Ukraine in general indicates the presence of quite significant differences in the degree of its education, which are primarily due to the different levels of urbanization of the country's regions and regional labor markets. In these conditions, high-quality management of regional education, taking into account the economic, social and demographic situation, the balance of its interaction with the market of educational services, acquires special importance. The need for a new form of

management organization – innovative, entrepreneurial, etc. requires that each educational institution implement a system of adaptation measures, the main of which are diversification of education, development of new economic mechanisms, marketing of educational and scientific services. The situation in the agricultural sector creates a number of challenges, the main ones of which are the organization of improving the conditions for conducting business activities, carrying out qualitative transformations of the agribusiness enterprises themselves, capable of ensuring the competitiveness of agricultural production on the market (domestic and foreign), food security of the state, and approaching European policy in the field of agriculture. The criteria of innovativeness, the least riskiness and maximum efficiency create the basis for increasing the competitive potential of agricultural enterprises, make it possible to update their technical and technological base, minimize risks, ensure access to investment resources and high profitability of activities. The organization of agribusiness enterprises largely depends on the size of the rural population, its concentration, sex-age structure, and the specific weight of labor resources. Therefore, the qualitative transformation of the village, its saturation with competitive personnel is the way to the revival of Ukrainian villages and agribusiness enterprises.

The ability of the company's personnel to adapt to changes in the external and internal environment faster than competitors, to learn and develop becomes a reliable source of its social, strategic and economic advantages. The innovative development of the enterprise, including the agro-industrial complex, today requires both the deepening of the professional qualification level of employees and its constant improvement, which ultimately leads to the strengthening of the competitive position of the enterprise on the market. So, if the knowledge of graduates at the beginning of the 20th century depreciated after 30 years, at the end of the century – after 10, then modern specialists must be retrained every 3-5 years. According to scientists' forecasts, in the coming years the average level of education will increase to 13.5%, more than half of the created jobs require secondary special education, and more than a third require higher education [18;20]. This can be achieved only on the basis of an effective organization of professional development, which should become one of the main functions of personnel management. Analyzing the domestic experience of personnel development, it is worth noting that in Ukraine the average periodicity of upgrading the qualifications of employees is insufficient. It is twice lower than the normative one, and in agriculture, wholesale and retail trade it is 10 times lower. While, for example, in Japan, the periodicity of professional development is up to 1 year, and in the countries of the European Union it is 3-5 years. Experts pay attention to the low levels of training of personnel, their interest in innovative development of the enterprise and innovative management. This especially applies to management, engineering and technical personnel and highly qualified workers [1; 19]. An analytical study of the staff's readiness for change shows their unwillingness to use various kinds of innovations, which is connected with the fear of changing the usual way of life, reluctance for additional training without material benefits and incentives, etc.

Among the measures that would contribute to the innovative development of agribusiness enterprises and the competitiveness of their personnel, we consider the following:

– activation of financing of innovative activities of enterprises [20];

– creation of a favorable business environment and infrastructure for the activities of agro-industrial complex enterprises;

– formation of infrastructure to increase the mobility of highly qualified workforce;

– creation of conditions for attracting foreign capital to finance the activities of Ukrainian enterprises regarding the introduction of intellectual and scientific and technical resources in agricultural production;

– development and implementation of the state program for the development of bank lending to the innovative activities of agro-industrial complex enterprises;

– stimulation of enterprises' own developments, which will allow them to enter the markets not only with products produced using intellectual and scientific and technical resources, but also with the rights to such resources. This will make it possible to increase own profits, which can be reinvested in further scientific research and the implementation of their results in production, etc.

Employees who are able to create new knowledge and actively use it become subjects of innovative work. The result of such work is new ideas determined by creative abilities, a creative approach to one's activity, an active position in the management of the enterprise, conditions for the realization of creative and mental abilities in the labor market, etc.

Today, a successful manager knows that investment in the development of the company's personnel is one of the ways to accumulate their potential, and further investment in the form of capital investments in the workforce will lead to further development of the competitiveness of the personnel. With this in mind, the nature of investing in a person should be long-term, not temporary. Therefore, the training and retraining of personnel, their training throughout their working life should become the main postulates of the personnel strategy of agro-industrial complex enterprises. For effective functioning, they need financial assets and an effective system and effective management methods. Currently, the search for highly qualified, experienced specialists has become a problem for most Ukrainian agro-industrial complex enterprises, because old staff have left, and new ones are not leaving, mainly due to meager salaries and exhausting working conditions.

That is why personnel-technologies of personnel selection and recruitment, including: headhunting, recruiting, screening, direct search, "weaving of networks", have acquired special importance. Their rational use by personnel-managers will provide agro-industrial complex enterprises with an influx of highly educated young personnel capable of flexibly adapting to the market environment and making flexible decisions regarding the competitive advantages of a particular enterprise.

Another problem of the modern enterprise and its innovative development in the conditions of increased globalization is the need to form an effective, flexible motivational system capable of encouraging the anticipatory development of human potential. It becomes a necessary element of strategic management of personnel development. Work motivation and the effectiveness of the management system are inextricably linked. It ensures the process of motivating all employees of the enterprise to activity, and therefore can be considered a type of managerial activity. Work motivation, as a type of activity, is aimed at meeting the various needs of both an individual employee and the company's staff as a whole, on the one hand, and on the other hand, at obtaining expected work results and successfully achieving the company's mission. An effective system of stimulating innovative activity provides a shift in emphasis in the personnel motivation system [21]. An effective enterprise management system will help increase the competitiveness of the employee himself and the enterprise he works for. Increasing efficiency should be included in strategic plans for personnel management and achieved by creating the latest systems of development, encouragement and retraining of hired personnel [22].

CONCLUSIONS

The study of social sustainability of agro-industrial complex enterprises confirms the need to apply a set of measures to ensure it, starting with monitoring the achieved level of sustainability and ending with measures to support it through the development and implementation of social development strategies. That is why the competitiveness of the personnel requires the formation of measures to ensure social development, which would be based on the application of modern information and communication management technologies, timely response to changes in the external environment and a strategic vision of the future state of the enterprise. It was determined that the human factor currently plays a key role in the development of modern enterprises. It ensures their technical and technological development through innovation and investment activities, economic – through increased labor productivity, GDP growth, social – meaningful work and staff stability.

It has been proven that the intensification of crises, the worsening of the coronavirus infection, and the deterioration of the ecological situation in the state determine the need not only to find ways to adapt the personnel potential of agro-industrial complex enterprises in modern conditions, but also to activate it in order to ensure the process of its functioning and the sustainable development of the economy as a whole. Personnel development is not limited only to the needs and requests of a specific person in self-improvement, it becomes a driver of other components of innovative development of the enterprise. At the same time, a significant role is assigned to the motivation of work on the effectiveness of the management system.

In order to increase the competitiveness of the personnel of agribusiness enterprises, it is worth proposing measures aimed at its preservation and development, in particular: a) provision of effective employment; b) revision of the labor payment mechanism aimed at increasing wages and incomes of employees; c) improvement of the mechanism of social security and protection of employees; d) investing in vocational training at work during working life; e) development of the mechanism of motivation to work, through the realization of the creative abilities of employees; f) a person's desire to acquire new competencies and skills through continuous learning.

The competitiveness of personnel is a significant factor in the formation of competitive advantages of agribusiness enterprises. A promising direction of further research is the diagnosis of the components of the sustainability of personnel potential, in particular the intellectual component of modern agricultural enterprises as a guarantee of the country's food security in the context of socio-economic transformations. Analysis and evaluation of personnel, its constant monitoring and diagnosis will allow to be a qualitative measure of the effectiveness of social policy. The results of monitoring and controlling will become the basis of the information base of the process of formation, use and management of personnel competitiveness. It was determined that the prospects of the agricultural sector of the national economy will depend, on the one hand, on the ability to quickly and effectively adapt to the new, modern requirements of today, caused by globalization processes, and on the other hand, on the professionalism and social stability of the staff.

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Глобалізаційні виклики та конкурентоспроможність персоналу підприємства

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Анотація. Показник ефективності управління персоналом в багатьох аспектах визначає успішність інноваційної діяльності кожного сучасного підприємства. Водночас, соціальний аспект розвитку персоналу відіграє вагому роль в успішному функціонуванні кожного конкретного підприємства в умовах глобалізаційних викликів. Підприємства АПК складають підґрунтя продовольчої безпеки країни, а дослідження питань, пов'язаних з розвитком персоналу особливо в частині його соціального спрямування має як теоретичний, так і прикладний характер. Наразі створення продукції в АПК держави вимагає не тільки кількісних показників персоналу, але й має залежність від його якісних факторів, серед яких пріоритетність надано здатності до створення інновацій. Проблема переведення підприємств агропромислового комплексу на інноваційну модель розвитку є однією з вагомих та пріоритетних, і вимагає особливої уваги. Таким чином, метою статті є трактування сутності соціальної складової персоналу за обставин інноваційних змін в економіці як умови конкурентоспроможності персоналу. У статті досліджено окремі аспекти соціальної складової персоналу в умовах інноваційного розвитку підприємства, посилення глобалізаційних викликів, які стоять перед економікою України. Обґрунтовано, що в сучасних умовах діяльності підприємства назріла проблема стійкості персоналу. Визначено можливість розгляду даного питання через такі компоненти як мотиваційна, управлінська та суспільна. Визначено, що конкурентоспроможність персоналу є визначним чинником у формуванні конкурентних переваг будь-якого підприємства. Доведено, що освіта та професійний розвиток персоналу стають домінуючими чинниками формування конкурентних переваг підприємств агропромислового комплексу

Ключові слова: розвиток, соціальна складова, підприємство, персонал, інновація, конкурентоспроможність, глобалізація, потенціал

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Information support for development of rural green tourism enterprises in Ukraine in conditions of COVID-19 pandemic

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Abstract. The current state has been studied and the specificity of the development of rural green tourism in Ukraine has been determined. The problems of practical application of information support by business entities working in the tourism industry have been identified. The essence and necessity of large-scale information support of the rural green tourism industry have been substantiated and its features have been investigated. The analysis of information technology used today in the field of information support for the rural green tourism industry has been carried out. The impact of the global COVID-19 pandemic on the development of the tourism industry in Ukraine has been established. Measures to extend information support in the field of rural green tourism under conditions of adaptive quarantine have been identified. The proposals for improving the level of information support for the rural green tourism industry have been summarized

Keywords: rural green tourism, enterprises, development of rural areas, information technology, region, information support

Problem formulation. The relevance of developing rural green tourism in Ukraine is due to the urgent need to immediately address the problems of socio-economic development of rural areas, which, in most cases, are depressing. This will allow to diversify the directions of economic development of the Ukrainian countryside, to contain the demographic decline and, in combination with other spheres of activity, to solve urgent problems of the regions.

Rural green tourism worldwide is a developed and highly profitable sector of the economy. With further urbanization, the demand for this type of recreation in the world will grow, and therefore – will increase the need for rural estates and tourist attractions that these services can offer. Ukraine has a rather strong resource potential in this area, which has not yet received the appropriate level of information support, and therefore, as a result, is underused and remains in low demand by tourists. This is especially true in rural areas, which have a rich cultural and historical heritage, a significant nature reserve and food base, but are located at a considerable distance from the known tourist routes 1].

In addition, surveys conducted by Ukrainian travel agencies among their clients in 2020 show that in the context of the COVID-19 pandemic, the demand for travel products that provide recreation with a limited number of people around, but with minimal restrictions on their own freedom of action has increased [2]. Under such conditions, rural green tourism will be able to become an alternative in the organization of full recreation in both family and individual format.

Analysis of recent research and publications. A wide range of issues of rural green tourism has been studied by such foreign scientists as Y. Ramanauskene, A. Harhasas, K. Dapkute, K. Dronh, R. Dapkus, A. Kennon, V. Kotlinskyi, S. Medlik, V. Midlton, M. Rosite, Y. Sikora, A. Steina, Y. Kholovei and others. Many domestic

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researchers have devoted their scientific publications to the general problems of tourism development. In particular, we are talking about such scientists as: B. Bartmann, M. Jordi, J. Kloeze, O. Beidyk, V. Kyfiak, O. Kolotukha, O. Korol, O. Liubitseva, M. Malska, A. Mokliak, G. Chernova, I. Yakovenko. Development and implementation of programs for the development of rural green tourism is the range of scientific interests of such domestic scientists as: A. Birkovych, V. Vasylieva, P. Horishevskyi, A. Zinchenko, V. Holovatska, T. Zinchuk, S. Illiashenko, S. Melnychenko and others. However, the active development and prospects of this type of tourism requires further research.

According to J. Kloeze rural green tourism is a concept that includes all tourism activities that develop in the rural environment [3, p. 15-16].

An alternative definition was given by B. Bartmann: "Rural green tourism is a concept that includes tourism activities organized and managed by the local population, based on close connection with the environment – natural and anthropogenic" [4].

The term "rural green tourism" is interpreted by Montaner X. Montehano as an activity that takes place in contact with nature, life in camps or settlements. This activity can be combined with agricultural work, acquaintance with life of small settlements, walking excursions, studying of fauna and flora [5].

The European organization Euroter gives the following definition: "Rural green tourism is tourism that supports the development of agricultural regions, preservation of cultural heritage and ecology of the village, the revival of local traditions and products. This type of tourism is characterized by regional identification and meets the needs of tourists in accommodation, food, leisure activities and other services that contribute to the sustainable development of the social sphere of the village" [6].

According to S. Kuzyk "... in the global economic crisis, rural green tourism can get a new impetus for further development, because many citizens of our country will choose for active recreation Ukrainian Carpathians, Podilsk or Dnieper regions, rather than too expensive foreign facilities on advertised international routes" [7, p. 264]. V. Fedorchenko and T. Dyorova note that "this type of tourism, by promoting the development of small business in agricultural regions, gives urban residents the opportunity to actively rest in private agriculture, and farmers to improve their financial situation..." [8, p. 152].

The purpose of writing the article was to generalize the theoretical provisions, as well as to determine the specifics and problems of practical application of information support by businesses operating in the field of rural green tourism.

The main objectives of this study are:

1) analysis of the current state of information support of the rural green tourism industry in Ukraine;

2) identifying problems with the use of information technology by businesses operating in this field;

3) development of recommendations for improving the level of information support in the field of rural green tourism.

In the process of working on the tasks, the following methods of economic research were used: analysis – in identifying internal trends, problems and opportunities for the development of the object of study, comparative analysis – when comparing indicators in Ukraine with indicators in the world, abstract-logical – in substantiation of proposals and measures for further implementation of information support tools in the activities of rural green tourism entities, synthesis – when summarizing the results.

Presenting main material. Since the beginning of the XXI century and to date, rural green tourism, according to WTO experts, according to the pace of its development ranks first among the sectors of the world tourism industry, and is developing dynamically. The main driving force of its rapid development is the attempt of the progressive world community to restore nature, as the living conditions of modern man are characterized by the mismatch of the environment of his physiological and psychological needs. Therefore, in modern economic conditions to meet the needs of people living in urban areas, a significant role is played by rural green tourism, which is able to ensure economic and demographic stability in rural areas of any country and solve its socio-economic problems. The increase in demand for rural recreation is also growing due to increased incomes and the number of paid vacations, rising levels of education, development of transport infrastructure and cheaper services. Close interaction of city tourists with traditional rural cultural life allows to understand and respect national customs and traditions more deeply, develops the personality, promotes formation of national self-consciousness [9].

In Europe, the development of rural green tourism was associated with the industrialization of agriculture, which in the period after World War II underwent significant modernization changes. Increasing the manufacturability of agricultural work contributed to the growth of commercialization of agriculture, reducing the number of farmers and prices for agricultural products, the overall reduction of farm incomes. This has led to changes in agriculture as a sector of the economy. Based on limited conditions, farmers in European countries (France, Britain, Italy, etc.) began to look for alternative uses of their assets by diversifying their activities in order to ensure a sufficient level of income [10].

Statistics show that 68% of Western Europeans spend their weekends in their own country and 20% in other European EU member states. In general, about 90% of Western Europeans stay in Europe during the

holidays. Of these, 25% (ie, one tourist out of four) spend their weekend in the countryside, taking into account the economic point of view (low prices), as well as guided by the quality of stay. Data on the type of tourist destinations living in the countries of the European Union are presented in the table.

Table. Distribution of recreation places of tourists-citizens of the European Union depending on the tourist area in 2019

Country	Area for recreation			
	rural	mountain	town	sea cost
Belgium	25	15	5	55
Denmark	25	14	19	42
Spain	27	9	11	53
France	24	17	13	46
Greece	8	11	12	69
Ireland	27	6	37	30
Italy	11	24	12	53
Luxembourg	19	12	17	52
Netherlands	39	13	12	36
Portugal	29	8	7	56
Germany	34	15	7	44
Great Britain	29	13	10	48

Source: *[11]*

The EU's main goal for the development of rural green tourism is to develop a tourism product that provides direct income to agriculture for the continuous improvement of life in rural communities, as well as the preservation of historical heritage.

The share of tourism in the general economy of Ukraine is a topic of in-depth discussions and as of 1 January 2021, according to official statistics, is about 3-4% of GDP, which is much lower than the international average (equal to 10%). Therefore, tourism is practically not taken into account in the formation of economic policy at the national level. However, the latest data from international structures (primarily the UN World Tourism Organization, UNWTO) confirm the calculations of domestic experts, who determined this share at about 9% of Ukraine's GDP. This gives reason to consider that this indicator is much more important for the Ukrainian economy than before [12]. According to expert estimates, in the case of full disclosure of Ukrainian tourism potential, revenues to the budgets of all levels may amount to 10 billion US dollars per year, so much is received by countries that are measurable with Ukraine in terms of tourism and recreation potential [13, p. 27].

The concept of "rural green tourism" is a multifunctional, complex and systemic phenomenon that is actively spreading in the economic life of agricultural areas of Ukraine and contributing to their economic and social development. Leading economists identify this category with tourism based on rural estates or farms, or in rural areas in general, but does not include recreation in a kind of recreational areas. In a broad sense, rural tourism is understood as travel for the purpose of recreation and relaxation of the population, which involves accommodation in rural areas with the involvement of the private sector [14, p. 41-44].

The relevance of the development of this type of tourism in Ukraine is confirmed by global trends in the international tourism market. Thus, according to the Union for the Promotion of Rural Green Tourism in Ukraine, today the international tourism market is moving from the recreation model "SSS" (Sea – Sun – Sand) to the recreation model "LLL" (Lore – Landscape – Leisure) [15].

According to experts, the most priority regions for the development of rural green tourism enterprises in Ukraine are:

1. Western part: Zakarpattia, Ivano-Frankivsk, Lviv, Khmelnytsky regions.

2.Southernpart:Zaporizhia,Mykolayiv,Khersonregions.

3. Central and Northern parts: Kyiv, Vinnytsia, Poltava, Chernihiv regions [16, p. 15]. The least developed rural tourism is in Eastern Ukraine.

The creation of positive associations among tourists about recreation in the Ukrainian countryside was hindered by certain stereotypes, in particular about the unsuitability of rural housing, unattractive services, low level of staff. Over the last decade, the associative connections of tourists about the possibilities of rural tourism have changed in connection with their own experience of staying in the village during vacations, holidays and weekends using the services of agro-villages. Factors such as the socio-economic crisis of 2008-2009, the annexation of Crimea, quarantine measures related to the COVID-19 pandemic contributed to the growth of vacationers in rural areas and, accordingly, gaining experience [17].

The experience of Ukraine's European neighbors, first of all Poland, is of great interest [18, 19, 20]. Rural tourism was especially active here in the 1990s and was aimed at creating modern comfortable living and recreation conditions in order to stimulate the influx of foreign tourists. For Poland, as well as for Ukraine, the most notable features of the development of rural tourism and its regional unevenness are: deep differentiation of natural geographical conditions and economic uneven development of regions, cities and rural areas; historical past of specific territories; leisure traditions that have developed over the past decades, etc. As a specific form of activity in Poland, rural tourism is called "economic hospitality" [21, p. 4-14].

The generalization of data from the analysis of monographs and periodicals of domestic and foreign authors, statistics and empirical research allows to form the main directions of improving the quality of rural green tourism services, namely: the need to develop a system for assessing the quality of services; organization of staff training in the field of improving the quality of services; development and implementation of a service quality management system, information support for the development and operation of rural green tourism enterprises.

When forming a quality management system in the estate of rural green tourism it must be guided by the following principles:

1) to ensure the high technical quality of service, it is necessary to develop appropriate rules that would provide for systematic training of staff employed in the service and provide the necessary level of service to tourists;

2) differentiation of rural green tourism farmstead services should depend on understanding the needs of the consumer and trying to meet them through an individual approach with maximum care;

3) the main task of ensuring the quality of service is to meet or exceed consumer expectations;

4) service quality assessment should be based on consumer criteria;

5) the task of the rural green tourism estate is to meet the expectations of consumers, and not to try to anticipate their expectations, which may reach a level that is difficult to fulfill;

6) operations management should divide each service into a series of sequential actions, where each of them contributes to other parts of the process of customer satisfaction;

7) consumers judge quality by the original data. The task of the rural green tourism estate is to identify and eliminate shortcomings as significant obstacles to the provision of quality services;

8) each farmstead of rural green tourism needs to create a system of encouraging the interest of employees in providing quality services on time, as well as personal communication with consumers;

9) appropriate quality of services promotes the emergence of "loyal" consumers in order to ensure contacts and increase the income of rural green tourism estates;

10) the main and most important form of control is to take into account the satisfaction of consumer needs.

Rural green tourism estates should not only guarantee the quality of services and the ability to meet customer requirements, but also reflect the needs of the estate in creating a system of quality that is constantly improving [22, p. 78-85].

However, in Ukraine, compliance with world standards of the tourism industry and high quality in the provision of tourist services is still an acute problem in the field of rural green tourism. This is primarily due to the insufficient level of information support in rural areas.

The main and most accessible element of information support of business entities working in the field of rural green tourism in Ukraine is information technology, among which the Internet plays a major role.

In the world 2/3 of the tourist product offered by rural green tourism is realized through global information systems. Today, the governments of many countries, including the United States, Finland, Britain, Sweden, Germany, fund research in the field of communications [23, p. 191-193]. The potential tourist does not need to spend a lot of time on the selection and booking of a particular tourist product: just enter the parameters, and the computer system itself provides all the necessary information about the tourism service.

According to research by the Institute of Economics and Forecasting of the National Academy of Sciences of Ukraine, there are about 1 million 250 farmsteads (households) in Ukraine that can provide rural

tourism services, while about 2 thousand farmsteads advertise their proposals on the Internet resources [24, p. 113]. At the same time, in Ukraine, as of July 1, 2021, about 15.5 thousand villages are registered, where about 3.5 million Ukrainians live who do not have a high-speed fixed Internet connection. Therefore, there is a number of problems that slow down the process of implementing this technology, namely:

Low level of digital literacy of the rural population. It is believed that the low level of digital literacy of owners of rural green tourism establishments is the main reason for the lack of information about these establishments among tour operators and potential consumers of domestic tourism services.

Low financial capacity of the population. The market cost of connection to fiber-optic networks in rural areas for individuals is 2-3 thousand UAH, and for individuals – business entities and legal entities - an order of magnitude higher.

Excessive level of bureaucracy. Often, telecom operators are unable to build infrastructure due to unclear and formal failures by local governments and landowners where the infrastructure needs to be located.

High cost of renting electric poles.

In order to form a credible own marketing strategy in the global network, which would meet the generally accepted global requirements for tourism entities operating in the rural green tourism sector, it is also necessary to implement the following measures:

a) to study carefully and deeply the competitive behavior of other entities, consumer demand for tourism products, as well as analyze their own tourism resources;

b) to constantly update their knowledge of the existing legal framework in the field of tourism services, using business and legal servers;

c) to create a site for a tourist facility that is developed, promoted and maintained on an ongoing basis;

d) to constantly update advertising materials related to the activities of the tourist facility;

e) to assess the market situation, draw adequate conclusions and make decisions in accordance with the analysis [25, p. 329-335].

The updated website of the Union of Rural Green Tourism of Ukraine (hereinafter - the RGT Union) (https://www.greentour.com.ua/) plays a significant role in information, advertising and communication. There is a program modernized under European requirements for categorization of services "Ukrainian hospitable estate", which lists the benefits that tourists receive while vacationing in categorized homes. Homeowners here use their personal offices to communicate with potential tourists. A special section of the site is addressed to tourists, which provides recommendations for organizing a trip to the countryside and offers activities. The network of information-advisory and agrotourism centers (IAATC), which started its activity in 2015 on the basis of successful rural tourism estates, plays an important role in conducting training events for owners and at the same time informing potential visitors of rural areas [26].

As for the consequences of the COVID-19 pandemic in the field of rural green tourism, Ukraine, on one hand, is in a relatively better situation than most countries, as the share of such tourism product, along with other types of domestic and outbound tourism is much lower than inbound one. On the other hand, Ukrainian rural green tourism enterprises have not received a rapid systemic response and protection from the government in the form of possible measures to support the tourism industry compared to the average response and types of measures implemented by the governments of neighboring countries and EU member states. This has further complicated the situation of small and medium-sized businesses operating in this field [12].

It is worth noting the foreign experience of organizing information interaction of national nature parks with the local population engaged in rural green tourism and production of environmentally friendly products, which is especially relevant for Ukraine and for our study region. Given the high share of private farms in agricultural production, it can be argued that Ukrainian farmers have the potential to grow environmentally friendly products, but with the support of public authorities, national nature parks, or non-governmental financial organizations [20].

Global digitalization is fully penetrating the field of rural green tourism, where it almost completely changes many business processes, ranging from the technology of forming tourism products, including new distribution and promotion systems. One of the most promising digital technologies is blockchain technology.

The use of blockchain technology opens new opportunities for rural green tourism enterprises [27, p. 135-141]. Blockchain technology is a distributed digital database that allows you to do business in trusted and transparent way without the need for centralized management. Blockchain is a fundamentally new method of organizing big data, structuring, recording and storing information in blocks that can be verified. Platforms based on blockchain technology ensure the consistency of data and a high level of security. Blockchain technology has a number of advantages, which include the following:

Distributed agreement – the database is decentralized, which means the absence of centralized blockchain management. This allows you to completely get rid of intermediaries.

Transaction verification is performed using a specified set of rules and must be confirmed by all users.

Uniqueness – all transactions are unique and there are no duplicates.

Invariance – it is impossible to change the records added to the blockchain.

To achieve positive results and gain competitive advantages, rural green tourism enterprises must seek modern high-tech means to attract their customers and adapt their offer to the target audience, and blockchain technology is one way to obtain these competitive advantages [27, p. 135-141].

At the end of 2019, at the initiative of the EBRD and with the participation of external partners, a document "Roadmap for competitive development of tourism in Ukraine" was prepared, which was the result of intensive work of all major stakeholders in the tourism sector in Ukraine. Given the new circumstances of the global pandemic, we believe that it is necessary to make appropriate changes to the proposed Roadmap action plan for 2021 and include immediate measures to respond to the crisis COVID- 19 and maximize the tourism economy of Ukraine. In the current situation and in terms of adaptive quarantine, the following areas are a priority in the information support of rural green tourism:

– creation by public authorities of an official and reliable information portal, where all the necessary data will be posted;

– use of sociological and marketing research to obtain objective statistical information in the field of rural green tourism;

– optimization of tourist statistics;

– creation of high-quality content about rural green tourism facilities and their tourism opportunities with further promotion through modern communication channels in the national and international tourism markets;

– organization of excursion work online among student youth and the population;

– support for rural green tourism through the introduction of travel vouchers and credit lines for this type of tourism products;

– continuous optimization and updating of work instructions for the rural green tourism sector for the pandemic period.

As the global COVID-19 pandemic ends, it is necessary to initiate the implementation of the steps and follow-up actions outlined in the "Roadmap for competitive development of tourism in Ukraine" as recommended, as well as to monitor and adapt to possible irreversible changes in the global tourism caused by this crisis.

Conclusions and prospects for further research. Modern tourism is an extremely information-intensive field of activity, in which the accumulation, exchange, processing, transmission and use of quality information ensure the daily smooth functioning of the tourism industry. Ukraine has all the prerequisites for the intensive development of rural green tourism, but there are a number of factors that hinder the effective development of this type of activity. An important role for the development of tourism is played by the information support of rural green tourism facilities.

It is due to the effective use of information support and increasing the level of use of information technology that high competitiveness of rural green tourism as a highly profitable sector of the economy is possible. Therefore, the current stage of informatization of rural green tourism as a sector of the economy is characterized by a tendency to increase information flows and the introduction into practice of such modern information tools and technologies that radically change information processes. Over time, the informatization of rural green tourism facilities will provide consumers with free access to the full range of necessary information about the relevant tourism product, as well as provide the relevant government agencies with the necessary control over compliance with legislation in this area of tourism.

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Інформаційне забезпечення розвитку підприємств сільського зеленого туризму в Україні в умовах пандемії COVID-19

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Анотація. Розглянуто сучасний стан та визначено специфіку розвитку підприємств сільського зеленого туризму в Україні та закордоном. Встановлено проблеми практичного застосування інформаційного забезпечення суб'єктами господарювання, що працюють у цій сфері туризму. Обґрунтовано сутність та необхідність масштабного інформаційного забезпечення галузі сільського зеленого туризму та досліджено його особливості. Здійснено аналіз інформаційних технологій, що застосовуються сьогодні у площині інформаційного забезпечення сфери сільського зеленого туризму. Встановлено вплив світової пандемії COVID-19 на розвиток туристичної галузі в Україні. Визначено заходи з продовження інформаційного забезпечення у сфері сільського зеленого туризму в умовах адаптивного карантину. Узагальнено пропозиції щодо покращення рівня інформаційного забезпечення галузі сільського зеленого туризму.

Ключові слова: сільський зелений туризм, підприємства, розвиток сільських територій, інформаційне забезпечення, інформаційні технології, регіон, інформаційна підтримка

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Application of financial technologies in the banking system of Ukraine

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Abstract. The financial sector contributes to the growth of the population's well-being, stimulates business development, and helps to expand the markets for goods and services. With the passage of time, financial technologies are becoming more and more important, because after the global financial crisis, banking institutions were forced to adapt to new challenges. With the advent of the latest technologies, banks had to focus on the efficient provision of financial services, taking into account financial inclusion. In order to help consumers of financial services manage the financial aspects of business, while using new programs, financial technologies are used. They are a necessary mechanism for the formation of competitiveness of any company and any state. However, there is a problem of low involvement of the population in the financial sector, as not every individual has access to quality financial services and the necessary experience to use them in everyday life. Thus, the purpose of the article is research and analysis of the application of financial technologies in the banking system of Ukraine. The article examines the essence of financial technologies and their role in the development of the financial sphere of Ukraine. The question of the emergence of financial technologies is highlighted. It was considered how and with the help of which financial technologies the work of banking institutions is carried out during the COVID-19 pandemic. In order to determine the strengths and weaknesses, opportunities and threats, a SWOT analysis of the use of online technologies by banking institutions of Ukraine during the COVID-19 pandemic was conducted. It was found that there was an increase in demand among the fintech population, especially during the COVID-19 pandemic

Keywords: financial technologies, banking system, pandemic, startup, banking institutions, financial inclusion

INTRODUCTION

The financial sector stimulates the growth of the population's well-being, promotes business development, and helps expand the markets for goods and services. The role of financial technologies is becoming increasingly important, because after the global financial crisis (2008), banking institutions were forced to adapt to new challenges. With the advent of new technologies, banks had to refocus on the efficiency of providing financial services, taking into account financial inclusion. The above led to the emergence of the concept of "financial inclusiveness" or "inclusion", that is, the availability of financial services for retail consumers. Fintech is being used to help financial services consumers manage the financial aspects of business using new applications. They are an important tool for shaping the competitiveness of any company and any country. However, it is worth noting that there is a problem of low involvement of the population in the financial sector – not everyone has access to quality financial services and sufficient knowledge and experience to use them in everyday life. In order to activate the population's interest in using financial services, it is necessary, in our

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opinion, to create the following opportunities: accessibility, quality, safety, comprehensibility, simplicity. Such scientists as: S. Volosovich [1], L. Dudynets [2], T. Kalashnikova [3], G. Pochenchuk [4] A. Semenog [5], M. Tarasyuk [6], D Filipov, etc.

P. Shufel understands financial technology as a new financial industry that uses technology to improve financial activity [7]. Group of authors, A.Yu. Semenog, Y.M. Kryvych, S.V. Cirulyk [5], financial technologies are considered as services provided by technology companies with the help of special software and focused on the financial needs of customers. M.V. Tarasyuk, O.O. Koscheev [6] and L.A. Dudynets [2] understand the technologies used in the financial industry by financial technologies.

Noting the significant results of the scientific achievements of both foreign and Ukrainian authors, it is worth noting that the application of financial technologies specifically in the banking system of Ukraine requires further study and analysis, because the financial services market is actively developing, creating new innovative services and products. *The purpose of the article* is research and analysis of the application of financial technologies in the banking system of Ukraine.

THE ESSENCE OF FINANCIAL TECHNOLOGIES AND THEIR ROLE IN THE DEVELOPMENT OF THE FINANCIAL SPHERE OF UKRAINE

The industrial age of monopolies has already been replaced by the digital one. And this implies the flourishing of platform companies, which, having a relatively small number of full-time employees, generate no less capitalization compared to monopolies [8]. Thus, the market capitalization of one of the world's largest financial companies, Ant Financial, which was founded in China in 2015 and has 101,958 thousand employees, was (in 2019) $60 billion. USA, and the most expensive bank in the world, JPMorgan Chase (founded in 1799, where 235 thousand people work) – 245 billion dollars. USA [2]. Indicators of added value per employee in these companies differ significantly (12 million US dollars and 1 million US dollars, respectively) [8]. As of August 1, 2018, there were already 33 fintech companies with a billion-dollar capitalization (so-called unicorns) in the world [9].

Directions and features of the development of financial technologies:

– development of the global Internet network;

– development and popularity of smartphones and various applications;

– rapid growth and spread of social networks;

– creation of new innovative products and services of the "Big Five" technology companies, which contributes to the formation of new standards of quality, speed and convenience for consumers (Amazon, Facebook, Google, Apple, Microsoft,

– significant increase in migration processes, which led to money transfers;

– search for sources of financing for small and medium-sized businesses;

– alternative types of payments;

– marketplaces;

– artificial intelligence;

– digital identification and biometrics, etc.

Table 1. Prerequisites for the development of financial technologies in different countries of the world

Directions	Characteristics
Infrastructure	Technological readiness of the market: – mobile coverage and Internet access; – fintech solutions (active use of payment terminals, electronic money, expanding access to finance)
Favorable legal and regulatory environment	Simple and transparent rules for setting up a business, proper taxation rules, licensing requirements and protecting the rights of investors and businesses is key
Access to capital and investment	Countries – Singapore, Great Britain, China and India actively support investments in financial technology initiatives, which allows for rapid scale-up of projects
Expertise	Availability of qualified employees in various consulting areas, which helps to create appropriate incubators and initiatives with accelerators

Source: *built by the authors based on data [10-12]*

The development of financial technologies in European countries deserves attention. In particular, in Great Britain thanks to the creation of such initiatives as the FinTech Delivery Panel and the FinTech Steering Group, which bring together banks, fintech companies and government institutions to discuss and develop development programs financial technology market [10]. The cooperation of various institutions of the financial services market is implemented thanks to the functioning of the so-called Fintech Bridges,

which allow the effective exchange of information about innovations and new trends in the financial services market both within Great Britain and with other countries [10].

Unlike Great Britain, there are no special conditions for fintech business regulation in France [11]. Fintech companies that carry out banking operations undergo standard procedures for registration and obtaining a license [11]. However, the approach of French regulators consists of personalized assistance to fintech companies in providing comprehensive support [11]. In general, for the development of the financial technology market in the EU countries, an action plan was presented back in 2018 regarding the introduction of special rules of regulation, supervision and control that are more flexible than for other companies [11]. This plan is to be implemented by the European FinTech Lab (EU FinTech Lab) [11].The experience of India, whose fintech sphere is regulated by such institutions as the Reserve Bank of India (RBI), the Securities and Exchange Board of India (SEBI), the Telecom Regulatory Authority of India (TRAI), the Insurance Regulatory and Development Authority (IRDA), is also undoubtedly interesting, National Payment Corporation [12]. Also in India, a fintech sandbox mechanism has been introduced for financial startups, which for a certain period of time benefit from preferential regulatory requirements and state support for financial experiments [13].

In Ukraine, as in other countries of the world, there is a practice of subordinating fintech companies to general laws and regulations that regulate activities on the financial services market. Since most fintech solutions are aimed at providing payment services and money transfers (Table 2).

Table 2. Main legislative acts on the provision of payment services and money transfers in Ukraine

Name of the Law of Ukraine	Characteristics of the main provisions
About banks and banking activities from July 3, 2020.	regulates the structure of the banking system, economic, organizational and legal principles of creation, activity, reorganization and liquidation of banks
About payment systems and money transfers in Ukraine from July 3, 2020.	regulates the general principles of the functioning of payment systems and settlement systems in Ukraine, the concept and general procedure for transferring funds within Ukraine, establishes the responsibility of transfer subjects, and also determines the general procedure for supervision (oversite) of payment systems
About currency and currency transactions from April 28, 2020.	regulates the legal basis of currency transactions, currency regulation and currency supervision, the rights and obligations of subjects of currency transactions and authorized institutions and establishes responsibility for their violation of currency legislation
About electronic trust services from February 13, 2020.	regulates the legal and organizational principles of providing electronic trust services, including cross-border ones, the rights and obligations of subjects of legal relations in the field of electronic trust services, the procedure for state supervision (control) of compliance with the requirements of legislation in the field of electronic trust services, as well as legal and organizational principles of electronic identification
On financial services and state regulation of financial services markets dated October 4, 2020.	regulates the general legal principles in the field of providing financial services, the implementation of regulatory and supervisory functions for the provision of financial services

Source: *built by the authors based on data [14-18]*

It is worth noting that the legal and regulatory environment has been improving in recent years to support fintech and other startups. Among the important changes that took place in Ukrainian legislation:

1. permission to sign invoices and agreements with an electronic signature;
2. intensive use of documents in English;
3. simplified taxation system for IT companies (5% per year);
4. gradual lifting of restrictions on repatriation of dividends;
5. gradual adoption of European Union directives (PSD2);
6. introduction of identification and trust services for electronic transactions in the domestic market of Ukraine.

The desire of consumers to experiment with digital services has become the reason for the emergence and growth of new fintech companies. In Ukraine, this direction is actively developing, more than 100 companies operate on the market of financial services.

It is worth noting that in Ukraine the BankID system has been implemented and supported by the National Bank of Ukraine, which provides access to a number of banking and administrative services on the Internet through the identification of the client through

his password and login from online banking. In general, this contributes to the emergence of various digital financial products, online platforms for the provision of financial and administrative services, trading on the securities market. The specified system will allow a consumer who has passed the KYC procedure of one bank and received a national BankID to use it to open accounts in any other bank. Financial technologies involve attracting to the financial sector those people who have not yet used online services and were outside the banking system, as well as providing quality services to their regular users who receive an insufficient amount of financial services.

The incomplete filling of the niche of the financial sector in Ukraine, in our opinion, is also explained by the presence of certain obstacles to the banks' service to residents of remote settlements and small businesses (due to low financial literacy or public conviction).

At the beginning of 2017, fintech as one of the priority areas in the world was formed in the Comprehensive Program for the Development of the Financial Sector of Ukraine until 2020 [19].

While researching the fintech market in Ukraine, more than a hundred of its participants were interviewed and the following priority areas of application were identified:

– payments (69% of respondents);
– non-banks (63%);
– P2P lending (56%) [19].
– It should be noted that the most significant technological trends today include:
– machine learning (can provide assistance in optimizing production and business processes);
– artificial intelligence (understands questions formulated in natural language and finds answers to them in the database, recognizes faces in photographs);
– digital assistants; context trading [8].

Fintech aims to protect the rights of consumers of financial services regarding the disclosure of information about them (in transactions, advertising, etc.) (Fig. 1).

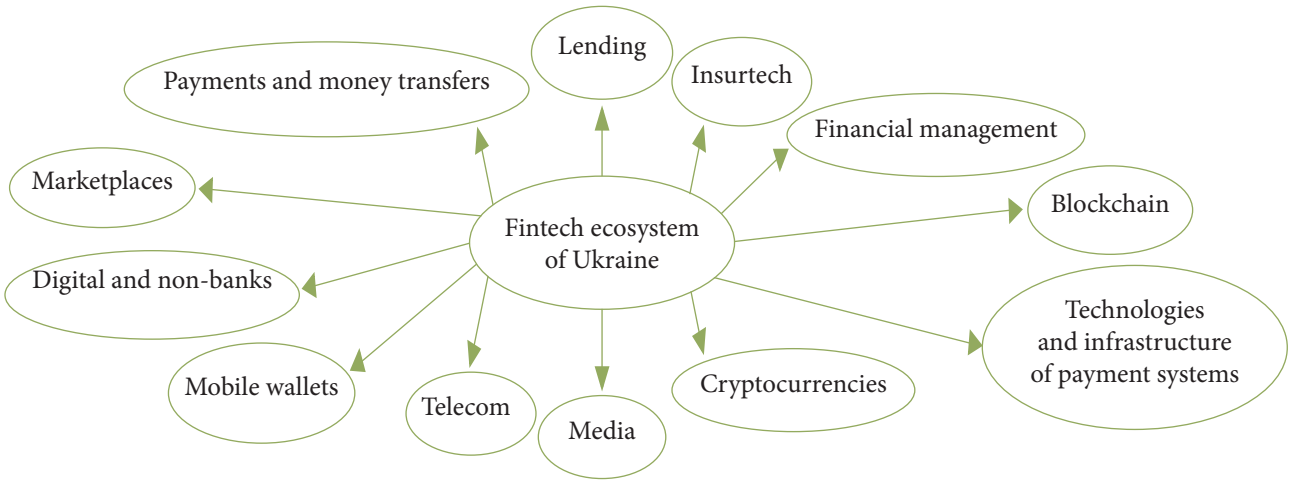

Figure 1. *Components of fintech ecosystem of Ukraine*
Source: *generated by the authors based on data [8]*

Thanks to financial technologies, global financial services in the field of micro-credit, micro-savings and micro-insurance will become useful for the population and help overcome poverty in all countries of the world [8].

In addition, we believe that fintech is capable of increasing the country's GDP and the standard of living of its population. It should be noted that even in 2017, specialized startups attracted 16.6 billion dollars in financial technologies. USA, while 1128 agreements were concluded [20].

We believe that the transformation of the financial sector of Ukraine into a transparent, fair and diversified system that supports enterprises of all sizes and serves the needs of citizens will lead to:

– increasing confidence in the banking system;
– expansion of access to finance in the non-banking financial sector;
– expansion of the use of electronic finance, activation of information and educational work with vulnerable population groups, etc. [20].

At the end of 2019, there were more than 100 active fintech companies in Ukraine, and most of them were founded within the last three years. 63% of fintech companies operate with their own funds, and the same number have broken even. The activation and strengthening of the development of the fintech sector is observed, so about 20 new companies will appear on the market in the near future. The rapid growth of the number of startups and the parallel development of the ecosystem will contribute to the increase of interest on the part of investors, as well as to the growth of the number of incubators and accelerators [20]. A vivid example of a domestic fintech company is JSC CB "PrivatBank".

The directions of Ukrainian fintech providers are shown in fig. 2.

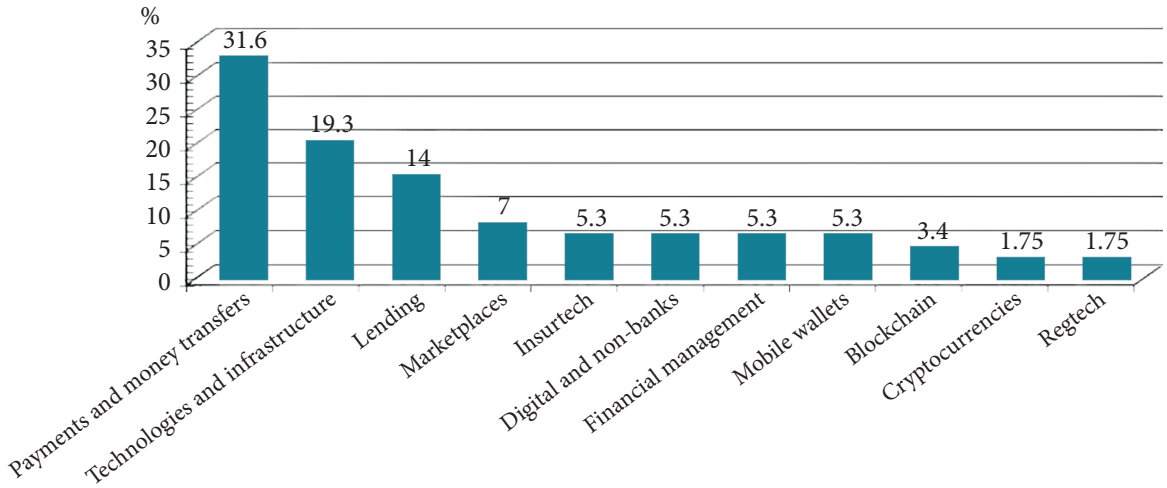

***Figure 2**. Main types of services of Ukrainian fintech providers*
***Source**: generated by the authors based on data [20]*

Payments and remittances occupy about a third of the areas of Ukrainian fintech providers (31.6%), technology and infrastructure occupy the second place (19.3%), lending takes the third place, and marketplaces take the fourth place. Among other directions, it should be noted: other tech, digital and neobanks, financial management, mobile wallets – 5.3% each, respectively. Blockchain (3.45%), cryptocurrencies and regtech (1.75%, respectively) occupy a small specific weight.

A large number of Ukrainian financial companies are targeting the common European market. Recently, there has been an active export of intellectual resources to other countries. This, in turn, forms the infrastructure necessary for the development of a startup environment with the use of accelerators and incubators.

As for the geographical location, more than 80% of Ukrainian fintech companies are located in Kyiv. Other base cities are Dnipro, Odesa, Kharkiv, Rivne and Lviv. This concentration is explained by the fact that the headquarters of large banks are located in the capital, and in general, Kyiv is the center of business life. But the presence of advanced IT infrastructure in the regions will enable fintech to develop more actively in regional centers, especially in those where the main offices of banks are located. It is worth noting that the geographical location and distribution of Ukrainian fintech companies differs significantly from data on the IT market in general. According to the report on the development of the Ukrainian IT industry, only slightly more than 50% of IT companies are registered in Kyiv. About 25% of startups have up to 10 employees, another 25% – from 11 to 25. Only 27% of companies have more than 50 employees. This distribution by the number of employees in Ukraine coincides with the global one, because according to Venture Scanner, 35% of fintech companies in the world have up to 10 employees, and 73% – up to 50. In total, fintech companies in Ukraine employ more than 4,000 people [20].

Funding problems and income - one of the main issues for startups is to find financing in the early stages of development. Up to 80% of startups in the world are financed with their own funds, as well as with the funds of friends and relatives (the so-called friends & family category). In Ukraine, about 70% of fintech companies work without attracting money from third-party investors, of which 61% rely exclusively on their own funds, another 9% – attract money from friends and relatives. 30% use external investments, mainly private investors and angel investments (Fig. 3) [20].

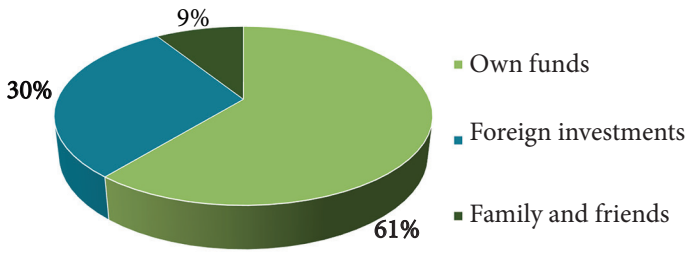

***Figure 3**. Specific weight of funding sources in the structure of fintech companies of Ukraine*
***Source**: generated by the authors based on data [20]*

The spread of COVID-19 has forced fintech companies to innovate more intensively. The COVID-19 pandemic has forced most banking institutions to start their work online, which has become more convenient for many service users. A massive improvement and update of websites and mobile applications has begun (Table 3).

Table 3. Online services of banking institutions of Ukraine

Name of banking institutions	Online services
JSC CB "PrivatBank"	Deposit operations without visiting bank branches. The ability to add the necessary services to the «basket» of the site, and then make payment.
JSC "OTP-Bank"	Monitoring of operations and sent documents for legal entities. In order to provide individuals with information about the functionality of the Internet banking system in an interactive mode on the Internet, a system user guide was developed.
JSC "Alfa-Bank"	The possibility of confirming operations using one-time passwords via SMS. Conducting transactions without entering details. Analytics of operations with your partners.
PJSC "PUMB"	The opportunity for its depositors to use the deposit constructor, with which you can independently choose the amount of the deposit, the term, the method of paying interest, the possibility of withdrawing and replenishing funds.

Source: *built by the authors based on data [10-12]*

For example, JSC "OschadBank" has created an additional application u-Take, which is designed for quick purchases in stores and restaurants without queues. Internet banking is used by over 200,000 clients of OTP Bank. Other banking institutions expanded the functionality of their online service in 2019 and are still improving it. JSC CB "PrivatBank" is the leader in providing online customer service. It won the 2019 PSM Awards with 47.7 percent of the vote [23]. It was found out that during the quarantine JSC KB "PrivatBank", like most banking institutions, started working online. A significant contribution in this regard was made by the mobile application Privat24, which can be used by institutions during the COVID-19 pandemic, has both strengths and threats, corresponding to maximum amounts of 4.3 and 4.2. a large package of bank services without leaving home. The application's capabilities include: payment by details, making a payment, paying for utilities, transfers from card to card, paying credit payments, changing the credit limit, issuing insurance, receiving receipts, currency exchange, paying for parking spaces, etc. Currently, it has more than 11 million users.

To determine the strengths and weaknesses, opportunities and threats, we conducted a SWOT analysis of the use of online technologies by banking institutions of Ukraine during the COVID-19 pandemic (Table 4).

Table 4. SWOT analysis of the use of online technologies by banking institutions of Ukraine during the COVID-19 pandemic

S (Strengths)	Wf (weight factor)	S (score)	Wf*S (multiplication)
1. Increasing the number of non-cash transactions in banking institutions of Ukraine	0.3	5	1.5
2. Increasing the volume of the electronic money market in the country	0.1	4	0.4
3. Convenience in carrying out operations for the population of the country.	0.3	4	1.2
4. Reduction of physical contacts among people during quarantine	0.3	4	1.2
Total:	**1**		**4.3**
O (opportunities)	Wf (weight factor)	S (score)	Wf*S (multiplication)
1. Digitization of the banking system	0.5	4	2.0
2. Speed of bank transactions	0.2	5	1.0
3. Development of joint projects with central banks of other countries	0.1	2	0.2
4. Expanding the scope of online operations	0.2	4	0.8
Total:	**1**		**4**

Table 4, Continued

S (Strengths)	Wf (weight factor)	S (score)	Wf*S (multiplication)
W (weaknesses)	Wf (weight factor)	S (score)	Wf*S (multiplication)
1. A decrease in the profitability of banking institutions due to a decrease in the interest rate	0.3	4	1.2
2. Fall in demand for loans due to a decrease in the solvency of the population	0.3	4	1.2
3. Decreasing the quality of conducting inspection checks in a remote format	0.2	3	0.6
4. Low quality or lack of internet connection in remote areas for banking operations	0.2	5	1.0
Total:	**1**		**4.0**
T (threats)	Wf (weight factor)	S (score)	Wf*S (multiplication)
1. An increase in cyber-attacks on the online accounts of clients, which increases the risk of loss of money by clients of banking institutions	0.3	5	.5
2. The presence of errors during operations due to insufficient financial literacy of the population	0.3	3	0.9
3. Reduction of cyber security of the banking system	0.3	5	1.5
4. Inability to solve some issues online	0.1	3	0.3
Total:	**1**		**4.2**

The strengths of the use of online technologies are: an increase in the number of non-cash transactions in banking institutions of Ukraine, an increase in the volume of the electronic money market in the country, convenience in carrying out transactions for the population, a decrease in physical contacts among people during quarantine.

With the development of innovative processes, the need to protect banking institutions from possible cyber attacks also increases. Threats also include: errors in transactions due to insufficient financial literacy of the population and the inability to resolve some issues online.

Digitization of the banking system makes it possible to provide financial services in simpler and more accessible formats. When using online technologies by domestic banking institutions during the epidemic, the impact of the weaknesses identified by us should be eliminated: a decrease in the profitability of banking institutions due to a decrease in the interest rate; a drop in demand for loans due to a decrease in the solvency of the population; decrease in the quality of conducting inspection checks in a remote format; low quality or lack of internet connection in remote areas for banking transactions.

CONCLUSIONS

One of the determining factors in the development of the modern financial system is the purposeful introduction of financial technologies. Fintech is technology used in financial services to help companies manage the financial aspects of their business using new applications. It is worth noting that there was an increase in demand among the population of financial technologies, especially during the period of the COVID-19 pandemic, because due to the spread of quarantine measures, almost all institutions stopped their activities and as a result there was a decrease in the level of profitability. To get out of such a difficult situation, mobile applications began to be created and used, which made it much easier to use the services of banking institutions during the pandemic. But financial companies should focus their attention on making the use of new financial technologies convenient, high-quality, accessible, understandable and safe for every consumer of financial services.

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Застосування фінансових технологій у банківській системі України

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Анотація. Фінансовий сектор сприяє зростанню добробуту населення, стимулює розвиток бізнесу, допомагає розширювати ринки товарів і послуг. З плином часу фінансові технології набувають все вагомішого значення, оскільки після світової фінансової кризи банківські установи були вимушені прилаштуватись до нових викликів. З появою новітніх технологій банки повинні були спрямовуватись на ефективне надання фінансових послуг із врахуванням фінансової інклюзивності. З метою допомоги споживачам фінансових послуг керувати фінансовими аспектами бізнесу, при цьому використовувати нові програми, застосовуються фінансові технології. Вони є необхідним механізмом утворення конкурентоспроможності будь-якої компанії і будь-якої держави. Однак існує проблема низького залучення населення до фінансового сектору, так як не кожен індивід має доступ до якісних фінансових послуг і необхідний досвід для їх використання в щоденному житті. Таким чином, метою статті є дослідження та аналіз застосування фінансових технологій у банківській системі України. У статті досліджено сутність фінансових технологій та їх роль у розвитку фінансової сфери України. Висвітлено питання виникнення фінансових технологій. Розглянуто, яким чином та за допомогою яких саме фінансових технологій здійснюється робота банківських установ у період пандемії COVID-19. Для визначення сильних і слабких сторін, можливостей і загроз проведено SWOT-аналіз застосування онлайн- технологій банківськими установами України під час пандемії COVID-19. З'ясовано, що відбулося збільшення попиту серед населення фінтех-технологій, особливо в період пандемії COVID-19

Ключові слова: фінансові технології, банківська система, пандемія, стартап, банківські установи, фінансова інклюзивність

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Transformation of the tax system of Ukraine in order to promote the development of agricultural production

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Abstract. The agricultural sphere in Ukraine is one of the main spheres of activity and belongs to the priority components of the country's national security. However, at the current stage of development, this area operates with significant inconsistencies, and the products produced are not always competitive in foreign markets due to non-compliance with the quality standards of foreign countries. It is possible to improve the state of affairs in the direction of intensification of agricultural activity with the help of stimulating levers of the tax system. Because the high tax burden, which the multiplicity of taxes provides to business entities, reduces the amount of their financial resources, which could potentially be used to update production capacities, improve production technologies, and increase the level of its innovation, etc. In addition, indirect taxes, in particular value added tax (VAT), significantly increase the cost of manufactured products and reduce their competitiveness in domestic markets. Thus, the purpose of the article is to analyze the situation in agricultural production and determine the factors of its desired transformation in the sphere of functioning of the tax system in order to stimulate the promotion of the development of this industry. Therefore, it is necessary to find out the main indicators of the economic, social and fiscal efficiency of the functioning of enterprises in the agrarian sphere and to indicate potentially relevant directions of development of the studied industry from the point of view of the transformation of the tax system. The article examines the current state of functioning of agricultural production in Ukraine from the point of view of economic, social and fiscal efficiency. Current trends in the transformation of the tax system in the conditions of the transitional economy of Ukraine are presented, which in the near future and in the long term encourage the industry to qualitatively new development

Keywords: agricultural production, economic efficiency, social efficiency, fiscal efficiency, rural population, single tax, fixed agricultural tax

INTRODUCTION

Agricultural production in Ukraine is one of the basic spheres of activity and belongs to the key components of the country's national security. However, at the current stage of development, this industry operates with significant imbalances, and the products produced are not always competitive on foreign markets due to non-compliance with the quality standards of foreign countries. It is possible to move the state of affairs in the direction of intensification of agricultural activity with the help of stimulating levers of the tax system. After all, it is the high tax burden that creates a multiplicity of taxes on business entities, which reduces the amount of their financial resources, which could potentially be involved in updating production capacities, improving production technologies and increasing the level of its innovation, etc. Separately, it should be noted that indirect taxes, such as value added tax (VAT), significantly increase the cost of manufactured products and reduce the level of their competitiveness in domestic markets.

Taking into account the priority of the agricultural sector for the security functions of Ukraine, as well as from the standpoint of the need to bring the conditions of its functioning to favorable for increasing ecological, economic, competitive and export potentials, scientists and practitioners direct their views on the optimization of the tax system of the state in the mentioned field of activity.

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In particular, V. Sinchak, analyzing the conditions of taxation in agriculture, emphasizes the need to use simplified and alternative taxation systems that will be "... calculated for different groups of subjects...", which, in turn, "... will have the opportunity to choose for calculations with the state most understandable for them, which, at the same time, would not restrain the development of their production and meet other important criteria necessary for the taxation system in general..." [1]. Currently, the changes to the tax system proposed by scientists are partially reflected in the current tax system: agricultural producers can use taxation according to the single tax system (group 4 of taxpayers).

Supporting the previous opinion, I. Volokhova notes the rates of the single tax for the 4th group of payers and the high tax burden created for agricultural producers as a result. Among the promising options for improving the taxation of agricultural production, the author mentions "that special taxation regimes should take into account types of agricultural production that differ in terms of profitability; stimulation of the development of high-tech industries; preferential implementation of special taxation regimes for village-forming enterprises – producers of agricultural products; ensuring the stability and convenience of paying taxes on producers of agricultural products; introduction of payment by taxpayers of a single tax of 4 groups of resource payments (land tax, rent for special water use)" [2]. In part, the above proposals can be considered rational, but the focus of alternative taxation on rural enterprises is a return to significant relaxations of large agricultural producers with the leveling of the role and prospects of small and medium-sized enterprises, and the obligation to pay taxpayers of 4 groups of resource payments destroys the very essence of the preferential taxation system, to which belongs to a single tax applies.

The differentiated approach of taxation of different agricultural producers and types of enterprises is also emphasized by L. Tulush, who at the same time emphasizes the need for "the action of tax regulators on the rational use and protection of agricultural land. The state should be able to regulate the economic turnover of agricultural land with the help of tax levers" [3]. This proposal is completely rational and takes into account the peculiarities and specifics not only of agricultural production, but also of relations between the state and economic formations of this sphere of activity.

The team of authors consisting of N. Novak, S. Koval and O. Krukovska, as a result of studying the peculiarities of taxation of agricultural enterprises in Ukraine and in foreign countries, also came to the conclusion that "... Taxation of agricultural activity should be differentiated. It should be carried out depending on the priorities of the development of types of agricultural activity, the scale of production, taking into account the pace of transition to ecological and organic production and the efficiency of the use of biological resources, factors affecting the price of products" [4]. The mentioned proposal is relevant in the conditions of modern imbalances in the development of agricultural production, however, the direct mechanism for implementing such an approach remains unclear.

The American Farm Bureau Federation (AFBF) emphasizes the need to adjust the taxation of the agrarian sphere of activity, which in 2017 achieved the adoption of a law on reducing taxation, motivating its necessity by the conditions of uncertainty in which agricultural producers work [5]. Similar are the operating conditions of Ukrainian agricultural producers, and therefore they also need to revise the tax system in order to ease the tax pressure on them.

The need to change the tax system for agricultural producers is also caused by the presence of double taxation of their activities and the stimulation of price growth for agricultural products due to high tax rates.

In the transformational conditions of Ukraine's economy, in the crisis situation caused by the COVID-19 coronavirus pandemic, the relevance of approaches to the implementation of agricultural activities is being reassessed. Therefore, the purpose of the article is to analyze the situation with the state of affairs in agricultural production and to determine the criteria for its desired transformation in the sphere of action of the tax system in order to stimulate the development of this industry. To do this, it is necessary to find out the main indicators of the economic, social and fiscal efficiency of the functioning of enterprises in the agrarian sphere and to indicate the potentially relevant directions of development of the studied industry from the point of view of the transformation of the tax system.

THE FUNCTIONING OF THE AGRARIAN SPHERE FROM THE POINT OF VIEW OF ECONOMIC, FISCAL AND SOCIAL EFFICIENCY

The conditions of modern management require from the participants of market relations not a purely formal approach to activity, but an economically weighted and even creative one. It is implied that the manufacturer must take care of the performance indicators of his own activity, and the products produced by him, in order to attract the buyer, must be better than those presented by competitors on the market. At the same time, on the scale of the state, all agricultural production, as a separate industry, must demonstrate indicators of the appropriate level of efficiency in terms of three components: social, economic and fiscal.

From this position, the most expected for manufacturers is economic efficiency. It is she who signals the success of the activity over a certain period of time. For economic entities, the indicators of such results are the financial result before taxation, net profit (loss), the level of profitability of all activities and the operating room in particular (Fig. 1).

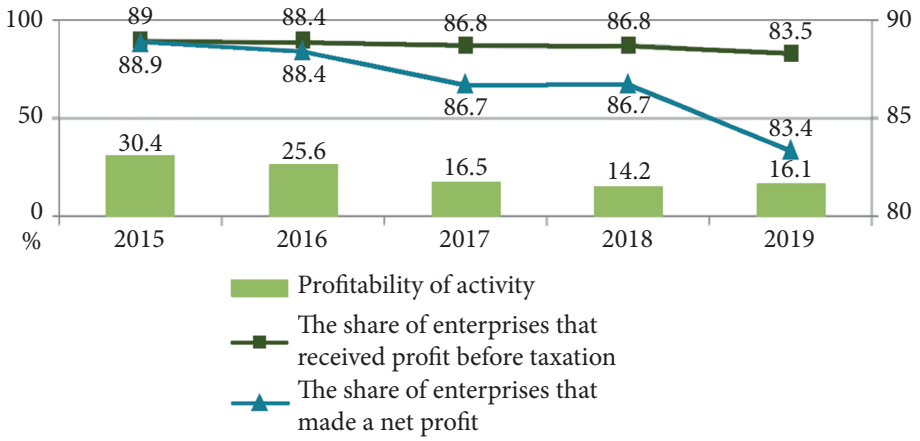

***Figure 1**. Dynamics of the main indicators of the economic efficiency of agricultural enterprises of Ukraine for 2015-2019*

***Source**: [6]*

Shown in fig. 1 data show a decrease in the profitability of agricultural enterprises for 2015-2019 by 14.3 percentage points. Separately by 5.5 percentage points the share of enterprises that operated with profit before and after taxation decreased. At the same time, it should be noted the corresponding increase in the specific weight of business entities that suffered a loss. The reason for the declining indicators is not only the unstable political and economic conditions in the country, but also the level of profitability of agricultural products in the fields of plant and animal husbandry (Fig. 2).

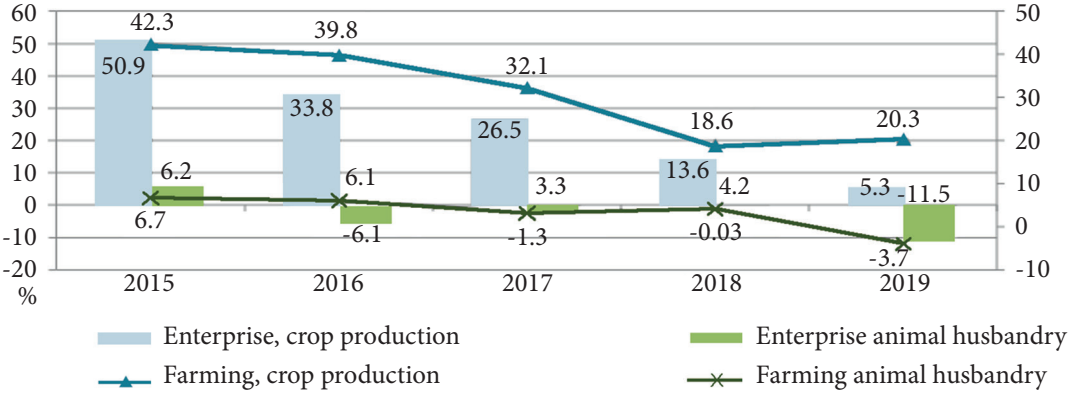

***Figure 2**. The level of profitability of crop and livestock products in agricultural enterprises and farms of Ukraine in 2015-2019*

***Source**: [6]*

First of all, it should be noted that crop production produced by agricultural enterprises and farms of Ukraine is characterized by a higher level of profitability than livestock production. At the same time, a decline was noted in both branches for 2015-2019: in crop production, the average level of profitability of products by enterprises decreased by 45.6% (in farms - by 22.0%), and in animal breeding – by 17.7% (in farms – by 10.4%). The lowest level of profitability in 2019 was noted for sugar beet – 15.4% for enterprises – 4.8% for farms, as well as for sheep and goats for meat: –39.7% for enterprises and 32.5% – farms.

According to the results of 2019, the most successful crop production by enterprises was the production of technical crops, in particular sunflower, with a profitability level of 23.5%, and by farms – potatoes (profitability of 50.3%); from animal husbandry, the highest level of profitability – 20.6% for enterprises and 20.1% for farms – was recorded for milk. At the same time, the average level of profitability in crop production in Ukraine in 2019 was 20.3%, and in livestock production – 3.7% [6]. The available results clearly demonstrated the advantages of crop production over animal production, which certainly provoked intra-industry imbalances in development.It should be noted separately that the efficiency of the agrarian sphere of activity in terms of production of agricultural products from 2015 to 2019 underwent negative changes. The reason for this was the high level of the cost price of agricultural products, primarily the expenses that form it (Fig. 3).

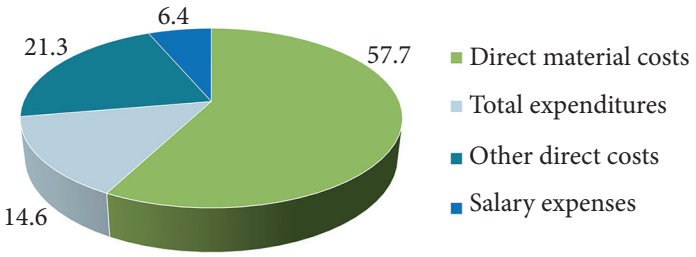

***Figure 3**. The structure of the production cost of agricultural products in Ukraine in 2019, %*

***Source**: [6]*

In 2019, as in previous years, the lion's share in the cost structure of the production cost is occupied by direct material costs, which include seeds, planting material and fodder (including purchased ones) – 19.7%, mineral fertilizers – 15 %, fuel and lubricants – 8.7%, fuel, energy and electricity – 1.6%. That is, the high cost of these components increases the cost of agricultural products and the costs of enterprises, which, accordingly, reduce the level of their incomes and profits. Separately, the level of investment attractiveness of the industry can be attributed to the consequent indicators of the economic efficiency of the functioning of the agrarian sector of the economy. However, even from this position, contradictory trends are noted: despite the fact that the level of capital investments involved in agriculture, forestry and fisheries in absolute terms increased from UAH 30.5 billion recorded in 2015 to UAH 59.1 billion in 2019, in the total amount of capital investments in the state in relative terms, it decreased from 11.0% (2015) to 9.4% [6]. In addition, one of the basic conditions of negative changes in the investment of agrarian activity was the high level of taxation, the lack of benefits for investors and the lack of transparency of the tax system. The next component of the effectiveness of the functioning of the agrarian sphere is social effectiveness. Focusing on this indicator, one should mention such indicators as the average monthly wage by industry, the number of people employed in agricultural production, the level of income and expenditure of the rural population, indicators of deprivation, etc.

Material deprivation, which proves the inability of the population to meet basic needs, can be considered as a general and quite transparent result of the state's social policy. And in Ukraine, this indicator is much higher than in European countries (Fig. 4).

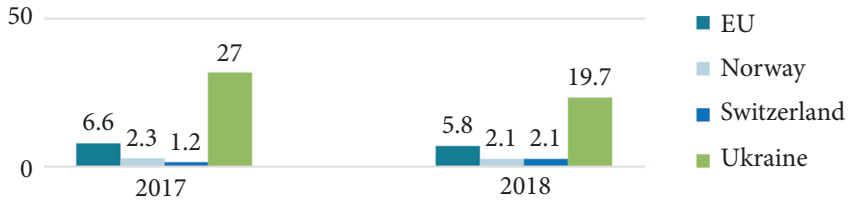

***Figure 4**. The share of the population with 4 or more signs of deprivation in the countries of the European space and in Ukraine in 2017-2018, %*

***Source**: [7]*

Data on material deprivation show that in Ukraine, as in most of the above countries, the situation has improved as of the end of 2018, but it still remains unsatisfactory in comparison with European countries. Based on the above data, we have, firstly, a high dependence of the well-being and solvency of the rural population on the level of wages, and secondly, significant amounts of hidden income, in the case of the rural population, from the management of personal peasant farms, which in most cases remain outside the scope of the tax system. In general, it should be noted that in Ukraine during 2015-2019, the number of employed population increased from 16.4 million people to 16.6 million people, of which 17.5% were employed in the agricultural sector in 2015, and in 2019 – 18.2%. That is, the social role of agrarian goods production as an industry that provides employment to the population has strengthened in a certain way. At the same time, the number of employees working in the agricultural sector decreased by 0.9% during the studied period – from 9.6% in 2015 to 8.7% in 2019 [7].

In part, this can be explained by the increase in the volume of labor migration of the population, as well as the increase in the number of personal peasant farms that operate either without hired persons or informally. At the same time, it should be emphasized the decrease in the number of agricultural economic entities for the period 2015-2019 by 3,834 units, including a 0.4% decrease in both the number of enterprises (-3,495 units) and the number of individual entrepreneurs, which worked in this field (-7329 units) [8].

The intensification of production at large enterprises and the rather low level of wages also became the impetus for the reduction of the number of hired workers and those employed in the agrarian sphere of production (Fig. 5).

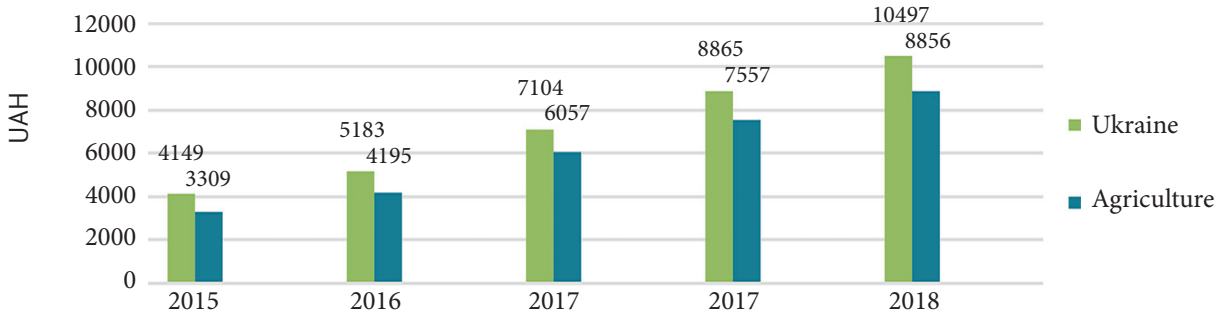

***Figure 5**. Average monthly nominal wages in Ukraine and in agriculture in 2015-2019*

***Source**: [6]*

The average monthly nominal wage in agriculture during the studied period was on average 17% lower than the national rate. And in this case, it is worth mentioning the seasonality of agricultural production, when a fairly common practice among farmers, especially in crop production, is to register workers and pay them wages only in certain periods that are active in terms of production technologies. Therefore, according to experts' estimates, the shadow sector in the agrarian sphere now amounts to 30 to 40% [9].

TRANSFORMATIONS OF THE TAX SYSTEM IN THE FIELD OF AGRICULTURAL PRODUCTION

An important indicator of the functioning of the agrarian sphere of activity is the level of income and the structure of expenses of households in rural areas. In particular, the share of the population and households with average per capita equivalent total incomes per month, lower than the average level of total incomes, the legally established subsistence minimum, and the actual subsistence minimum (Table 1).

Table 1. Dynamics of the specific weight of the rural population, which is outside the limit of key indicators of social security in Ukraine in 2016-2019, %

Population categories	Years			
	2016	2017	2018	2019
Population with average per capita equivalent total income, lower than:				
average level of total income	58.6	56.9	56.7	57.7
legally established living wage	3.9	3.3	1.8	1.3
actual living wage	51.7	36.3	31.5	29.5
Households with average per capita equivalent total income, lower than:				
average level of total income	54.8	54.2	54.8	56.7
legally established living wage	3.4	3.0	1.6	1.6
actual living wage	48.2	34.2	29.2	29.1

***Source**: [7]*

The situation in rural areas shows the following results: as of the end of 2019, every third person, including the household, had incomes below the actual subsistence minimum and almost 60% – below the average level of total incomes. And one of the factors of this situation is the level of wages in agriculture (Fig. 4), as well as hidden employment and, accordingly, shadow incomes. In the structure of total household incomes, almost 89% are monetary incomes, of which more than 50% are wages. And in the structure of expenses, on average over 5 years, 92.5% are consumer expenses.

Focusing on the fiscal aspects of the efficiency of the functioning of the agrarian sphere of production, it would be appropriate to consider the level of tax payments to the budgets of different levels by agricultural enterprises. Therefore, we can trace the role of the agricultural sector in filling the budgets of different levels (Table 2).

Table 2. Dynamics of tax revenues from taxpayers in the agrarian sector o budgets of various levels in 2018-2019, UAH billion

Type of receipt	2018	2019	Growth rate, %
Income tax	1.4	1.2	-0.15
VAT	19.5	21.0	+7.6
VAT refund	27.7	3.8	-86.2
Excise tax	4.6	0.02	-99.6
Rent for the use of subsoil	17.4	1.5	-91.4
Property taxes	4.1	4.9	+19.5
Ecological tax	0.07	0.08	+14.3
Personal income tax and military service	21.3	22.2	+4.2
Single tax	5.4	5.8	+7.4
In total	53.6	57.1	+6.5

Source*: [11; 12]*

As of the end of 2019, there was an increase in the amount of taxes paid in the agricultural sector for VAT (+UAH 1.5 billion), property tax (+UAH 0.8 billion), environmental tax (+UAH 0.01 billion), taxes from labor income (personal income tax and military service) - +0.8 billion UAH and from the single tax - +0.4 billion UAH. As for all others, significant downward trends are noted for them, which indicates that the tax burden on agribusiness is quite significant. The proof of this is the rating of branches of the national economy by the level of tax burden (Fig. 6).

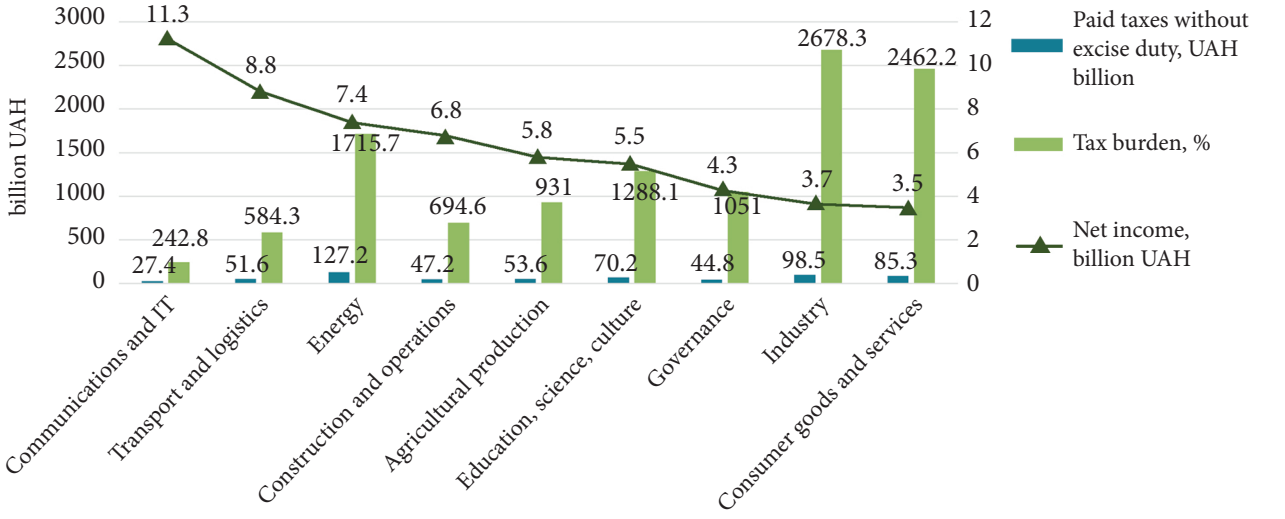

Figure 6*. Gradation of branches of the national economy by the level of tax burden in 2018*

Source*: [12]*

From the given rating, we can see that agricultural production ranks fifth with a rating of 5.8%. However, according to the level of net income, it is placed behind such industries as industry and consumer goods and services, although the studied indicator for them is much lower. In addition, a significant share of the tax burden is made up of indirect taxes, in particular VAT. This proves the need to review the conditions of the tax system regarding the mechanisms of its functioning in the agricultural sphere of activity and to find more loyal conditions for their implementation, which would contribute to the development of agricultural production both in the near future and in the long term.

Thus, we can assert that the effectiveness of the functioning of the agrarian sphere of activity in today's transformational conditions requires significant adjustment. And it should be connected, first of all, with the revision of the conditions of the functioning of the tax system in order to strengthen the action of stimulating levers.

Based on the obtained and highlighted results, it is necessary to single out the following areas of transformation of the tax system in the field of agricultural production:

– introduction of a progressive scale of VAT depending on the type of products produced;

– strengthening of environmental taxation for business entities that do not conduct eco-oriented activities;

– differentiation of taxation systems for agricultural producers depending on their size and production volumes (Fig. 7).

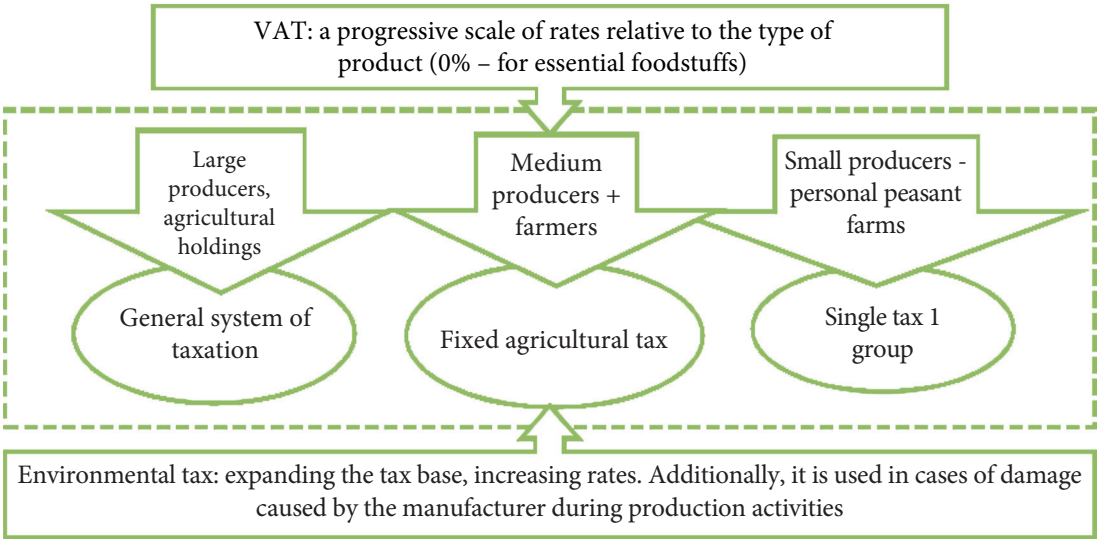

***Figure 7**. Proposed transformations of the tax system in order to stimulate agricultural production*

The first step to easing the tax pressure on agricultural producers should be a review of the current VAT rates on agricultural products. That is, it is advisable to exempt the category of products related to basic food products from VAT taxation, taking into account the indicator of material deprivation of the population of Ukraine. After all, the functioning of VAT contributes to the increase in the price of goods and products at each stage of their sale.

Separate attention should be focused on environmental taxation. Cases where agricultural producers, practicing intensive cultivation technologies without observing crop rotation norms, actively use mineral fertilizers that have a negative effect on flora and fauna have become more and more frequent in agricultural production. And in this case, more aggressive environmental taxation (expansion of the tax base and increase in tax rates) will become a prerequisite not only for the careful use of harmful substances in the production process, but also for improving the quality of products, increasing the level of their environmental friendliness and optimizing the environment. Similar trends are trending in the tax systems of foreign countries for the post-pandemic period.

Gradation of taxation systems for agricultural producers depending on their size would also be rational. In particular, it is advisable to tax large agricultural enterprises (type of agricultural holdings) according to the general system, medium-sized enterprises and farms - according to the system of fixed agricultural tax, and small and micro-enterprises, which should also include personal peasant farms – according to the alternative system of the single tax (group 1) . Given the imbalances of development, it is advisable to introduce tax holidays and reduced tax rates for producers practicing activities in unpopular and unprofitable areas.

CONCLUSIONS

The need to transform the tax system in the entire national economy of Ukraine has been ripe for a long time, especially in agricultural production. And the conditions of the pandemic and the consequences of quarantine restrictions only deepened the existing crisis phenomena. During the period 2015-2019, the agricultural sector of Ukraine demonstrated declining performance indicators in economic, social, and fiscal terms. However, the situation can be rectified by distinguishing between manufacturers according to their size, the type of products they produce, and the field of activity. In particular, relaxation for medium-sized forms of business in the form of a fixed agricultural tax and inclusion of personal peasant farms in the form of small producers as single tax payers of group 1 to the cohort of taxpayers will expand their opportunities and create prerequisites for the formation of a market for ecologically clean agricultural products of high quality. As for large manufacturers, they are left with the general taxation system.

Separately, it is proposed to review the conditions of functioning of VAT and environmental tax in agricultural production. As for the first, it is worth applying a progressive scale of rates, where the taxation of essential food products will be carried out at 0%. Environmental taxation should be made tougher and higher rates should be applied to producers who cause harm during production activities.

The proposed transformation data will stimulate the development of agricultural production in the small and medium segments, as well as contribute to the restoration of rational activity aimed at the ecological production of high-quality products.

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Трансформація податкової системи України з метою сприяння розвитку аграрного виробництва

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Анотація. Аграрна сфера в Україні є однією з основних сфер діяльності та належить до пріоритетних складових національної безпеки країни. Однак на теперішньому етапі розвитку ця царина працює зі значними невідповідностями, а продукція, що виробляється, не завжди є конкурентною на зовнішніх ринках в силу невідповідності стандартам якості іноземних держав. Покращити стан справ у напрямку активізації аграрної діяльності можна за допомогою стимулюючих важелів податкової системи. Оскільки високе податкове навантаження, яке надає суб'єктам господарювання множинність податків, зменшує кількість їх фінансових ресурсів, які потенційно могли б бути використані задля оновлення виробничих потужностей, удосконалення технологій виробництва та підвищення рівня його інноваційності тощо. Крім того, непрямі податки, зокрема податок на додану вартість (ПДВ), значно збільшують вартість виготовленої продукції і знижують рівень її конкурентоспроможності на внутрішніх ринках. Таким чином, метою статті є аналіз ситуації в аграрному виробництві та визначення факторів його бажаної трансформації у сфері функціонування податкової системи задля стимулювання сприяння розвитку даної галузі. Відтак, потрібно з'ясувати основні показники економічної, соціальної та фіскальної ефективності функціонування підприємств аграрної сфери й позначити потенційно актуальні напрями розвитку досліджуваної галузі зі сторони трансформації податкової системи. У статті розглянуто сучасний стан функціонування аграрного виробництва в Україні з позиції економічної, соціальної і фіскальної ефективності. Наведено актуальні в умовах перехідної економіки України напрями трансформації податкової системи, що у найближчому часі та на тривалу перспективу спонукають галузь до якісно нового розвитку

Ключові слова: аграрне виробництво, економічна ефективність, соціальна ефективність, фіскальна ефективність, сільське населення, єдиний податок, фіксований сільськогосподарський податок

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Potential resources and approaches to the management of organic raw materials of Ukraine to replenish humus reserves in grants

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Abstract. Currently, the problem of global climate transformations, as well as natural environment, insufficient amount of food and energy, loss of biological diversity and sustainability of ecological systems are being actively reflected. The problem of imbalance of biogeochemical carbon cycles as a result of intensive or irrational agriculture is one of the fundamental aspects of global changes in the environment. Management of the processes of carbon cycling and sequestration in the soil is the main link in solving such urgent global issues as overcoming soil degradation and mitigating the effects of climate change. Development and involvement of methods of sustainable soil organic carbon management priority for soil protection in Ukraine. In turn, climate change and its consequent aspects have increased interest in calculating the quantitative assessment of changes in soil organic carbon reserves in agroecosystems in order to identify the carbon sequestration potential of arable soils. Thus, the purpose of the article is to provide an assessment of the supply of soil-climatic zones of Ukraine with sources of organic raw materials to increase the amount of humus reserves in the soil, as well as to highlight approaches to management in order to increase their efficiency. It was concluded that the systematic use of organic materials in agriculture will contribute to reducing the imbalance of biogeochemical carbon cycles, as well as increasing the stability of agrocenoses. The estimated supply of organic fertilizers in the regions of Ukraine under various scenarios was calculated. The characteristics of potential resources of organic raw materials of natural origin and organic waste from the standpoint of humus formation are given. Approaches to the management of organic materials to increase the efficiency of humus accumulation in soils are proposed

Keywords: organic raw materials, humus, zonal availability, approaches to resource management

INTRODUCTION

In the 21st century the problems of global changes in the natural environment and climate, shortage of food and energy, loss of biodiversity and sustainability of ecosystems are brought to the fore. The problem of the imbalance of biogeochemical carbon cycles as a result of intensive or irrational agriculture is a part of global changes in the natural environment. Soil organic matter (SOM) plays an important role in solving the problems of sustainability of agro-ecosystems, soil degradation and production of ecologically clean products. During the period 1850-2005, as a result of erosion, 74±18 Pg of carbon was lost, of which 79-85% fell on agricultural lands and pastures [1]. According to the Regional Assessment of Soil Changes in Europe and Eurasia [2], humus loss is observed on 23-70% of agricultural land areas. According to [3], arable soils

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contain 25-75% less organic carbon than their counterparts in natural ecosystems. Management of carbon cycle and sequestration processes in the soil is a key link in solving such urgent global problems as overcoming soil degradation and mitigating climate change [2].

Development and implementation of sustainable soil organic carbon management methods are extremely important for soil protection in Ukraine. The country joined the UN Convention to Combat Desertification, in which it made a voluntary national commitment to increase the organic carbon content of soils by at least 0.1% by 2030. Increasing SOM reserves improves the ecological properties of the soil, including the preservation and restoration of soil biota, optimizes the nutritional regime and the level of moisture, thereby increasing the long-term resistance of arable soils to degradation under the influence of anthropogenic factors.

Climate changes, disruption of ecosystem stability, degradation of soil resources have led to interest in measuring and quantifying changes in soil organic carbon reserves in agroecosystems in order to identify the carbon sequestration potential of arable soils. Carbon sequestration by soil is the subject of a wide range of research around the world. According to studies [4; 5], increasing the content of organic matter in the soil to a depth of 2 meters by 5-15% will reduce the concentration of CO_2 in the atmosphere by 16-30%. It is estimated that the total volume of annual absorption of carbon dioxide, including natural dynamics and the use of carbon-saving technologies, is 23-28% of annual emissions into the atmosphere within russia.

The ability of the soil to stabilize and retain the carbon of organic matter, which arrived with organic materials, forms the carbon sequestration capacity of the soil. Carbon sequestration by soil resources is influenced by a complex of interconnected factors (climate, soil type, intensity of management), which determine the accumulation of carbon in the soil or its loss. The ability of the soil to hold carbon is controlled not only by the content of finely dispersed granulometric fractions of dust and clay with a size of <0.05 (0.02) mm [6], but also by the capacity of cation exchange, the mineral composition of the soil and depends on the level of moisture and the temperature regime [7].

Carbon sequestration depends on the level of soil carbon saturation. Management practices that will promote sequestration in one soil may not be effective in another where the carbon content is approaching a stable level. Such soil will accumulate less organic carbon and at a slower rate. This is important for planning and developing sustainable management actions and practices that maintain and increase SOM stocks. According to the results of long-term stationary experiments, it was established that the use of organic fertilizers contributes to the increase of organic carbon in the soil by 12-23% [8-10]. The average value of humus content for long-term manure application is lower than the value for short-term application, indicating a decrease in the rate of organic carbon sequestration relative to emission, as the total humus content approaches equilibrium.

Considerable attention of researchers is paid to the quantitative assessment of carbon reserves in soils, mechanisms of its stabilization with the use of organic materials to increase the reserves of organic matter in the soil. The introduction of organic raw materials with a certain biochemical composition balances the balance between sequestration and emission of organic carbon and is an effective measure for the restoration of SOM reserves [11-13]. Under the conditions of application of composts with an increased content of humic acids, slow mineralization of nitrogen in soils is observed, which improves not only soil fertility, but also conditions for humification of organic matter [9]. Quantitative and qualitative transformations of the constituent pools of SOM from the moment of their biosynthesis to full biological mineralization are closely related to the specific process of humification of the organic soil substrate. Humification is a process of biophysical and chemical fixation of organic substances in the form of stable fractions of humic substances, which protect organic matter from complete mineralization [6; 14]. During the decomposition of organic raw materials by soil microorganisms, 70% of organic carbon is lost in the form of CO_2 due to emission, 20% is transformed into humic compounds, and 10% is transformed into non-humic organic compounds and microbial biomass [15-17]. Common management practices that can contribute to soil carbon storage include the use of cover crops, crop rotation management, organic fertilization, and more efficient management of tillage activities.Minimizing the loss of humus in the soil can be ensured by arranging arable land by removing land unsuitable for plowing and conserving degraded land, implementing anti-erosion measures, and mandatory exclusion of practices of burning vegetation and its residues in the fields. The implementation of agricultural practices to increase the content of soil carbon depends on a complex of factors related to natural conditions (climate, soil), land use system, and also depends on the social and cultural context (farm specialization, market and availability of means of production, subsidies, education farmers and desire for change) [18].

Methods of increasing the accumulation of organic matter in the soil include the use of scientifically based fertilization systems, which will contribute to the arrival of a significant amount of carbon and its long-term stay in the soil. The material basis of the reproduction of soil carbon is organic fertilizers, which at the same time act as a leading factor in the sustainable development of ecologically balanced farming systems, in particular organic farming. In organic

farming systems, the stock of stable carbon in the surface layer of the soil increases [19], thereby ensuring its sequestration [20].

The purpose of the work is to assess the supply of soil and climate zones of Ukraine with organic raw material resources for replenishing humus reserves in the soil and highlight approaches to management in order to increase their efficiency.

CONCEPTS IN THE MANAGEMENT OF ORGANIC RAW MATERIALS OF UKRAINE

Anthropogenic load and interference in natural soil processes disrupts the process of humus accumulation, which leads to a change in the ratio between the synthesis and mineralization of organic matter in the soil. The processes of dehumification cause deterioration of the agronomic properties of the soil and decrease in fertility, which can affect the functioning of the biosphere as a whole. A comparison of the humus content of the soils of Ukraine during the time of Dokuchaev (1882) with the current state shows that the loss of humus has reached the level of about 20%.

The weighted average indicator of humus content in the soils of Ukraine according to the results of the X round of agrochemical land certification (2011-2015) is 3.16%. This reflects a positive trend of soil humus compared to the data of the previous survey round, which revealed an average humus content of 3.14%. This trend is associated with the growth of organic substances entering the soil, mainly due to plant residues and siderates. So, over the past five years, 2.5-4.8 t/ha of straw and 11.6-16.6 t/ha of siderates were applied annually. In terms of soil and climate zones, the most significant increase in humus content in soils is observed in the Polissya zone – 4% (compared to 2006-2010), the smallest in the Forest Steppe zone - 0.6%. The developed crop production sector of Ukraine annually generates a large amount of the non-marketable part of the harvest, which in 2020 exceeded 139 million tons (Table 1). The non-marketable part of the harvest of agricultural crops is a source of reproduction of organic matter in the soil, a harvest and energy substrate for microorganisms, a producer of low-molecular soluble organic compounds that are of fundamental importance for soil metabolism. The agronomic efficiency of using straw as a fertilizer has been proven by numerous experiments and practice.

Table 1. Volumes of the non-commercial part of the harvest of the main agricultural crops in farms of all categories of Ukraine (2020), million tons

Soil and climate zone	Wheat and other cereals	Corn for grain	Cereals and legumes	Soya	Rapeseed	Sunflower	Total
Forested	13.5	8.2	0.1	2.1	1.3	2.6	27.8
Forest steppe	34	21.4	0.3	3.2	1.5	11.2	71.6
Steppe	21.4	4.1	0.5	0.8	2.4	11.1	40.3
Across Ukraine	68.9	33.7	0.9	6.1	5.2	24.9	139.7

The disadvantage of the non-marketable part of the harvest of agricultural crops is the fact that the organic compounds in their composition are chemically stable and slowly decompose in the soil. According to the results of long-term stationary experiments of the NSC "Institute of Agriculture of the National Academy of Sciences", the use of only plant residues does not compensate for the loss of soil humus due to increased mineralization, which leads to losses of organic matter at the level of 1.27 t/ha [21]. A specific feature of the chemical composition of manure compared to root and crop residues is that it contains "ready-made" humus substances [22].

The general trend in recent years is a decrease in the volume of production and use of animal manure. Since 1985, the application of cattle manure to arable soils has decreased 16 times. Currently, the use of organic fertilizers by zone of Ukraine ranges from 0.13 to 1.20 t/ha. Over the past five years, the largest amount of organic fertilizers was applied in the Polissya zone (from 0.8 to 1.2 t/ha), the smallest – in the Steppe zone (from 0.13 to 0.25 t/ha). Organic fertilizers are mainly used for fodder crops, the least - for grain crops (except corn). According to statistical data, in 2020 manure was applied to only 1.9% (0.8 million hectares) of agricultural land. On the other hand, the transition of agriculture to an intensive path of development led to the emergence of powerful complexes of animal husbandry and poultry farming with a consistently high output. Violations of the ratio of the amount of organic waste generated on farms and animal husbandry complexes and the area for their application, imperfection of manure and litter removal and storage systems, non-compliance with the terms and norms of application of organic fertilizers carry the risk of environmental pollution with biogenic elements. The total annual output of manure and droppings in 2020 in farms of all categories is 106.2 million tons (Table 2).

Table 2. Volumes of animal manure in farms of all categories of Ukraine, 2020, million tons

Soil and climate zone	Cattle manure	Pig manure	Sheep manure	Poultry droppings of all kinds	Total
Forested	19.5	6.9	0.3	4.0	30.7
Forest steppe	28.7	9.9	0.3	11.7	50.6
Steppe	13.8	6.4	0.6	4.1	24.9
Across Ukraine	62.0	23.2	1.2	19.8	106.2

According to calculations, the use of the entire amount of animal manure and poultry droppings in terms of bedding manure, at the output level of 2020, will ensure the fertilization of agricultural land with traditional organic fertilizers in a dose based on dry matter in the Polissya zone – 1.9 t/ha, in in the forest-steppe zone – 1.5 t/ha, in the steppe zone – 0.5 t/ha (Table 3). In the case of plowing the entire volume of the available non-marketable part of the harvest of the main agricultural crops according to the data of 2020, application in the Polissia zone is possible at a dose of 4.9 t/ha, in the Forest Steppe – 6.4 t/ha, in the Steppe zone – 3.4 t/ha, which in terms of litter manure is 2.8 t/ha, 3.2 and 1.9 t of dry matter per hectare of sown area in the Polissia, Forest-Steppe and Steppe zones of Ukraine.

Table 3. Estimated annual supply of organic raw materials for replenishing soil organic matter by regions of Ukraine

Soil and climate zone	Potential resource for application to the soil in terms of litter manure, t per hectare of sown area									
	The non-marketable part of crop production		Animal manure and poultry droppings involvement		A potential resource in the case of involving the full amount of manure, the non-marketable part of the harvest of legumes, corn, sunflower					
					share of cereal straw					
					80 %		60 %		40%	
Forested	11.0**	2.8***	7.5	1.9	16.9	4.2	15.2	3.8	13.5	3.4
Volynska	10.1	2.5	6.1	1.5	14.6	3.7	12.9	3.2	11.2	2.8
Zhytomyrska	9.8	2.5	4.0	1.0	12.3	3.1	10.8	2.7	9.3	2.3
Zakarpattia	8.7	2.2	18.4	4.6	25.9	6.5	24.7	6.2	23.4	5.9
Ivano-Frankivska	10.9	2.7	9.3	2.3	18.7	4.7	17.1	4.3	15.5	3.9
Lvivska	10.6	2.7	6.7	1.7	15.9	4.0	14.4	3.6	12.9	3.2
Rivnenska	10.7	2.7	5.3	1.3	14.5	3.6	12.9	3.2	11.3	2.8
Chernihivska	16.4	4.1	2.9	0.7	16.4	4.1	13.5	3.4	10.6	2.6
Forest steppe	12.8	3.2	4.7	1.2	15.4	4.2	13.3	3.8	11.2	3.4
Vinnytsia	11.1	2.8	5.8	1.5	15.0	3.8	13.1	3.3	11.2	2.8
Kyivska	10.9	2.7	5.6	1.4	14.6	3.7	12.8	3.2	10.9	2.7
Poltavska	13.3	3.3	3.0	0.8	14.1	3.5	11.9	3.0	9.6	2.4
Sumska	18.3	4.6	3.0	0.8	18.1	4.5	15.0	3.7	11.9	3.0
Ternopilska	14.5	3.6	4.5	1.1	16.7	4.2	14.4	3.6	12.1	3.0
Kharkivska	11.2	2.8	2.6	0.7	11.7	2.9	9.7	2.4	7.6	1.9
Khmelnytska	15.7	3.9	4.9	1.2	18.1	4.5	15.7	3.9	13.2	3.3
Cherkasska	9.4	2.4	5.5	1.4	13.3	3.3	11.7	2.9	10.1	2.5
Chernivetska	10.9	2.7	7.2	1.8	16.7	4.2	15.2	3.8	13.8	3.5
Steppe	7.5	1.9	2.0	0.5	8.2	2.0	6.8	1.7	5.5	1.4
Luhanska	6.7	1.7	1.3	1.7	6.8	1.7	5.5	1.4	4.3	1.1
Dnipropetrovska	7.4	1.9	2.5	1.9	8.6	2.1	7.2	1.8	5.8	1.5
Donetska	8.0	2.0	2.3	2.0	8.8	2.2	7.4	1.8	5.9	1.5
Zaporizhzhska	7.4	1.9	1.5	1.9	7.6	1.9	6.3	1.6	5.0	1.2
Kirovohradska	6.9	1.7	1.5	1.7	7.3	1.8	6.1	1.5	4.9	1.2

Table 3, Continued

Soil and climate zone	Potential resource for application to the soil in terms of litter manure, t per hectare of sown area									
	The non-marketable part of crop production		Animal manure and poultry droppings involvement		A potential resource in the case of involving the full amount of manure, the non-marketable part of the harvest of legumes, corn, sunflower share of cereal straw					
					80 %		60 %		40%	
Mykolayivska	6.3	1.6	1.4	1.6	6.5	1.6	5.4	1.3	4.2	1.0
Odeska	5.1	1.3	2.3	1.3	6.5	1.6	5.5	1.4	4.6	1.1
Khersonska	9.2	2.3	1.7	2.3	9.5	2.4	8.0	2.0	6.5	1.6
Across Ukraine	10.2	2.6	3.5	2.6	11.9	3.0	10.2	2.6	8.5	2.1

***Notee**: * Based on the conditional standard - cattle manure bedding 75% moisture; ** on raw substance; ***per dry matter*

The forecast possible application of organic fertilizers, taking into account the entire available yield of manure and the non-marketable part of the harvest of agricultural crops in Ukraine, is for the Polissia zone – 4.7 t of dry matter in the equivalent of litter manure per 1 ha of sown area, for the Forest Steppe – 5.9 t/ha, in the Steppe zone – 2.5 t/ha. At the same time, the norm for ensuring a deficit-free balance of humus, depending on the soil and climate zone, should be from 8 to 14 t/ha.

The potential annual resource of organic raw materials for application to the soils of Ukraine under the scenario of using the entire volume of manure, non-marketable part of the crop of legumes, corn for grain and sunflower with the involvement of 40% of the annual volume of cereal straw varies from 1.4 t/ha in the Steppe to 3.4 t/ha in the Forest-Steppe and Polissia zone of Ukraine (equivalent to the dry matter of litter manure per hectare of sown area). In the case of involving 60% of the annual volume of grain straw, in addition to manure and the non-marketable part of the harvest of other crops, the application dose can reach 2.6 t/ha. The maximum application of organic raw materials (in the case of plowing 80% of the annual volume of grain straw) at the output level of 2020 in Ukraine can be 3 tons per 1 ha of the sown area in the equivalent of the dry matter of litter manure.

In connection with the shortage of traditional organic fertilizers, the role of attracting organic raw materials of various origins to replenish humus reserves is growing significantly. Sapropel, leonardite, processing industry waste (sewage sludge, biochar, biogas plant waste) are alternative sources of organic matter entering the soil and raw materials for the production of organic fertilizers.

Sapropel deposits in Ukraine have total reserves of 97 million tons, and are concentrated mainly in the Volyn region. The average productivity of local lakes is more than 1,000 tons per hectare. The mass fraction of dry matter of sapropel is 14-15%, the content of organic matter varies from 15 to 95% of the mass of dry matter with an organic carbon content of 35-38% (Fig. 1).

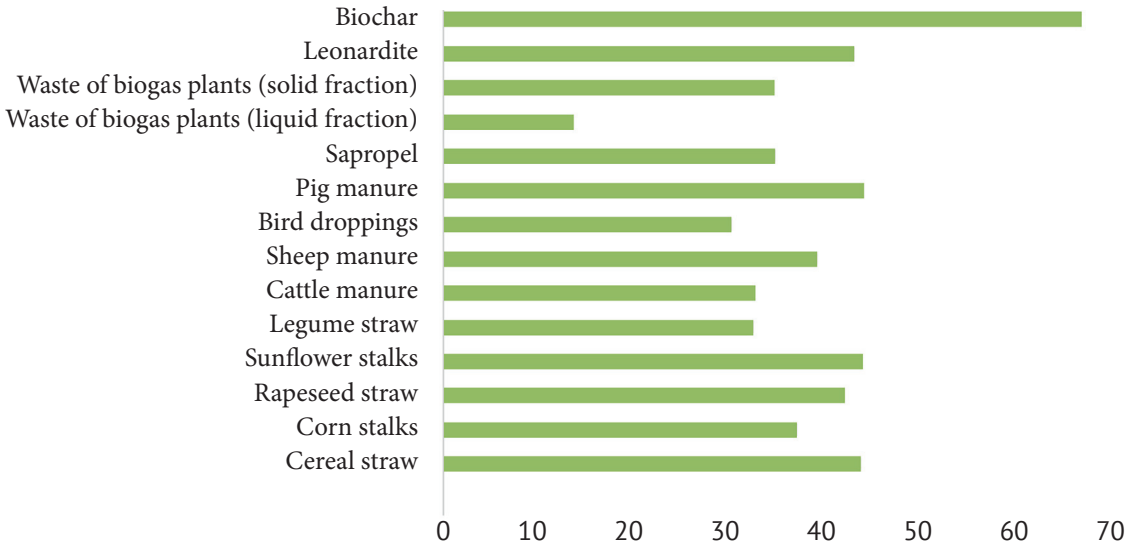

***Figure 1**. The average content of total carbon in organic raw materials of different origins*

Coal reserves in Ukraine amount to almost 117 billion tons, of which the share of lignite is 6-8% (7.1-9.4 billion tons). Oxidized lignite (leonardite) is used in agricultural production as a raw material for obtaining humates. The organic matter of leonardite contains from 37.4 to 48.5% of carbon on dry matter, the content of humic substances is 76-96% of the total carbon content.

Biochar is an organic raw material with a high carbon content (64-70%). With optimal pyrolysis, biochar retains more than 50% of the carbon contained in the original biomass [13]. Due to the resistance to decomposition by microorganisms when applied to the soil, which can take thousands of years, the release of organic carbon in the form of CO_2 slows down [23].

SOURCES OF FILLING THE SOIL WITH ORGANIC SUBSTANCES

A variety of organic wastes, which are part of the waste structure of all regions, can be considered as a resource for replenishing soil organic matter. In Ukraine, only 3-5% of the 3 million tons of PES are used in agriculture. While the utilization of PES in agriculture is a common practice in Portugal – 87% of the volume of PES, Spainx – 65%, Great Britain – 69% and the USA – 47% [24; 25]. Since the direct utilization of PES entails great environmental risks, in the presence of high concentrations of heavy metals, the world considers it more rational to use composts from these wastes in order to ensure the sanitary and hygienic standards of the final product. Anaerobic technologies for the processing of organic raw materials for energy needs generate waste that is environmentally friendly [26] and has a sufficiently high content of organic carbon (from 11.5 to 33.5%). An organic fertilizer is a product ready for application to the soil that meets the specified requirements (does not contain pathogens, viable weed seeds, toxic substances and heavy metals above the maximum permissible concentration (MPC), has an optimal environmental response, etc.). Effective use of organic fertilizers should be based on the exclusion of contamination of surface and underground waters, soils, translocation of nitrates into agricultural products.

A systematic solution to the problem of production and application of fertilizers based on organic waste is connected with the need to develop a legal framework and expand research on the development of adaptive technologies for their processing that meet environmental requirements and modern market conditions of product manufacturers. The involvement of organic raw materials of various origins in the production of organic and organo-mineral fertilizers (OMF) is a promising way of saturating arable soils with organic carbon. The production of long-acting OMF based on livestock and poultry waste, which gradually release nutrients during interaction with the soil during the growing season of plants, is one of the rational ways to reduce the negative impact of waste on the environment (soils, ground and surface water, etc.).

The processes of transformation of organic raw materials in the soil largely depend on its composition. Composting straw, manure, manure and other sources of organic raw materials changes the quality of the final product. The organic matter of mature composts is of particular value for potential humus formation in soils because it contains humic substances resistant to decomposition, characterized by a high molecular weight [27]. The production of composts based on waste of organic origin is of great environmental importance, as it allows for the safe disposal of waste and the maximum involvement of biogenic elements in the biological cycle.

To regulate the humus state of arable soils, it is necessary to control the amount and quality of the supply of carbon compounds and, no less important, the processes of their transformation in the soil. It was established that the humification coefficients of organic fertilizers are significantly affected by the rate of their application [28]. With an increase in manure rates against the recommended ones, the mineralization of organic matter increases with a simultaneous decrease in the intensity of humus formation. Only with a uniform distribution of manure organic substances in the soil mass can the maximum yield of newly formed humus be achieved. The depth of application of organic fertilizers has an unequivocal effect on humification; if they are applied to a depth of 20-30 cm, the humification coefficient increases to 60%. After the combined application of manure, according to the recommended zonal norms, and mineral fertilizers, the humification coefficients increase by 10% [29]. However, you can hope for such an increase in the degree of humification only after applying mineral fertilizers together with fresh straw or semi-rotted manure. Applying mineral fertilizers with ready-made compost, rotted manure or humus does not increase this coefficient. In the NSC "Institute of Soil Science and Agrochemistry named after O.N. Sokolovsky" developed generalized standards for the humification of organic raw materials, which are equal to 30% for manure, 25% for the non-marketable part of legumes, 17% for corn, sunflower, and 15% for grain straw. Norms are developed for soils of heavy granulometric composition. For medium-loamy soils, the given standards are reduced by 10%, light loamy soils by 20%, sandy loamy soils by 50%, clay-sandy soils by 85% [30].

The pace and degree of saturation of the soil with organic carbon depend not only on the quantity and quality of organic raw materials, but also on the rate of fixation of organic substances. Saturation with organic carbon depends on physical and chemical properties, which are not identical in different soil types. As a result, the real dimensions of sequestration

are possible only up to a certain level, which corresponds to the limit of soil saturation with organic carbon, above which the arrival of fresh organic matter does not lead to an increase in carbon.

CONCLUSIONS

The systematic use of organic materials in agriculture will help reduce the imbalance of biogeochemical carbon cycles and increase the stability of agrocenoses. The calculation of the approximate supply of different soil and climatic zones of Ukraine with traditional organic fertilizers showed a deficit of the available volume of manure formation and the non-marketable part of the harvest of the main agricultural crops for replenishing the soil with organic matter. Even the maximum involvement of these materials does not ensure the recommended zonal norms of introduction into the soil. According to the scenario of using the entire amount of manure, the non-marketable part of the harvest of grain and leguminous crops, corn and sunflower, and with the involvement of 40% of the annual amount of cereal straw, the forecasted dose of organic fertilizers application on average in Ukraine reaches 2 t/ha (equivalent to the dry matter of litter manure per hectare of cultivated area).

In the context of replenishment of organic carbon reserves in the soils of Ukraine, taking into account the shortage of traditional organic fertilizers, the role of attracting organic raw materials of various origins (sapropel, leonardite, organic waste from the processing industry, municipal economy, etc.) is significantly increasing. Organic waste is characterized by the possibility of processing and elimination by thermal methods for energy needs. However, it is proposed to consider them primarily as a source of carbon-containing compounds and nutrients for plants after appropriate technological decisions have been made.

In order to carry out targeted, scientifically based optimization of the humus state of soils, it is necessary to control the quality of organic fertilizers, taking into account the characteristics of the organic component, which is an important factor influencing the processes of mineralization-humification of carbon in the soil. The implementation of bioconversion technologies of organic materials, in the process of which the substrate undergoes a significant transformation with the formation of a humified product, is considered promising. It is equally important to regulate the processes of transformation of organic materials in the soil. In arable soils, in order to intensify the processes of humus formation, it is important to manage the introduction of organic fertilizers by placing them deeper (>20 cm) and combining them with mineral fertilizers.

Involvement of raw resources of organic origin in the production of fertilizers, implementation of processing technologies to improve their remedial properties, compliance with recommended doses, application methods and the optimal ratio between organic and mineral fertilizers in specific crop rotations and soil-climatic conditions will increase the efficiency of fertilizer application to replenish soil organic carbon . A balanced zonal scientific-methodical approach to the management of organic raw materials in the context of increasing the carbon content in the soil will contribute to preserving the fertility of the soils of Ukraine, rational nature management and environmental protection.

The modern tasks of studying soil organic matter are to reveal the mechanisms of chemical (biophysical and chemical) processes of humification of organic materials, to develop more effective indicators of humus state and composition, as well as to create and develop organic carbon management technologies. The implementation of the latest technologies for increasing the content of organic carbon in the soil, for which there are currently technological and economic barriers, will have a significant potential for carbon sequestration in the soil in the long term, in case of deepening of research and availability of economic incentives.

Considering the importance of the indicator of the content of organic matter for diagnosing changes in the humus state during soil monitoring, it is necessary to conduct a broad discussion of the need and method of converting organic carbon into humus in order to optimize the work of the agrochemical service of Ukraine and create an informative database of the qualitative state of soils.

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Потенційні ресурси та підходи до управління органічною сировиною України для поповнення запасів гумусу в ґрунтах

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Анотація. Наразі знаходять активне відображення проблеми глобальних трансформацій клімату, а також природного середовища, недостатньої кількості продовольства і енергії, втрати біологічного розмаїття та стійкості екологічних систем. Проблема дисбалансування біогеохімічних циклів вуглецю у результаті інтенсивного або нераціонального сільського господарства є одним з основоположних аспектів глобальних змін у довкіллі. Керування процесами кругообігу та секвестрації вуглецю в ґрунті є головною ланкою у вирішенні таких нагальних питань загальносвітового масштабу, як подолання деградації ґрунтів та применшення наслідків кліматичних змін. Розроблення та залучення методів сталого управління органічним вуглецем ґрунту пріоритетними для охорони ґрунтів Україні. У свою чергу, кліматичні зміни та наслідкові від цього аспекти посилили інтерес до обрахування кількісної оцінки змін запасів органічного вуглецю ґрунту в агроекосистемах задля виявлення потенціалу секвестрації вуглецю орними ґрунтами. Таким чином, метою статті є надання оцінки забезпеченості ґрунтово-кліматичних зон України джерелами органічної сировини для посилення кількості запасів гумусу в ґрунтах, а також висвітлення підходів до управління з метою підвищення їх ефективності. Зроблено висновок, що систематичне використання органічних матеріалів у землеробстві сприятиме зменшенню розбалансування біогеохімічних циклів вуглецю, а також підвищенню стійкості агроценозів Проаналізовано наявні ресурси органічної сировини для поповнення запасів органічного вуглецю ґрунтів у різних ґрунтово-кліматичних зонах України. Було розраховано орієнтовну забезпеченість органічними добривами областей України за різних сценаріїв. Наведено характеристику потенційних ресурсів органічної сировини природного походження та органічних відходів з позиції утворення гумусу. Запропоновано підходи до управління органічними матеріалами для підвищення ефективності акумуляції гумусу в ґрунтах

Ключові слова: органічна сировина, гумус, зональна забезпеченість, підходи до управління ресурсами

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The use of electrophysical indicators during the cultivation of strawberries on drip irrigation

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Abstract. Electrophysical research methods are widely used in countries with developed agricultural production for the purpose of soil monitoring and surveys. One of these methods of research is determining the electrical conductivity of the soil. Because with the help of this indicator, it is relevant to clarify the boundaries of soil differences, which makes it possible to use it in precision agriculture. Thus, the purpose of the article is to compare the changes in the electrophysical parameters of typical chernozem under different fertilization systems under conditions of drip irrigation. In order to carry out the analysis, individual soil samples were taken for each year of research in the period 2018-2020 in the spring (May) before the start of strawberry flowering. From the selected and air-dried soil samples using the quarting method, average mixed samples were selected for analysis. It was concluded that electrophysical indicators undergo changes according to the depth of sampling, which is related to the assimilation of useful substances from the soil by plants and fertilization mechanisms and correlates to a significant extent with the acid-alkaline indicators of the soil. A three-year study (2018-2020) of the influence of different fertilization systems under drip irrigation conditions on the electrophysical parameters of typical chernozem during the cultivation of garden strawberries was conducted. It was established that the greatest changes in electrophysical indicators (electrical conductivity, general mineralization, salinity) of typical chernozem occur from the ridge part to a depth of 20-30 cm. The difference in the obtained values of electrophysical indicators between variants of different fertilization of typical chernozem (control, mineral system, organo-mineral system, organic system), as well as during years of research

Keywords: typical chernozem, electrophysical parameters, drip irrigation, fertilization

INTRODUCTION

In countries with developed agricultural production, electrophysical research methods are widely used for soil surveys and monitoring. One of them is the determination of the electrical conductivity of the soil [1; 2].

With the help of this indicator, it is convenient to specify the boundaries of soil differences, which makes it possible to use it in precision agriculture [3]. The electrical conductivity indicator is a kind of indicator of changes occurring in the soil, because it is closely correlated with many indicators of fertility.

Electrical conductivity of the soil is the ability of the soil to conduct an electric current, expressed in siemens per unit area (S/m – siemens per meter, or μS/cm – microsiemens per centimeter). Electrical conductivity is an indicator that responds sensitively to changes in soil moisture and temperature, grain size composition, cation exchange capacity, salinity, content of exchangeable cations, content of organic matter, etc.

The electrical conductivity of the soil solution characterizes the content of salts in it, which directly affect the growth and development of plants, which is an important aspect of soil quality. Therefore, this indicator is widely used abroad in the soil quality control system both in the field and in laboratory conditions.

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Changes in electrical conductivity along the soil profile reflect the features of ionization of individual horizons as a result of phase transitions of substances associated with changes in temperature, humidity, redox processes, intensity of mineralization processes, migration of ions and ionized components [4].

Traditionally, electrical conductivity was used to diagnose soil salinity, but recently the use of electrical conductivity values to diagnose other parameters of soil fertility has become widely used in agronomic practice, primarily due to the availability and cheapness of measurements [5]. Quite strong correlation dependences of electrical conductivity with other important agronomic characteristics of the soil were found, in particular, the content of organic substances in the soil, mobile forms of the main nutrients, the presence of Ca, Mg in the soil absorption complex, and the yield of agricultural crops [6; 7].

The dependence of soil electrical conductivity on contamination with heavy metals, hydrocarbons, and pesticides is studied [8]. It was established that electrical conductivity depends on soil moisture, salt concentration, air content, temperature, type of soil-forming rock, etc. In particular, electrical conductivity increases with increasing soil moisture until full moisture capacity is reached, and then remains relatively constant. The presence of clay minerals montmorillonite, illite, and vermiculite in the soil-forming rock contribute to a certain increase in the electrical conductivity of the soil in comparison with sandy soils [9; 10].

The use of fertilizers, especially in significant amounts, can change the amount of soluble mineral salts in the soil, thereby increasing electrical conductivity, which can also have a negative effect on the yield of agricultural cultures [11; 12]. Of particular interest for studying changes in soil electrical conductivity and establishing correlations between it and the main agronomic characteristics of soil fertility and agrocenosis productivity are long-term experiments with the introduction of different rates of fertilizers under different fertilization systems for crops [9].

The purpose of the study is to compare the changes in the electrophysical parameters of typical chernozem under different fertilization systems under conditions of drip irrigation.

The research was carried out by field and laboratory methods within the Forest-Steppe Zone of Ukraine, on the territory of the Educational-Scientific-Production Center "Experimental Field" of the Kharkiv National Agrarian University named after V.V. Dokuchaeva, where strawberries are grown on drip irrigation with fertilizer for the third year in a row.

The following options were chosen for research in the field where garden strawberries are grown (4 rows in each option):

1. option – control (without fertilizers);
2. option – mineral system ($N_{64}P_{64}K_{64}$);
3. the organo-mineral system option ($N_{64}P_{64}K_{64}$+manure 50 t/ha);
4. option – organic system (manure 50 t/ha).

Additional options for conducting research in 2020 were chosen:

5. variant (black steam) – a field of field crop rotation (more than 100 years) without the use of irrigation;
6. option (overlay) – herbaceous vegetation, more than 70 years old.

An experiment for strawberries of the garden variety "Roksana" was laid in the fall of 2017 on an area of 0.3 hectares. Planting was carried out using ridge technology with the use of a mulching film and drip irrigation. The predecessor of strawberries was black steam.

Nitroamophoska $N_{16}P_{16}K_{16}$ and semi-rotted manure were used for fertilization in the experiment. Strawberry planting was carried out in a staggered staggered order in two strips with a distance between plants of 25 cm with rows of 130 cm. Watering was carried out as needed to ensure constant soil moisture within 75%, which was measured by a field hygrometer. The technology of the cultivation system provides for the use of chemical plant protection agents against harmful organisms and non-root feeding during the flowering phase.

Electrophysical indicators were studied in samples of typical deep heavy loam black soil on loess loam from the surface layer of the soil – the ridge (in the experiment with the cultivation of garden strawberries), and then every 10 cm to a depth of 50 cm in the specified variants of the experiment

MATERIALS AND METHODS

Individual soil samples were taken in each research year (2018-2020) in the spring (May) before the start of strawberry flowering. Average mixed samples for analysis were selected from the selected and air-dried soil samples using the quarting method. After that, the average mixed samples were sieved through a Ø1 mm sieve. The soil that did not pass through the sieve was crushed in a mortar. Sand fractions that did not pass through the sieve were added to the sample. Soil samples from each soil layer were placed in storage bags.

Aqueous soil suspension (1:5) was prepared by mixing 10 g of air-dry soil with 50 ml of distilled water in a polypropylene container, intensively stirred for 2 minutes and left for 1 hour to settle the soil-water suspension.

With the help of a conductometer-salt meter (EZODO-8200 M), electrophysical indicators were determined in the upper part of the soil-water suspension (electrical conductivity, general mineralization, salinity). Analyzes were performed in three to five times.

RESULTS AND DISCUSSION

Studies of electrophysical indicators are very rarely used when determining the properties and genesis of soils. At the same time, as noted by a number of

authors, a certain simplicity and speed of determination, as well as a wide range of these indicators in connection with changes in the physical factors of the environment, testify in their favor [13; 14; 15].

In our research,was studied the effect of drip irrigation (control option) and application of fertilizers (mineral, organo-mineral, organic) on the electrical conductivity of aqueous soil suspensions.

Electrical conductivity (Soil Conductivity) of typical chernozem. According to the research results obtained in 2020, a pattern of increasing electrical conductivity with depth can be observed in the options with strawberry cultivation, and in the option without irrigation and the fallow option there are some peculiarities regarding the distribution of values (Fig. 1).

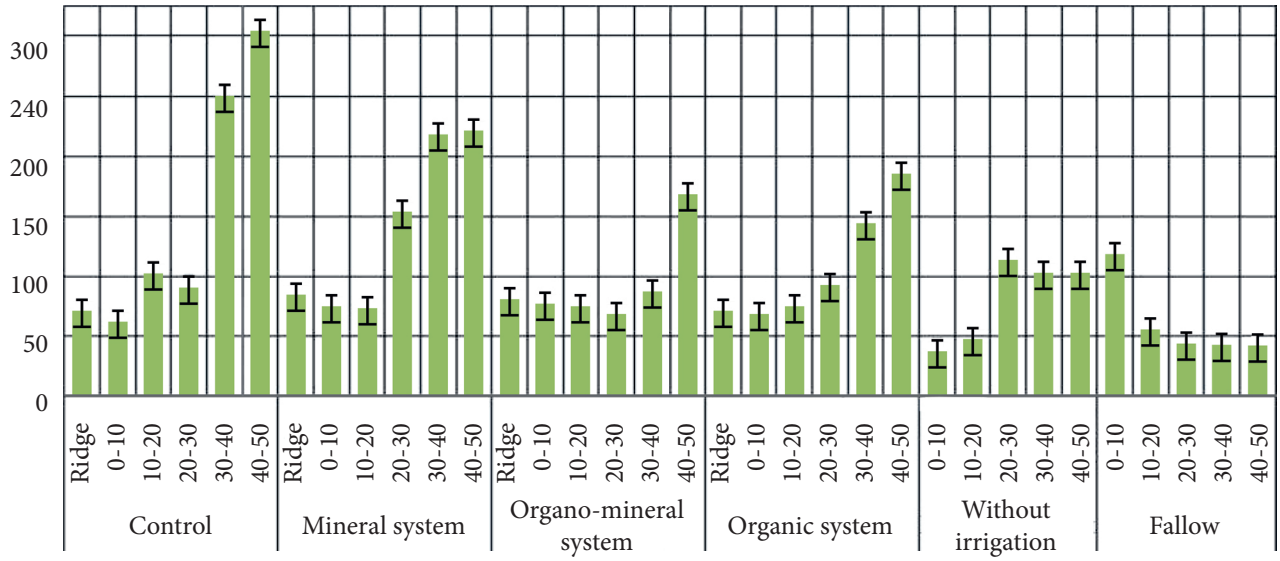

Figure 1. *Electrical conductivity of typical chernozems (2020), μS/cm (NIR_{05}=7)*

Thus, on the control version, the electrical conductivity of the ridge part and the 0-20-cm layer is within the smallest significant difference – 60-65 μs/cm ((HIP_{05}=7). A slight increase starts from a depth of 20-30 cm, and a very significant one - from 30-40 cm up to 249 μs/cm and up to 302 μs/cm in a 40-50 centimeter layer.

The mineral fertilizer system is characterized by a similar trend in the distribution of indicators. Electrical conductivity decreases from the crest to 10-20 centimeters from 83 to 71 μs/cm. In the middle part of the studied depth, the indicators increase by more than 2 times, and the 30-50 centimeter layer has a value of 216-219 μs/cm, which is 2.5-2.6 times more than the upper layers.

On the variant with the organo-mineral system, there is a slight fluctuation of the electrical conductivity of the water-soil suspension up to a depth of 30-40 cm, and the increase in the indicator occurs only in the lower investigated depth of 40-50 cm – 166 μs/cm, which is 2 times more than the lower layers.

The use of an organic fertilization system leads to a gradual increase in values from the upper part to 20-30 centimeters. At a depth of 30-40 cm, there is a 2-fold increase in the indicator compared to the ridge part to 140 μs/cm, and its increase by 42 μs/cm in the 40-50 cm part.

The option without irrigation has the lowest values in the 0-10 and 10-20 cm layers. Then the indicator increases sharply to 111 μs/cm and slightly decreases by 10 μs/cm in the 30-40 and 40-50 centimeter soil layer.

The highest values in the 0-10 cm layer were recorded on the fallow variant at 116 μs/cm. In a layer of 10-20 cm, the electrical conductivity decreases by more than 2 times, and further to a depth of 40-50 cm, it decreases by more than 2.5 times to 39-40 μs/cm.

Taking into account all the studied options, we can say that the highest values of electrical conductivity are in the lower part from 30 to 40 centimeters in the options of control and mineral fertilizer system. Mediocre indicators, also in the lower investigated part, on the variant of the organo-mineral system and the organic fertilizer system, and another 20-30 centimeter soil thickness of the mineral system.

The lowest electrical conductivity of water-soil suspensions is observed in most options in the ridge part and up to 20-30 centimeters, and in the options without irrigation and fallow, all values can be characterized as the lowest among the research options. Such low values of electrical conductivity in the spring period are formed due to the strengthening of processes of assimilation of nutrients by garden strawberry plants from the soil, as a result of intensive growth.

The specific electrical conductivity of the soil during drip irrigation in the garden strawberry growing options was 60-302 μs/cm. The area has a partial leaching of salts (nutrients) into the lower layers of the soil, which can be caused by the use of drip irrigation and the technology of growing plants using a

film, which prevents the evaporation of water together with easily soluble salts into the upper layers of the soil. Therefore, from a depth of 30 cm, there is an increase in the specific electrical conductivity of the soil to 140-302 μs/cm.

When growing strawberry crops without the use of fertilizers in our experiment, the electrical conductivity of the soil was at the level of 60-302 μs/cm. The use of only manure for fertilizing crops practically did not change the electrical conductivity of the upper layers of the soil. The use of organo-mineral and mineral fertilization systems leads to some increase in the indicator. At the same time, the greatest increase in electrical conductivity of the soil was observed in the mineral system [9].

Similar trends in the increase in electrical conductivity when mineral fertilizers are applied are expected and confirmed by the research of other scientists. During the three-year period of the experiment, the electrical conductivity of the soil with the mineral fertilizer system is the highest among the variants of the experiment. However, at the same time, the soil, according to the classification of the Food and Agricultural Organization of the United Nations, remains within the limits of electrical conductivity, which characterize it as not saline. In other words, the electrical conductivity indicators do not exceed the level that can be harmful to plants [9; 16].

Electrical conductivity of irrigation water. For drip irrigation, when watering is carried out quite often, it can be assumed that the soil solution and irrigation water are identical. For cultures, theoretical maximum values of electrical conductivity were established, below which plants cannot grow. To determine the theoretical yield reduction from the use of specific irrigation water, the electrical conductivity of the water is determined, which is much easier than determining the electrical conductivity in the soil. Next, the electrical conductivity of water is compared with the limit values of the electrical conductivity of the soil. If the electrical conductivity of the water is lower, then they conclude that a decrease in yield due to salinity is not expected. Otherwise, they say about a decrease in productivity.

So, the water used for irrigation has the following measured characteristics: electrical conductivity – 1142 μs/cm; total mineralization – 757 ppm; salinity – 570 ppm; pH of water is 6.88.

According to the literature, the threshold value of electrical conductivity for irrigation water of loamy soils is 900 μs/cm. Accordingly, in our case, the exaggeration of the indicator is 242 μs/cm, which can negatively affect the productivity of garden strawberry plants.

In the general case, the following levels are set for the assessment of irrigation water by electrical conductivity, presented in Table. 1.

Table 1. Classification of irrigation water by electrical conductivity

Electrical conductivity of water, μs/cm	Classification of irrigation water according to mineralization (level of soluble salts content)
<650	low
650-1300	average
1300-2900	high
2900-5200	very tall
>5200	extremely high

After determining the actual salinity of irrigation water, a conclusion is made about the feasibility of growing this crop or another crop is chosen that can grow in these conditions without reducing productivity.

Therefore, according to the level of the content of soluble salts, irrigation water can be classified as moderately saline. *Total mineralization (Total Dissolved Solids) of typical chernozem.* Characterizing the general mineralization separately for each variant of research, the largest values can be traced in the lower layers, and the smallest - in the upper ones (Fig. 2). Thus, the total mineralization on the control version is equal to 40-46 ppm, the version with mineral fertilizer 47-56 ppm, organic-mineral – 44-57 ppm, and only organic - 43-60 ppm and increases to values of 110-200 ppm.

The option without irrigation has a value of 73 ppm in a layer of 20-30 cm, which corresponds to the largest and 20 ppm in a layer of 10-20 cm – the smallest value of the option. The fallow variant of use is characterized by an increase in total mineralization in the upper 0-10 centimeter layer of the soil – 77 ppm and its subsequent decrease to 35-26 ppm in the depths.

According to the indicator of total mineralization, the highest values among all research options were found on the control and mineral fertilizer system from a depth of 30 to 50 cm – 165-199 ppm and 142-144 ppm, respectively. We have average values in soil samples from a depth of 30-40 and 40-50 cm of the organic system – 93 and 120 ppm, of the organo-mineral system, only at a depth of 40-50 cm – 110 ppm and 20-30 centimeter thickness of the variant of the mineral system – 101 ppm. All other values of the indicator of total mineralization can be classified as low – from 40 to 60 ppm. Also, the options without irrigation and the

fallow option for all studied depths from 0 to 50 cm are subject to the lowest values of total mineralization.

Salinity (Salinity) of typical chernozem. The salinity of the soil of the control variant begins to increase from 31-36 ppm from the upper part to 10-20 cm and 45 ppm at 20-30 cm (Fig. 3). In the layers of 30-40 and 40-50 cm, the highest values were found – 125 and 151 ppm.

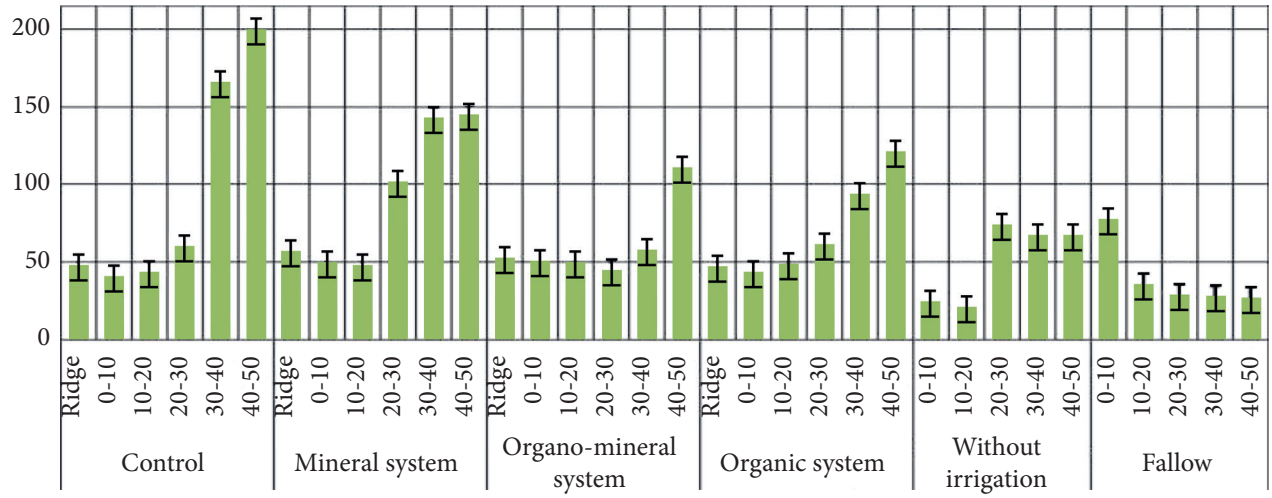

***Figure 2**. General mineralization of typical chernozems (2020), ppm (HIP_{05}=5)*

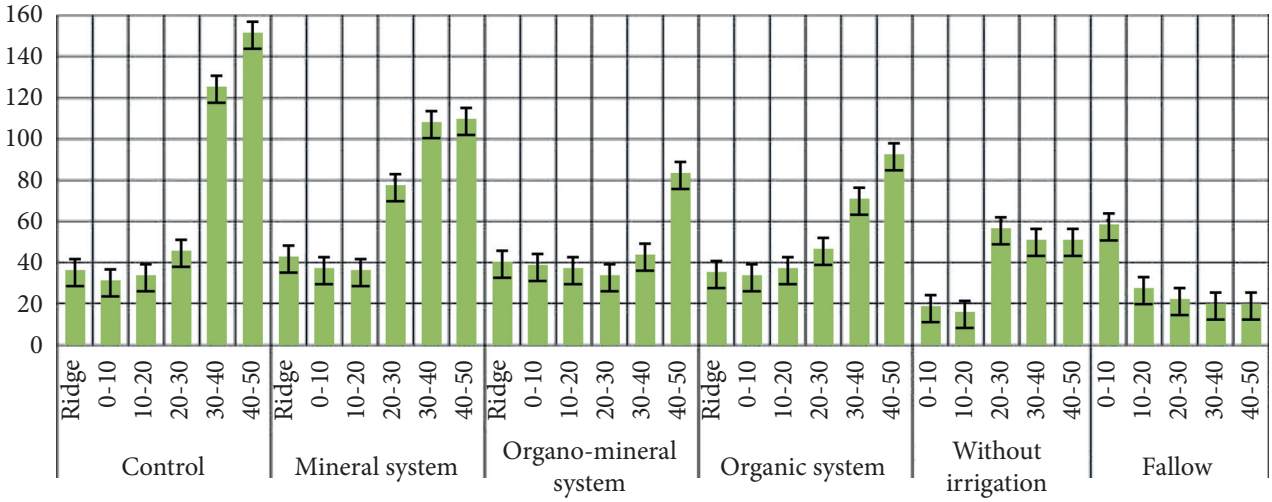

***Figure 3**. Salinity of typical chernozems (2020), ppm (NIR_{05}=4)*

On the version of the mineral system, first there is a slight decrease in values from 42 to 36 ppm, and then an increase more than twice and a significant increase (NIP_{05}=4) in the 30-50 cm layer to 108-109 ppm.

The organo-mineral fertilizer system is also characterized by almost similar salinity indicators with a difference in the upper part of 2-3 ppm, but the highest value of 83 ppm in a layer of 40-50 cm (less than 26 ppm).

The organic fertilizer system has salinity in the upper part at the level of indicators of the control variant, and in the lower part - the variant of the organo-mineral system.

The value of 56 ppm corresponds to the highest value in the version without irrigation in the layer of 20-30 cm. Smaller values of 15-19 ppm were recorded in the upper layers, and higher values in the lower ones – 50-51 ppm. In the 0-10 cm layer of the fallow variant, in contrast, salinity of 58 ppm is highest in the 0-10 cm layer, with a sharp 2-fold decrease in the next 10 cm layer and fluctuations within the smallest significant difference in the 10 to 50 cm layers.

We have the highest values of the salinity index in the control options and the mineral fertilizer system in the two lower studied layers. The lowest values correspond to the upper ridge parts and 0-30, 0-40 centimeter layers. Similarly, the lowest values are observed in all 10-centimeter layers of variants without irrigation and fallow.

Correlation of electrical conductivity data and soil pH. We conducted a correlational analysis of data on the dependence of water pH and salt pH on electrical conductivity, general mineralization, and salinity of soil-water suspensions (Table 2).

Table 2. Correlation matrix of data of electrophysical parameters and pH of typical chernozem

Cond	–	1,00	1,00	0,62	0,67
TDS	1,00	–	1,00	0,62	0,67
Salt	1,00	1,00	–	0,62	0,67
pH water	0,62	0,62	0,62	–	0,93
pH salt	0,67	0,67	0,67	0,93	–
	Cond	**TDS**	**Salt**	**pH water**	**pH salt**

On the control version, the correlation of electrical conductivity and aqueous pH is 0.88, and with saline pH is 0.91, which corresponds to a very strong direct relationship. The following option with the use of a mineral fertilizer system has a similar dependence – 0.96 and 0.98, respectively.

An even greater correlation between these data can be observed on the option without drip irrigation – 0.97 and 0.98.

The variant with organo-mineral fertilizer is characterized by an average inverse correlation of electrophysical parameters and aqueous pH, but a strong direct correlation with saline pH – 0.76.

On the version of the organic system, feedbacks were recorded with water pH – -0.87 and salt pH – -0.69. The variant of fallow use has a practically similar, but even greater inverse correlation dependence, where the relationship between electrical conductivity and water pH is -0.94, and salt pH is -0.79.

However, first of all, based on the obtained data arrays, we can state a very strong direct correlation between the water and salt pH data, which is 0.93. Secondly, a strong direct relationship between pH data (aqueous and saline) and indicators of electrical conductivity, salinity and general mineralization was revealed. The correlation between electrophysical indicators and aqueous pH is 0.62, and saline pH is 0.67 (Table 2).

Dynamics of changes in electrophysical parameters of typical chernozem. According to the data obtained during the 2018-2020 research, we can trace the dynamics of electrophysical indicators on the variants with the cultivation of garden strawberries (Fig. 4).

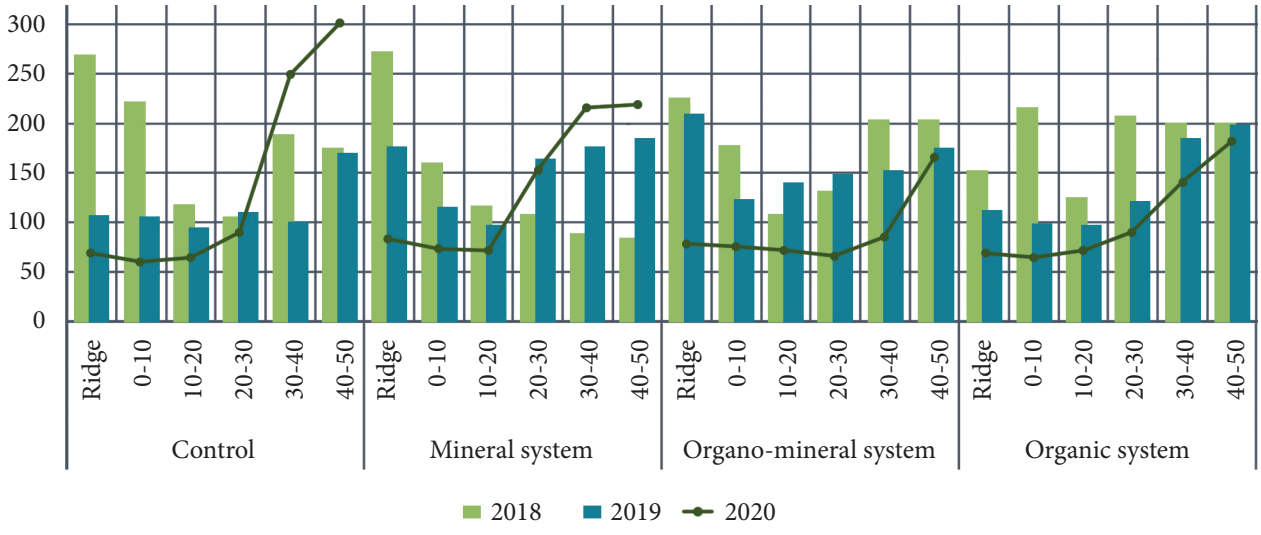

Figure 4*. Dynamics of changes in electrical conductivity of typical chernozem under different fertilization options (2018-2020), µs/cm (NIR$_{05}$ 2018=5; 2019=10; 2020=7)*

Thus, on the control variant, the highest values were found in the 30-40 and 40-50-centimeter soil layer in 2020 of the study (249 and 302 µs/cm) and the ridge part of 2018 (268 µs/cm). We have average values in 2018 and 2019 in the lower studied part of the soil, and the lowest in the middle of 2018 and the upper part of the control version in 2019, 2020 (93-106, 60-89 µs/cm).

The dynamics of the highest values of the variant with the use of mineral fertilizers shows the highest values in the ridge part of 2018 (272 µs/cm) and, conversely, the lower one – in 2020 (219 µs/cm).

Average electrical conductivity in most of the analyzed samples in 2019 (163-183 μs/cm).

The lowest values in the soil layer from 10 to 50 cm in 2018 (83-115 μs/cm) and the upper part up to 20 cm in 2020 (71-83 μs/cm).

The highest electrical conductivity of soil-water suspensions in 2018 on the option of organic-mineral fertilizer in the upper and lower parts of the studied depth. In most cases, the electrical conductivity in 2019 is average (122-151 μs/cm), and in 2020 it is low (66-86 μs/cm).

The organic fertilizer option is characterized by the highest values of 2018 research (high – 197-215 μs/cm and average electrical conductivity – 124-151 μs/cm). Low values of the indicator were recorded up to 20-30 cm in 2019 and 2020 (respectively 97-110 and 65-90 μs/cm), and the highest, again, in the thickness of 30-40 and 40-50 cm (182-198 μs /cm).

Therefore, in most cases, there is a decrease in the electrical conductivity of soil-water suspensions in 2020 of the research compared to 2019 and 2018, which may be caused by a decrease in the content of available nutrients and organic matter, since fertilizers were applied only in the year of the experiment (2017) or by weakening the biological activity of the soil.

The biggest changes occurred in the control variant in the comb part, where the values decreased from 268 μs/cm in 2018 to 69 μs/cm in 2020, the variant of the mineral system (decrease by 189 μs/cm) and organo-mineral (decrease by 146 μs /cm).

On the contrary, an increase in electrical conductivity occurred in 2020 compared to previous years in the lower studied stratum of the control options and the mineral fertilizer system. The 30-40 and 40-50 centimeter thickness of the organic fertilizer variant is characterized by practically constant indicators for three years. According to indicators of total mineralization and salinity, a similar trend is observed regarding the dynamics of changes, but somewhat with other digital indicators.

CONCLUSIONS

Electrophysical indicators change depending on the depth of sampling, which is related to the assimilation of nutrients from the soil by plants and fertilization systems and correlates to a large extent with the acid-base characteristics of the soil.

The study of the electrical conductivity of 2020 typical chernozem when growing strawberry crops without the use of fertilizers was at the level of 60-302 μs/cm. The use of only manure for fertilizing crops practically did not change the electrical conductivity of the upper layers of the soil. The use of organo-mineral and mineral fertilization systems leads to some increase in the indicator. At the same time, the highest electrical conductivity of the soil was observed in the mineral system, where mineral fertilizers that acidify the soil are an additional factor of influence, which, accordingly, leads to a decrease in electrical conductivity.

With the help of the electrical conductivity indicator, it is possible to quickly determine the suitability of water for irrigation of the planned crop with a known granulometric composition of the soil. Therefore, the use of water for drip irrigation with an average content of soluble salts leads to their accumulation in the soil.

Based on the dynamics of the obtained values, we can state that in most cases there is a decrease in the electrical conductivity of soil-water suspensions in 2020 of the research compared to 2019 and 2018, which may be caused by a decrease in the content of available nutrients, organic matter, or a weakening of the biological activity of the soil .

The obtained data confirm the effectiveness and efficiency of the use of electrophysical parameters of the soil during the application of fertilizers and the use of drip irrigation.

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Використання електрофізичних показників під час вирощування суниці на краплинному зрошенні

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Анотація. Електрофізичні методи дослідження є широко використовуваними у країнах з розвиненим аграрним виробництвом з метою проведення грунтових моніторингу та обстежень. Одним з таких методів досліджень є визначення електропровідності ґрунту. Оскільки за допомоги цього показника релевантно уточнювати межі грунтових відмін, що дає змогу застосовувати його у точному землеробстві. Таким чином, метою статті є порівняння змін електрофізичних показників чорнозему типового за різних систем удобрення в умовах краплинного зрошення. Задля здійснення аналізу було відібрано індивідуальні зразки ґрунту кожного року досліджень в період 2018-2020 рр. навесні (травень) до початку цвітіння суниці. Із відібраних та висушених до повітряно-сухого стану ґрунтових зразків методом квартування було відібрано середні змішані зразки для проведення аналізу. Зроблено висновок, що електрофізичні показники зазнають змін відповідно до глибини відбору зразків, що пов'язано із засвоєнням корисних речовин із ґрунту рослинами та механізмів удобрення і корелюють у значній мірі із кислотно-лужними показниками ґрунту. Проведено трирічні дослідження (2018-2020) впливу різних систем удобрення в умовах крапельного зрошення на електрофізичні показники чорнозему типового під час вирощування суниці садової. Встановлено, що найбільші зміни електрофізичних показників (електропровідність, загальна мінералізація, солоність) чорнозему типового відбуваються від гребеневої частини до глибини 20-30 см. Виявлена відмінність в отриманих значеннях електрофізичних показників між варіантами різного удобрення чорнозему типового (контрольний, мінеральна система, органо-мінеральна система, органічна система), а також протягом років досліджень

Ключові слова: слова: чорнозем типовий, електрофізичні показники, крапельне зрошення, удобрення

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The effect of biological preparations on CO_2 emission and microflora in the root zone of corn

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Abstract. The process of improving farming systems reflects the main periods of development of the agricultural sphere as a whole. The development of farming systems is an integral part of industrial production, as well as scientific and technological progress. It is important to spread and implement so-called alternative farming systems that eliminate or minimize the use of agrochemicals. Crop residues are an important source of arable soil fertility reproduction, while the microbial transformation of fresh organic matter in arable soils informs processes such as food production, the greenhouse effect, and the global carbon cycle. In turn, the integral indicator that most clearly and fully reflects the nature of the intensity of mineralization of organic matter in the soil is the emission of carbon dioxide. Thus, the purpose of the article is to conduct research during the growing season on the processes of "soil respiration" and the amount of microflora in the soil of the basal zone of plants, which will make it possible to reveal the influence of the elements of biologization of agriculture on the indicators of the biological activity of podzolized chernozem. CO_2 emission processes and the abundance of the main groups of microflora were monitored during the 2020 growing season in the stationary field experiment "Influence of different levels of biologization of agriculture on soil fertility". The article presents the results of observations of carbon dioxide emissions and other indicators of biological activity of the soil in order to determine the effectiveness of the implementation of elements of biologization of agriculture. It was established that the application of a complex of agricultural measures (soil treatment with a stubble destructor, pre-sowing treatment of seeds with a biopreparation and two-time foliar treatment with a humic preparation) increased CO_2 emissions and increased the number of microflora in the root zone of corn compared to the control. A significant increase in the yield of corn grain from the use of a complex of biological preparations was noted (up to 16% depending on the variant)

Keywords: emission of carbon dioxide, biologization of agriculture, agricultural activities, soil microflora, corn

INTRODUCTION

The development of agricultural systems in any country primarily reflects the main stages of the development of agriculture in general. The renewal and evolution of farming systems are inextricably linked with industrial production and scientific and technological progress. One of the new challenges of modern times is the deterioration of the environment and agro-ecosystems, in particular, the increase in soil degradation, which necessitates a change in the modern strategy of agriculture. It is likely that the path of further intensive

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general chemicalization of agriculture is economically impractical and ecologically dangerous. In this regard, in many countries, the so-called alternative farming systems, which exclude or minimize the use of agrochemicals, have become widespread. In Ukraine, studies of the effectiveness of various measures of biologicalization of agriculture have also been conducted for a long time [1;2], and with the adoption of the Law of Ukraine "On the Production and Circulation of Organic Products", these issues have become particularly relevant.

Plant residues are the most important resource for reproducing the fertility of arable soils. One of the most expedient means of their use is to work them into the soil, without removing them from the field, in order to reproduce organic matter and preserve the functional properties of soils in agrocenoses. However, post-harvest plant residues of grain crops decompose rather slowly due to the high content of lignin and cellulose and low nitrogen content, which can lead to a decrease in the yield of fertilized crops that follow them in the crop rotation. One of the ways to accelerate the decomposition and increase the humification coefficient of stubble and straw, which has become widespread in recent years in the practice of the agro-industrial complex, can be their treatment with microbial preparations - stubble destructors. At the same time, the introduction of highly effective strains and consortia of destructive microorganisms is ensured directly on the straw and, in the future, into the soil [3].

Microbial transformation of fresh organic matter in arable soils determines such processes as the global carbon cycle, food production, and the greenhouse effect. The integral indicator that most fully reflects the intensity of mineralization of organic matter in the soil is the emission of carbon dioxide.

In recent years, considerable attention has been paid to the impact of CO_2 concentration on the kinetics of soil microbial respiration.

It has been established that the increase in the amount of CO_2 in the atmosphere can affect the biomass and activity of soil microorganisms only indirectly - due to the increase in the amount of root exudates and other organic substrates of plant origin accessible to microbial decomposition [4-6]. Depending on the type of plant under which the microbial population is formed, both an increase and a decrease in the emission flow can be observed.

In some scientific studies, it has been established that the use of biological destructors accelerates the processes of mineralization and humification of straw in the soil, reduces the manifestation of phytotoxicity, and increases the yield of subsequent crops [7-10]. In field experiments on chernozem soils, during autumn processing and plowing of winter wheat straw with microbiological fertilizer Baikal EM-1 (2-3 l/ha), the number of plant residues that did not decompose before spring decreased from 8.5 to 1.9 and 3, 2 t/ha. In production tests on sod-podzolic soil, after processing chopped straw with this biopreparation (with the introduction of urea – 10-12 kg per 1 ton of straw) by spring, plant residues were almost completely decomposed [11].

According to O. De Kok-Mercado, microbial biopreparations can show limited decomposing effectiveness in agricultural soils due to a certain dependence of the growth of microorganisms on environmental factors. This author's research examined the effectiveness of a microbial preparation, which includes the microorganisms Bacillus subtilis, Rhodotorula lactose, Debaromyces hansenuii, Hansenula anomala, Cladosporium cladosporiodes, designed specifically to activate the decomposition of plant residues in No-Till agricultural systems, namely to intensify the decomposition of corn residues in the loamy soil of Iowa. It is assumed that this preparation is characterized by the potential ability to accelerate the decomposition of plant residues and can be effective in soils with a low content of organic matter and low activity of the indigenous soil microbial community [12].

At the same time, along with certain positive results that testify to the effectiveness of biological preparations designed to accelerate the decomposition of straw, there are experimental data of some researchers that showed the absence of a stable and sustainable effect from the use of destructors both in terms of increasing the decomposition of straw and in relation to changes in the emission flow of carbon dioxide gas from the soil [13-15]. The effect of "effective microorganisms" (EM) was investigated in a field experiment (2003-2006) in Switzerland. The experiment was developed in order to clearly distinguish the influence of microorganisms directly and the substrate that served as their nutrient medium (introduction of the drug after sterilization). In this study, no effect of introduced microorganisms (EM) was found on yield and soil microbiological parameters such as soil respiration and microbial biomass. Based on the obtained results, it was concluded that "effective microorganisms" are not able to improve the yield and quality of the soil in the medium term (4 years) in agriculture in the conditions of the temperate climate of Central Europe [16].

In view of the above, the purpose of the article is to conduct observations during the growing season on the processes of "soil respiration" and the number of microflora in the soil of the root zone of plants, which will allow to reveal the influence of elements of biologization of agriculture (application of a complex of biological preparations, which includes a stubble destructor) on indicators of biological activity podzolized chernozem.

MATERIALS AND METHODS

CO_2 emission processes and the abundance of the main groups of microflora were studied during the 2020 growing season in the stationary field experiment

"The influence of different levels of biologization of agriculture on soil fertility" (registered under No. 07 in the Register of "Stationary Field Experiments of Ukraine"), which was established in 1989 in SE "DG "Grakivske" NNC "IGA named after O.N. Sokolovsky" near the village. Novy Korotych of the Kharkiv district of the Kharkiv region. The soil of the experimental field is chernozem, gilded with low humus, heavy loam on forest-like loam. The arable layer of the soil contains: humus according to the Tyurin method 4.1% [17]; of total nitrogen – 0.21% [18], mobile phosphorus according to the Chirykov method – 111 mg/kg of soil, mobile potassium according to the Chirykov method – 90 mg/kg of soil [19]. They studied the effect on "breathing" and the number of soil microorganisms of the complex application of biological preparations of various purposes. For the study, four variants of the experiment were laid:

1. Soil treatment with the Humistern stubble destructor, pre-sowing seed treatment with the biopreparation Humikor, two-time foliar treatment of plants with the liquid humic preparation Humisol-Plus 03 Corn (in the phase of 3-5 and 9-11 leaves) (all preparations produced by AF "Hermes");
2. Control, without treatments;
3. Urea + soil treatment with the Humistern stubble destructor, pre-sowing seed treatment with the biopreparation Humikor, two-time foliar treatment of plants with the liquid humic preparation Humisol-Plus 03 Corn (in the phase of 3-5 and 9-11 leaves);
4. Urea, without processing.

The cultivated plant is corn for grain.

Observations of the intensity of CO_2 emissions from the soil were carried out in the field three times during the growing season of 2020. Instrumental control of the intensity of carbon dioxide emission from the soil surface was carried out using a testo 535 portable gas analyzer with isolation from atmospheric air. Measurements were performed 3-5 times a day with further averaging and statistical processing of the results. Simultaneously with the measurements of the intensity of carbon dioxide release, the temperature and humidity of the soil in the 0-20 cm layer were determined using a portable thermometer and hygrometer.

Portable gas analyzers are a convenient means of preliminary operational control of the gas composition of the soil. The testo 535 portable gas analyzer is designed to determine the concentration of carbon dioxide in soil air and in the surface part of the atmosphere. The device has a display part and an infrared probe-absorber. Probe type – 2-channel infrared sensor. The measurement range is from 0 to 104 ppm CO_2. The portable CO_2 gas analyzer is especially useful in cases that require mobility and frequent changes of the place of observation, because the light weight and compactness make this device very convenient to use. To increase the accuracy and objectivity of the measurement results, you should choose an exposure of up to 15 minutes, a working chamber with an average absorption volume of 2-3 dm^3 with a vertical fixation of the infrared probe at a distance of 1.5-2 cm from the soil surface [20].

The number of the main groups of microflora in the soil samples of the basal zone of plants was determined by the method of microbiological sowing of the soil suspension with the appropriate dilution on solid nutrient media [21-24]: organotrophic bacteria - on meat-peptone agar (MPA), microorganisms that assimilate nitrogen from mineral compounds, and actinomycetes – on starch-ammonium agar (KAA), oligotrophic microorganisms – on starvation agar (HA), fungi – on Richter's medium, Azotobacter – on Ashby's medium with the addition of trace elements, phosphate-mobilizing bacteria on Muromtsev's medium (for bacteria that dissolve mineral phosphates soil), and Mönkinoi (for bacteria that dissolve soil organic phosphates); (repetition 3 times: each soil sample was sown on each nutrient medium in 3 parallel Petri dishes). Soil samples for microbiological research were taken twice during the growing season - the first time 3 weeks after the last treatment of plants with liquid humic fertilizer, the second time – 2 months after the first, before harvesting.

RESULTS AND DISCUSSION

According to the results of field measurements obtained during the growing season of 2020, the difference in the release of carbon dioxide from the soil surface for the tested options is quite significant. The obtained results show an increase in the emission flow of carbon dioxide with the use of a complex of agricultural measures (treatment with a stubble destructor, treatment of seeds with a biopreparation and two-time foliar treatment with a humic preparation) (Fig. 1; 2).

An increase in the intensity of "breathing" was also observed with the introduction of urea. The data of many authors confirm that the use of biological preparations accelerates the decomposition of high-carbon plant residues and increases the biogenicity of the soil. The effectiveness of biological preparations also increases in combination with compensatory doses of nitrogen [25; 26].

The positive effect of the use of a complex of biological preparations on the microflora remained at the end of the growing season, although it was weaker than what was observed in July. The number of bacteria assimilating organic nitrogen compounds in the soil samples of variants treated with preparations without mineral fertilizers was 37-59% higher than that of the soil of the control plots, microorganisms assimilating mineral nitrogen – by an average of 31%, actinomycetes – by 11 %, oligotrophic microorganisms – by 5-8%. The number of micromycetes, as in the previous sampling period, decreased by 8-32%. On average, the number of microorganisms of the studied groups in the

soil of the root zone of corn in the variants with the use of agricultural measures without the introduction of mineral fertilizers was 15% higher than the control indicators. In the soil samples of the root zone of the plants, selected on the plots of options with additional treatment with urea, a larger number of microorganisms was also observed with the use of agromeasures, also to a lesser extent, than during the previous period of sampling. The number of organotrophic bacteria in the soil samples of the variants treated here was greater than in the control soil (surface treatment of the soil with urea) by 11-49%, microorganisms that assimilate nitrogen mineral compounds by 54%, oligotrophs by 10%, eutrophs by by 46%. The number of microscopic fungi decreased by 12-45%. Generalization of the data obtained during the second sampling showed that at the end of the growing season in the soil of the basal zone of plants with the use of a complex of preparations, the number of microorganisms of the main groups was on average higher than in the control, by 15% in the case without mineral fertilizers and by 18% in the background of urea.

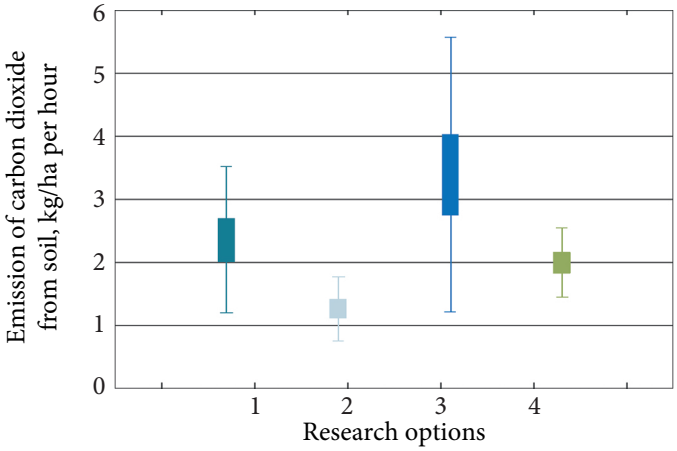

Figure 1. *Emission of carbon dioxide from the soil in different versions of the experiment, kg/ha per hour*

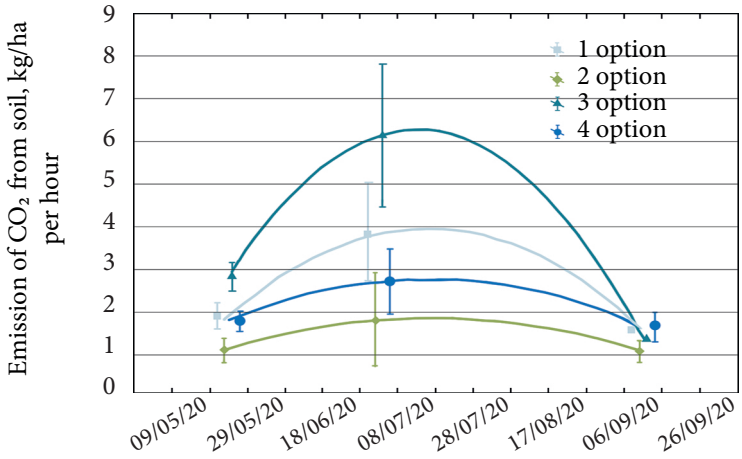

Figure 2. *Seasonal dynamics of carbon dioxide emissions from the soil in different variants of the experiment, kg/ha per hour*

The amount of CO_2 produced by the soil is determined both by biological factors (the rate of growth and development of plants and microorganisms, root respiration) and by the physical conditions of the environment (temperature and humidity of the air and soil, etc.). In this regard, the emission of CO_2 from the soil surface has quite clear daily and seasonal dynamics. The authors observed an increase in emission in the summer period with a gradual fading until autumn (Fig. 2).

As you know, biological preparations "work" most actively during the initial period of decomposition, in optimal conditions of humidity and temperature for microbiota. The accompanying observations

of soil temperature and humidity showed the highest values in June-July, and in September, soil humidity was critically low, close to the humidity of plant wilting. According to the authors, this became one of the limiting factors that suppress "soil respiration" in the autumn period (Fig. 3, 4).

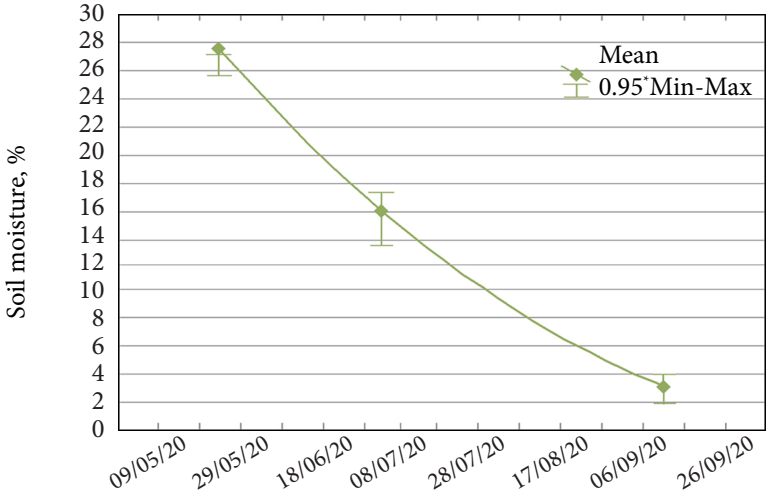

***Figure 3**. Seasonal dynamics of moisture in the arable soil layer*

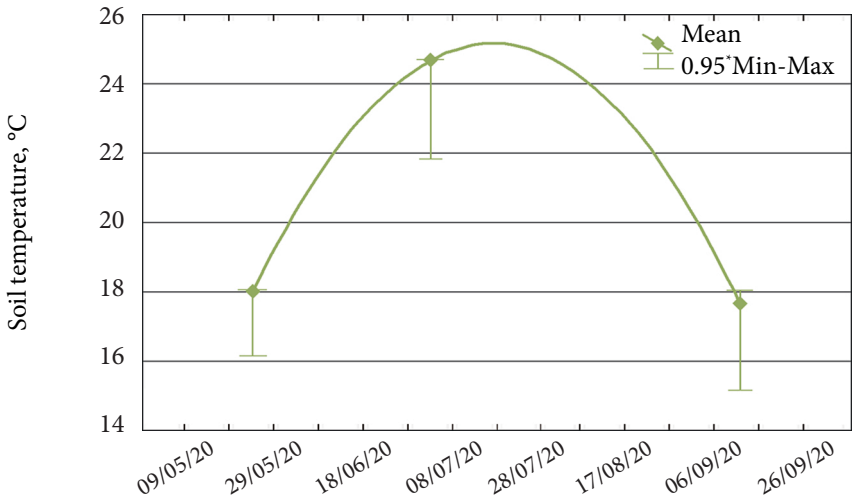

***Figure 4**. Seasonal temperature dynamics of the arable soil layerr*

As it known, root respiration makes up approximately 40% of the total soil respiration. Therefore, the growth of vegetation and root mass of plants significantly affects the overall emission flow. In particular, the influence of changes in humidity and soil temperature, as the main natural factors regulating the course of biological processes, during the growing season is covered by the action of a set of anthropogenic factors, primarily due to the contribution of root respiration. The largest contribution of root respiration to the emission flow is made by grain stubble crops – winter rye, winter wheat, barley, CO_2 intake from the soil under which is 35% higher than from the soil under steam. Row crops (corn, sunflower) are inferior to them in this, probably due to less coverage by the root system of the upper soil layer [27; 28].

The obtained yield data of corn grain demonstrate a significant increase in the yield with the use of a complex of agricultural measures (treatment with a stubble destructor, seed treatment with a biopreparation and two-time foliar treatment with a humic preparation) both without the introduction of mineral fertilizers – by 14.5%, and against the background of urea – by 16% (Fig. 5).

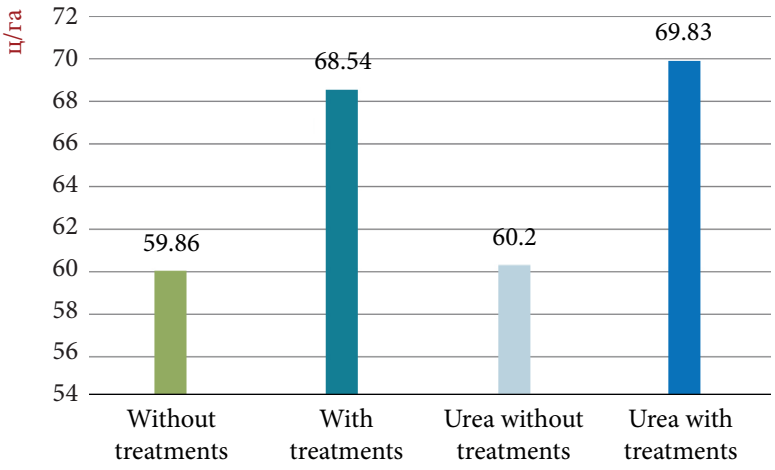

Figure 5. *Grain yield of "DN Vita" corn*

CONCLUSIONS

According to the obtained data, the use of a complex of agricultural measures, which includes the use of a stubble destructor, has a significant impact on the formation of the emission flow of carbon dioxide from podzolized chernozem and the microbial community in the root zone of plants. It has been confirmed that CO_2 emission from the soil surface has quite clear daily and seasonal dynamics. We recorded an increase in emission in the summer period with a gradual fading until au-tumn, which illustrates the direct connection of "soil res-piration" with the seasonality of the microbial coenosis.

The influence of hydrothermal factors and the growth of the root mass of the plant are undoubted-ly significant factors in changes in the emission flow. But the systematic complex application of biological preparations can, by accelerating the decomposition of high-carbon plant residues and increasing the biogenicity of the soil, significantly affect the dynamics of carbon dioxide production and the balance of soil carbon as a whole.

An increase in the number of microflora in the root zone of corn plants was noted, in particular, agronomically useful bacteria – nitrogen-fixing, phosphate-mobilizing, which contribute to the optimization of plant root nutrition.

In the conditions of the growing season of 2020, reliable increases in the yield of corn grain of the "DN Vita" variety from the use of a complex of biopreparations amounted to 14.5% without the introduction of mineral fertilizers, against the background of urea – 16%.

The use of modern microbial preparations in corn cultivation technologies can also limit non-productive losses of compounds of biogenic elements in the soil profile. Prospective studies are aimed at scientific justification for the further introduction into agricultural production of microbial preparations based on beneficial microorganisms, which can significantly reduce the chemical load on the environment and contribute to carbon sequestration in the soil.

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Вплив біопрепаратів на емісію CO_2 та мікрофлору у прикореневій зоні кукурудзи

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Анотація. Процес удосконалення систем землеробства відбиває основні періоди розвитку сільськогосподарської сфери в цілому. Розвиток систем землеробства є невід'ємною частиною промислового виробництва, а також науково-технічного прогресу. Важливим є розповсюдження та впровадження так званих альтернативних систем землеробства, що нівелюють або мінімізують використання агрохімікатів. Рослинні рештки є вагомим джерелом відтворення родючості орних ґрунтів, водночас перетворення мікроорганізмами свіжої органічної речовини в орних ґрунтах ознаменує такі процеси, як виробництво продовольства, парниковий ефект, а також глобальний кругообіг вуглецю. У свою чергу, інтегральним показником, що найбільш чітко та повно відображає характер інтенсивності мінералізації органічної речовини в ґрунті, є емісія вуглекислого газу. Таким чином, метою статті є проведення досліджень протягом вегетаційного періоду за процесами «дихання ґрунту» та кількістю мікрофлори у ґрунті прикореневої зони рослин, що дасть змогу виявити вплив елементів біологізації землеробства на показники біологічної активності чорнозему опідзоленого. За процесами емісії CO_2 та чисельністю головних груп мікрофлори спостерігали впродовж вегетаційного періоду 2020 р. у стаціонарному польовому досліді «Вплив різних рівнів біологізації землеробства на родючість ґрунту». У статті викладено результати проведення спостережень за емісією вуглекислого газу та іншими показниками біологічної активності ґрунту з метою визначення ефективності впровадження елементів біологізації землеробства. Встановлено, що застосування комплексу агрозаходів (обробка ґрунту деструктором стерні, передпосівна обробка насіння біопрепаратом та двократна позакоренева обробка гуміновим препаратом) посилили емісію CO_2 та підвищили чисельність мікрофлори у прикореневій зоні кукурудзи порівняно з контролем. Відмічено достовірний приріст урожаю зерна кукурудзи від застосування комплексу біопрепаратів (до 16 % залежності від варіанту)

Ключові слова: слова: емісія вуглекислого газу, біологізація землеробства, агрозаходи, мікрофлора ґрунту, кукурудза

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The influence of the use of the drug Albit on the formation of the seed productivity of the pre-basic material of potatoes

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Abstract. The indicator of high and productive potato harvests is the use of new high-yielding varieties, effective planting material, proper provision of plants with useful substances, ensuring crop care, protection of plants from weeds, diseases and pests, maintaining optimal soil moisture during the growing season. One of the priority indicators that determine the low yield of potatoes in many areas of Ukraine, both favorable and unfavorable for potato growing, is the use of low-quality seed material that is affected by infectious phytopathogens. reproduction of healthy seed material is one of the main tasks of potato seed production. The use of biological preparations to stimulate the development of plants, increasing their endurance to negative environmental stimuli is relevant for the accelerated reproduction of such material. Thus, the purpose of the article is to study the effective technological aspects during the reproduction of pre-basic seed material of potatoes, which includes the use of the biological preparation Albit, in the conditions of the southwestern territory of the Forest Steppe of Ukraine. The article presents the results of studies of the influence of methods of application of the complex drug Albit on the formation of potato productivity in the process of reproduction of pre-basic seed material in the conditions of the southwestern part of the Forest Steppe of Ukraine. In the course of research, it was established that in order to achieve a high level of realization of the biological potential of the culture and product quality when growing pre-basic potato seed material, it is advisable to treat the tubers at planting with Albit 100 ml/t and to spray twice in the seedling and budding phases of vegetative plants with the drug in a dose of 50 ml/Ha

Keywords: potato, harvest, seed productivity, growth regulating substances, tuber fractions

INTRODUCTION

The criterion for high and guaranteed potato yields is the use of new high-yielding varieties, high-quality planting material, full supply of plants with nutrients, timely care of crops, effective protection of plants from weeds, diseases and pests, maintenance of optimal soil moisture during the growing season, compliance with technological regulations.

One of the main factors determining the low yield of potatoes in almost all areas of Ukraine, both favorable and unfavorable for potato growing, is the use of low-quality seed material affected by infectious phytopathogens.

Protection of seed potatoes from viral and other diseases, as well as preservation of reproductive properties of varieties is provided by the potato seed production system. Potato seed production is a branch of potato growing, the task of which is the cultivation of planting material of high reproductions of both potato

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varieties that have been in production for a long time, and new ones, to the extent that they are entered into the State Register of plant varieties suitable for distribution in Ukraine, with mandatory preservation their purity, biological and economic qualities for varietal replacement and systematic varietal renewal in farms of various forms of ownership.

Proper seed production is the most important condition for obtaining high and stable potato yields.

A characteristic feature of the modern innovative development of potato seed production is the production of high-quality seed material of new varieties, resistant to diseases, with high adaptability to various natural and climatic conditions and valuable economic characteristics, which is an important condition for their commercial attractiveness.

In market conditions, along with the increase in potato production, the problem of seed quality has arisen as one of the most important factors in the seed production system. High-performance planting material, with regular variety renewal under all other equal conditions and measures, provides a yield increase of up to 50%.

Therefore, the reproduction of healthy seed material and the increase in the production of super-super-elite in a short period of time is one of the main tasks of potato seed production [1].

The use of biological preparations to stimulate the growth and development of plants, increase their resistance to negative environmental factors (drought, frost, stress after treatment with pesticides, etc.), to harmful organisms is currently relevant for the accelerated reproduction of such material.

Wide use of modern growth-regulating substances is one of the factors of increasing productivity, improving quality and realizing the potential productivity of potato varieties. The use of plant growth regulators in potato plantations in modern conditions of climate deterioration, with the rejection of the use of organic fertilizers and a decrease in quality indicators of soil fertility, increases the overall productivity of potatoes, and increases the reproduction rate of the improved source material. According to the results of the research of the Institute of Potato Growing of the National Academy of Sciences, foliar fertilization with the growth regulator gibberellin A1 at the rate of 20 g/ha during propagation of healthy potatoes by seedling culture increased the yield of seedlings from in vitro plants by 19-26% and increased their reproduction coefficient, depending on the variety, by 18-22%. The use of succinic acid at a rate of 2 kg/ha led to an increase in yield by 21-25% and an increase in the size of tubers by 32-38% [2].

The use of growth-regulating substances of the new generation, which are a combination of synthetic or natural phytohormones and synthetic or natural humic acids, makes it possible to reduce the volume of chemical fertilizers and plant protection agents. The use of such combinations in spring and autumn stabilizes soil biology.

An increase in the yield of seed tubers of the standard fraction was noted during the complex treatment of potato tubers and plants with Stimpo plant growth regulator. In the Strumok variety, in the version using tubers 28-60 mm in size at a planting density of 74.1 thousand pcs./ha – by 82.1 thousand pcs./ha or 16.4%. When planting tubers with a density of 66.7 thousand pieces/ha – by 87.3 or 18.0%. When using small tubers <28 mm in size (66.7 thousand pieces/ha), the yield of seed tubers increased by 47.8 thousand pieces/ha or 11.3% [3].

Scientific and practical interest in plant growth regulators is growing in many countries. Such interest in their use is caused by the fact that, in the opinion of many scientists and technologists, the possibilities of using fertilizers for further growth of crop yields are running out, and therefore the main additions to plant productivity will be achieved through the use of biologically derived preparations.

According to the research results of RUP "Scientific and practical center of NAAS of Belarus for potato growing and fruit growing", the application of the plant growth regulator Mikrostim B,Cu on the background of N_{120} P_{70} K_{130} ensured an increase in the yield of potato tubers of the Manifest variety by 2.8 t/ha (from 42.4 up to 45.2 t/ha), an increase in starch content by 0.9% [4].

It is possible to improve the quality of the potato crop by improving the elements of the technology of growing potatoes, namely biologization.

The use of environmentally safe preparations based on microorganisms that improve nitrogen and phosphorus nutrition of plants, promote the activation of growth processes, strengthen plant immunity, produce biologically active substances, participate in the biocontrol of phytopathogens, increase the productivity and marketable quality of potatoes.

By affecting the transmission of genetic information, synthetic biostimulants can increase the yield of agricultural crops by up to 48%. They accelerate cell division, intensify the vital activity of cells of plant organisms, increase the permeability of intercellular membranes and accelerate biochemical processes in them, which leads to the strengthening of the processes of nutrition, respiration and photosynthesis. Plants use fertilizers more efficiently.

In recent years, as a result of climate change and a number of organizational and economic factors (the main part of production is in the individual sector, poor-quality planting material, lack of crop rotation, violations of the system of soil cultivation and care), there have been significant changes in the phytosanitary state of agrocenoses of Ukraine. Small areas have turned into reservations for the accumulation of diseases and pests [5].

In modern conditions, the most effective way to control harmful organisms is chemical protection of plants. Its use is a simple and reliable method of obtaining consistently high yields of agricultural crops.

However, the active use of pesticides has a negative impact on human health and the environment. When agricultural land is treated with chemical protection agents, part of it is lost due to wind erosion, dispersion in the atmosphere with air currents.

Depending on the physical properties of the preparation form and the technology of application, 40-70% of the rate of consumption settles on plants and soil, forming the initial stock of the toxic substance [6].

Therefore, now, as an alternative to such a protection system, agricultural producers are increasingly choosing various options for ecologically safe biological farming.

For modern potato farming, the study and implementation of biological means of protection in production is relevant. Namely, the development of an effective system for controlling the spread and level of disease development. Especially fungal (phytophthora, rhizoctoniosis, alternaria, common scab, dry fusarium, rot), which significantly reduce productivity and affect the marketability and shelf life of tubers during long-term storage [7].

Depending on the timing of planting and methods of processing plants and tubers with chemical and biological preparations, research has established the level of productivity of Skarbnytsia and Lileya potato varieties in the conditions of four soil and climate zones of the Lviv region (Forest Steppe, Polyssia, Carpathian Foothills and Carpathians).

It was noted that the treatment of tubers with biological preparations before planting plants in the budding and flowering phases with Planriz, Diazophyt, Phosphoenterin and the fungicide Ridomil Gold MC 68 WG generally contributed to an increase in the yield and marketability of potatoes compared to the control variant by an average of 1.3-1.5 times , increasing the standard part of tubers.

The use of biological preparations (on the background of high technology) can preserve the potato crop and ensure the production of ecologically clean products, and therefore significantly reduce, and sometimes completely prevent the use of chemical protection agents [6].

The results of a three-year study conducted at the Institute of Potato Growing of the National Academy of Sciences on the study of the influence of planting dates and treatment of tubers before planting with biological preparations on the yield, marketability, and quality indicators of new potato varieties showed that the dates of planting and treatment of tubers with biological preparations influenced the productivity of the studied varieties. The highest overall yield was obtained in the variant using the biological preparation Planryz at all planting times [8].

Treatment of vegetative potato plants with bioorganic fertilizers with re-regulating properties Prostin and Polistin contributed to the growth of the yield of Lileya tubers up to 37.6 t/ha or 11.2% higher than in the control [9].

To date, about 4,000 biologically active substances have been identified and studied to varying degrees in global practice, 10% of which have found practical use in the production of agricultural products.

These drugs, regulating the activity of metabolism in seeds and fruits, activate or inhibit the processes of energy resource utilization, affect overwintering, increase resistance to drought, suppressing the activity of some enzyme systems, to the action of chemical protection agents, affect the processes of growth and development, accelerate ripening. All this ultimately affects the quantity and quality of the harvest [10].

During 2016-2018, scientists of the Ukrainian Plant Quarantine Research Station of the Institute of Plant Protection of the National Academy of Sciences conducted a study of the effectiveness of the use of biologics in potato plantations on yield and profitability indicators in field conditions on gray forest, silty, heavy loam soil.

It was established that the use of various combinations of biological preparations, including Pseudomonas fluorenscens bacteria, compared to the control variant, contributed to the increase in productivity, yield of a smaller part of non-standard tubers, and higher profitability of potatoes [11].

The use of various types of microbiological preparations in modern technologies not only improves the productivity and quality of products, increases resistance against phytopathogens, but also contributes to the recovery of agrocenoses from the harmful effects of pesticides. An ecological alternative to plant protection is the reduction of phytopathogens under the influence of biological preparations. The study of the effect of treatment with biological preparations (Planryz, Fitodoktor) of seed material and affected potato plantations with Alternaria was carried out on the basis of the Ukrainian Research Plant Quarantine Station of the Institute of Plant Protection of the National Academy of Agrarian Sciences (UkrRPQS IPP of the NAAS).

The results of the experiments indicate the expediency of using biological preparations against potato Alternaria. The technical efficiency of their action when processing potato seed material on all studied varieties was 26.6-47.1% [12]. The analysis of literary data shows the perspective of the study of biological preparations in Ukraine. Marketing of drugs of biological origin is actively developing in our country. The data available in the scientific literature are insufficient for a correct and justified choice of the most effective of them, taking into account the area of use. There is conflicting information about the influence of biologics on some quality indicators of the crop. All this calls for a deeper study of these issues.

The purpose of the research is to study effective technological elements in the process of reproduction of pre-basic seed material of potatoes, which includes the use of Albit biological preparation, in the conditions of the southwestern part of the Forest Steppe of Ukraine.

STUDY OF PRODUCTIVITY OF PRE-BASIC POTATO SEED MATERIAL ACCORDING TO THE METHOD OF APPLICATION OF THE COMPLEX DRUG ALBIT

The study of the productivity of the pre-basic seed material of potatoes depending on the method of application of the complex drug Albit was carried out during the 2019-2020 growing season at the Ternopil State Agricultural Research Station of the Podillia Agricultural Fodder Institute of the National Academy of Agrarian Sciences of Ukraine on the fields of breeding and seed rotation scientific and technological department of crop production and agriculture with the early-ripening variety Tiras. Albit (producer of PE "Rodonite") is a complex preparation, biofungicide, anti-stressor, which has the properties of growth regulator and fungicide, used for seed treatment and foliar treatment of plants.

The antidote (antistress) effect of Albit when used with chemical pesticides ranges from 5 to 93%, i.e. Albit is able to prevent crop losses. The drug increases the yield of cereals, legumes, sugar beets, potatoes, sunflowers, flax, vegetables, fruits, fodder herbs and other agricultural crops by 12-23%. The fungicidal effect of Albit is based on strengthening the immunity of plants, stimulating their natural ability to resist diseases. Strengthening the natural protective mechanisms of plants, the drug acts as a broad-spectrum systemic fungicide. Due to the reproduction of nitrogen fixers and other useful bacteria in the soil, activating the supply of nutrients to plants, Albit increases the coefficients of mineral nutrition elements used by plants from the soil and from fertilizers by 18-47%. As a result, plants use the available nutrients more effectively, allowing to reduce the consumption of mineral fertilizers by 10-30%. In addition, the biological preparation strengthens the drought resistance of plants and ensures a stable harvest. The high reproducibility of the action of the drug, that is, the ability to ensure a stable harvest in various conditions, opens up wide prospects for its use. The composition of the Albit preparation: poly-β-hydroxybutyric acid from soil bacteria (Bacillus megaterium and Pseudomonas aureofaciens), terpene acids from coniferous extract, a balanced starting set of macro- and microelements. Albit does not contain living microorganisms, but only bacteria from them, which makes the effect of the drug more stable, less susceptible to the influence of environmental conditions. The advantage of Albit over similar drugs is its compatibility with all pesticides and fertilizers. It is characterized by low cost and environmental friendliness as a biological drug, while at the same time it is close to chemical drugs in terms of efficiency and stability.

The research was conducted in accordance with methodological recommendations for conducting research with potatoes, developed by the Institute of Potato Growing of the National Academy of Agrarian Sciences (Nemishaeve, 2002) [13].

According to the methodology, the following observations of plant growth and development were carried out during the vegetation period: phenological observations (the beginning (10%) and massive (75%) onset of phases of plant development were noted: seedlings, budding, flowering and death of tops); records of plant stand density after germination; records of disease. The density of plant stands was recorded by continuous counting of the number of plants in all accounting areas. During the visual inspection of crops for the presence of diseases in all variants of the experiment, over the years of observation, no plants affected by viral and other diseases were found. Harvest accounting was carried out by the method of continuous weighing of potatoes from each accounting plot. The structure of the crop was determined taking into account the requirements of DSTU 4013-2001 "Varietal and sowing qualities of seed potatoes. Technical conditions", and calculated by counting and weighing tubers by fractions: <28 mm; 28-55 mm, >55 mm in the transverse diameter of the tubers in the first and third repetitions. The marketability of the harvest was determined by the mass of all tubers >28 mm in transverse diameter, expressed as a percentage of the total harvest. The number of tubers in each fraction was counted and weighed and determined as a percentage of the total number or weight. Tuber damage by fungal and bacterial diseases was determined by external signs of affected tubers in three repetitions of all variants in samples of 100 potato tubers.

The planting area of the plot in the experiment is 28 m2, accounting – 25 m^2, repetition three times. The density of planting is 42,000 plants per hectare.

Soil conditions: deep chernozems, low-humus, slightly leached medium loamy granulometric composition. Agrotechnics of growing potatoes in the experiment, the fight against diseases and pests is generally accepted for the zone with the use of a complex of seed measures. The predecessor is winter wheat. Before planting, mineral fertilizer was applied at the rate of N80P80K80 (nitroamofoska).

According to the scheme of the experiment, when planting, seed tubers were treated with Albit (100 ml/t) and vegetative plants were sprayed with Albit (50 ml/ha) in the seedling and budding phase (Table 1). The formation of the harvest of agricultural crops, including potatoes, is significantly influenced by meteorological conditions. Fluctuations over the years, as well as seasonal changes in air temperature, atmospheric and soil moisture, play a significant role in the processes of nutrient exchange in the soil.

The years of research differed in the amount and nature of precipitation, air temperature.

Table 1. Scheme of the experiment

No	Drug, dose and method of use		
	Treatment of tubers before planting	Spraying of vegetative plants in the seedling phase	Spraying of vegetative plants in the budding phase
1	Control - water	-	-
2	Albite 100 ml/t	-	-
3	-	Albit 50 ml/ha	-
4	-	-	Albit 50 ml/ha
5	Albite 100 ml/t	Albit 50 ml/ha	Albit 50 ml/ha

During the two years of observation, the weather conditions of 2020 compared to 2019 were more favorable for the growth and development of potato plants, for the processes of stem formation, tying of tubers in the bush, and ultimately for the accumulation of potato tubers (table 2; 3, built according to the data of the Horostki agrometeorological station in 2019-2020).

Table 2. Average monthly air temperature for April-September, °C

Year	April	May	June	July	August	September
2019	10.0	14.2	21.3	18.9	20.5	16.1
2020	8.6	11.8	19.3	19.3	20.4	16.3
norm	8.1	14.1	17.3	18.8	18.3	13.8

Table 3. Amount of precipitation for the month of April-September, mm

Year	April	May	June	July	August	September
2019	25	121	54	30	22	13
2020	16	60	123	94	81	95
norm	40	62	82	91	65	55

The results of research carried out during 2019-2020 showed that the use of the complex drug Albit in the conditions of the southwestern part of the forest-steppe of Ukraine when growing additional basic material of potatoes of the Tiras variety helps to increase the yield compared to the control option - water treatment. The highest average yield of potatoes over two years (19.8 t/ha) was recorded in the options where tubers were treated before planting with Albit at a dose of 100 ml/t and spraying of vegetative plants in the seedling and budding phases with the drug at a dose of 50 ml/ha. The increase compared to control averaged 4.3 t/ha of tubers (21.7%) over two years of observation (Table 4).

Table 4. The effect of the use of the complex drug Albit on the yield of potatoes of the Tiras variety, t/ha, 2019-2020

No	Variants	Potato yield, t/ha			Growth to control (±)	
		2019	2020.	2019 -2020	t/ha	%
1	Control is water	14.4	16.5	15.5	-	-
2	Treatment of tubers before planting with Albit 100 ml/t	15.6	17.2	16.4	+0.9	5.8
3	Spraying vegetative plants in the seedling phase with Albit 50 ml/ha	16.2	18.3	17.3	+2.5	16.1
4	Spraying vegetative plants in the budding phase with Albit 50 ml/ha	16.3	20.2	18.3	+2.8	18.1
5	Treatment of tubers before planting with Albit 100 ml/t + spraying of vegetative plants in the seedling and budding phase with Albit 50 ml/ha	17.5	22.1	19.8	+4.3	21.7
	P,%	2.37	2.98			
	HIP0,05, t/ha	1.24	1.84			

Phenological observations conducted during the growing season of potatoes showed that the use of Albit to some extent influenced the dates of onset of phenological phases. During the observations, it was visually noted that the emergence of seedlings was more friendly and 2-3 days earlier compared to the control, on the options where the tubers were treated with the drug before planting. Potato productivity largely depends on the number of stems and tubers in the bush. All agrotechnical measures carried out should be aimed at creating optimal conditions for the formation of the named productivity factors. Observations during 2019-2020 showed that the use of Albit contributed to an increase in the average number of stems per potato bush. This indicator increased in all options, where the drug was used, but the option in which treatment of tubers at planting (100 ml/t) and two-time spraying of vegetative plants (50 ml/ha) in the seedling and budding phase was carried out stood out the most. In this version, this indicator was within 4.4 units on average over two years of research. at 3.0 pcs. in the control version (Table 5).

Table 5. The effect of the use of the drug on the formation of the number of stems and tubers in a bush of potatoes of the Tiras variety, pcs./bush, 2019-2020

No	Variants	Stem, pc./bush			Tuber, pc./bush		
		2019	2020	2019-2020	2019	2020	2019-2020
1	Control - water	2.9	3.1	3.0	9.9	10.2	10.1
2	Treatment of tubers before planting with Albit 100 ml/t	3.2	3.3	3.3	10.5	10.8	10.7
3	Spraying vegetative plants in the seedling phase with Albit 50 ml/ha	3.5	3.7	3.6	11.4	11.6	11.5
4	Spraying vegetative plants in the budding phase with Albit 50 ml/ha	3.6	3.9	3.8	11.9	12.6	12.3
5	Treatment of tubers before planting with Albit 100 ml/t + spraying of vegetative plants in the seedling and budding phase with Albit 50 ml/ha	4.2	4.5	4.4	12.8	13.2	13.0

The main components of the potato harvest are the formation of tubers under the bush. Analysis of two-year observations showed that the use of Albit provided an increase in the tuber-forming capacity of potato plants. The data in Table 5 show that an increase in the number of tubers under the bush was observed when using the drug in all variants of the experiment. On average over two years, the most of them were obtained in the variant where Albit was used to treat tubers before planting at a dose of 100 ml/t and for spraying vege-

tative plants at a dose of 50 ml/ha in the seedling and budding phase. In this variant, the yield of tubers from one bush was the largest and amounted to 13.0 units on average in 2019-2020. with control 10.1 pcs. The increase in this version was 2.9 pcs. (Table 5)

The ratio of the fractional composition of the crop for the years of the study differed by variant. It was established that the use of Albit contributed to the increase in marketability of tubers. Namely, an increase in the mass of tubers of the large (>55 mm) and seed (28-55 mm) fractions and a decrease in the mass of tubers of the small fraction (<28 mm in transverse diameter).

Over two years of research, in all variants where the drug was used, an increase in the mass fraction of tubers of the large fraction to 31.5-28.9% of the total mass of tubers was noted, respectively, according to the variants, while the control was 26.5%. The largest number of tubers of the seed fraction on average over two years of research was noted on the control variant – 59.4%. (Table 6).

Table 6. The structure of the Tiras variety potato harvest by weight depending on the use of biological preparation, 2019-2020

No	Variants	Tubers fraction								
		<28 mm			28-55 mm			>55 mm		
		2019	2020	2019-2020	2019	2020	2019-2020	2019	2020	2019-2020
1	Control - water	3.4	2.8	3.1	58.8	60.0	59.4	25.8	27.2	6.5
2	Treatment of tubers before planting with Albit 100 ml/t	3.0	12.2	2.6	9.0	8.0	8.5	8.0	9.8	8.9
3	Spraying vegetative plants in the seedling phase with Albit 50 ml/ha	2.4	1.6	2.0	7.8	8.4	8.1	9.8	30.0	9.9
4	Spraying vegetative plants in the budding phase with Albit 50 ml/ha	12.0	1.2	1.6	7.9	8.6	8.3	0.1	0.2	0.1
5	Treatment of tubers before planting with Albit 100 ml/t + spraying of vegetative plants in the seedling and budding phase with Albit 50 ml/ha	0.9	0.1	0.5	8.3	7.7	8.0	0.8	2.2	1.5

During a visual inspection of the crops for the presence of diseases, no plants affected by viral and other diseases were detected in all variants of the experiment for two years. When determining tuber damage by fungal and bacterial diseases based on external signs, minor tuber damage by common scab (0.3% on control) was detected in 2019.

CONCLUSIONS

As a result of scientific research conducted in Ternopil SARS IFA NAAS during 2019-2020, it was established that a high level of realization of the biological potential of the culture and the quality of products when growing pre-basic potato seed material on deep chernozems with low humus and slightly leached medium loam granulometric composition, it is advisable to treat the tubers when planting with the complex drug Albit in a dose of 100 ml/t and spray twice in the seedling and budding phase of vegetative plants with the drug in a dose of 50 ml/ha.

The analysis of the results of studies on the productivity of the basic potato seed material depending on the method of application of the complex drug Albit for the Tiras variety showed that a reliable increase in yield compared to the control was obtained in all options with the use of the drug. The highest yield of potatoes on average over two years was 19.8 t/ha (in 2020 – 22.1 t/ha) in variants where tubers were treated with Albit before planting (100 ml/t) and vegetative plants were sprayed in the seedling phase and budding with the drug at a dose of 50 ml/ha. The yield increase before control in 2020 was 5.6 t/ha (33.9%) and 4.3 t/ha (21.7%) on average for 2019-2020.

The use of Albit, as one of the elements in the technology of production of pre-basic seed material for potatoes, helps to improve the marketability of the crop, increase the average number of stems and tubers in the bush and, accordingly, increase the productivity of the crop as a whole. In modern agro-ecological conditions,

it is of great importance to further optimize techniques for the study and application of the latest biological preparations in the cultivation of seed potatoes, first of all, in the reproduction of pre-basic and basic seed material in order to obtain quality products and reduce the chemical load on the soil and plants.

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Вплив застосування препарату Альбіт на формування насіннєвої продуктивності добазового матеріалу картоплі

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Анотація. Показником високих і результативних урожаїв картоплі є використання нових високопродуктивних сортів, ефективного садивного матеріалу, належне забезпечення рослин корисними речовинами, забезпечення догляду за посівами, надання захисту рослин від бур'янів, хвороб та шкідників, дотримання оптимального стану вологості ґрунту в період вегетації. Одним з пріоритетних показників, які визначають низьку врожайність картоплі по багатьох зонах України, як у сприятливих, так і несприятливих для заняття картоплярством, є використання насіннєвого матеріалу низької якості, який є ураженим інфекційними фіто патогенами. розмноження оздоровленого насіннєвого матеріалу є одним із основних завдань насінництва картоплі. Застосування біопрепаратів для стимуляції розвитку рослин, підвищення їх витривалості до негативних подразників навколишнього є актуальним для прискореного розмноження такого матеріалу. Таким чином, метою статті є дослідження ефективних технологічних аспектів під час репродукування добазового насіннєвого матеріалу картоплі, що включає застосування біопрепарату Альбіт, в умовах південно-західної території Лісостепу України. У статті представлено результати досліджень впливу способів застосування комплексного препарату Альбіт на формування продуктивності картоплі у процесі репродукування добазового насіннєвого матеріалу в умовах південно-західної частини Лісостепу України. У ході досліджень встановлено, що для досягнення високого рівня реалізації біологічного потенціалу культури та якості продукції при вирощуванні добазового насіннєвого матеріалу картоплі доцільно проводити обробку бульб при садінні Альбітом 100 мл/т та проводити дворазове обприскування у фази сходів та бутонізації вегетуючих рослин препаратом у дозі 50 мл/га

Ключові слова: картопля, урожай, насіннєва продуктивність, ріст регулюючі речовини, фракції бульб

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Justification of the introduction of a seed separator for vegetable and tomato crops as part of a technological line

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Abstract. Directing the production of seeds of vegetable and fruit crops can provide an opportunity to introduce industrial and intensive mechanisms, which are designed for complex mechanization and automation of production processes in seed production. Improvement and development of the field of seed production of vegetable and fruit crops will help to ensure agricultural production with seeds of own production, which will significantly contribute to the reduction of the cost price and the increase in the productivity of the production of various crops. In current conditions, it is difficult to create specialized farms that produce seeds of vegetable and melon crops, at the same time, obtaining their own seeds by producers growing melons and other crops will make it possible to reduce the costs of producing these crops. the creation of modern seed-separating machines and flow lines that meet the requirements of modern production and belong to complex technical systems requires conducting scientific research on the interaction of working bodies with the technological mass of fruits, the laws of technological processes. It is important to substantiate the principles of operation, structural parameters and kinematic modes of machines and their constituent parts. Taking this into account, conducting such studies is relevant and expedient, and they have important national economic significance.Thus, the purpose of the article is to substantiate the implementation of the improved design of the separator of seeds of vegetable and tomato crops as part of the technological line, to conduct comparative tests of the basic and experimental separators according to the main indicators of the technological process to confirm the effectiveness of the introduction of the sample into the technological line. The test of the improved design of the seed separator in various technological configurations was carried out on the basis of the technological line for the selection of seeds of vegetable and tomato crops: with a serial separator, with an experimental separator, complete with a MOS-300 machine. Comparative characteristics of such indicators as productivity, seed loss, the content of impurities in seeds, and seed damage are given. The implementation of a seed separator in the technological line for extracting seeds of melon crops is substantiated

Keywords: vegetable and vegetable crops, separator, technological line, selection of seeds

INTRODUCTION

Specialization and concentration of seed production of vegetable and fruit crops can make possible the introduction of industrial and intensive technologies designed for complex mechanization and automation of production processes in seed production. The development of the field of seed production of vegetable and fruit crops will contribute to providing agricultural producers with seeds of their own production, which

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will have an impact on reducing the cost price, increasing the production of such crops as watermelon, melon, cucumber, and tomatoes. But taking into account the fact that in modern conditions it is difficult to create specialized farms that produce seeds of vegetable and melon crops, and obtaining their own seeds by producers who grow melon crops, cucumbers, and tomatoes will allow to reduce the costs of producing such crops.

The natural and climatic conditions of the south of Ukraine make it possible to provide the country with vegetable crops of its own production and to create a raw material base for the processing industry in this area. In the specialized farms for the production of seeds of vegetable crops that existed in Ukraine, technological lines were used, equipped with machines and equipment taking into account the culture (watermelon, melon, cucumber, tomatoes) whose seeds were obtained. Currently, such technological complexes are practically not used, and for obtaining seeds, farms receive separate machines for seed selection, or complete small technological lines (depending on the capabilities of the farm). The use of such machines in labor-intensive seed production processes leads to large losses, and the efficiency of seed selection is low.

This situation is caused by the lack of theoretical and experimental processes for the selection and finishing of seeds of vegetable and fruit crops, which has an impact on the development of machines and technological lines.

Thus, the creation of modern seed-separating machines and flow lines that meet the requirements of modern production and belong to complex technical systems requires conducting scientific research on the interaction of working bodies with the technological mass of fruits, the laws of technological processes. Such studies will make it possible to substantiate the principles of action, structural parameters and kinematic modes of machines and their working bodies. Taking this into account, conducting such studies is relevant and they have important national economic significance.

At one time, a serious structure was created for the production of seeds of vegetable and melon crops. Large farms were working, the main type of activity of which was the production of seeds and which had a decent material and technical base for this, cleaning machines, even of imported production, etc. The domestic designs of machines for the separation of seeds of various crops, which are currently implemented in our country, do not meet the necessary parameters and the quality of the technological process. It is very important to have high-tech seed processing equipment [1]. The territorial differentiation of the production of the main vegetable crops in the regions of Ukraine, the peculiarities of the formation of the balance of vegetables and their supply to the population were studied, the problems and prospects of the development of the industry as a whole were indicated [2].

The organization of production of elite and reproduction seed production of vegetable and melon crops is relevant, in order to obtain high-quality varietal seeds [3]. Research was carried out in the field of the development of a machine for preparing the soil for planting melons [4]. Protected cultivation of cucumber provides higher productivity and higher quality than open cultivation [5]. The question of storage and processing of fruits, stages of scientific support of the field of melon growing were considered [6]. Methodical approaches for determining the competitiveness of various varieties of melon crops of domestic breeding compared to foreign analogues are given, and the coefficients of competitiveness are determined [7].

A device for extracting the seeds of agricultural crops was patented, which was also tested on vegetable crops [8]. To determine the optimal parameters of machines for the selection of seed mass of vegetable and tomato crops, a modeling method is presented, which is based on the nonlinear canonical distribution of a random vector. A block diagram of the procedure for calculating the parameters of the canonical decomposition is presented [9]. The method was tested on the basis of the technological process of seed selection using an experimental sample of a pressure-separating type machine [10]. The use of the method of determining the qualitative composition of the crushed seed mass of vegetable and melon crops (watermelon, melon) in the process of seed selection made it possible to determine the percentage content of the components of the crushed technological mass [11]. The results of experimental studies of a laboratory device of a new design for the separation of melon seeds from the technological seed mass are presented [12]. The article presents the structural-technological scheme of the selection of seeds of vegetable and fruit crops and the analysis of shortcomings in the operation of the machine and the technological line [13], and the factors that have the greatest influence on the quality of the technological process are established [14].

A sample of a machine for mechanical extraction of seeds from melon is presented, consisting of a frame, a loading hopper, a crushing and extraction unit, a seed transport auger, brushes for cleaning and seed extraction. A conclusion was made about the effectiveness of the sample application based on cleaning efficiency, extraction efficiency, machine productivity, power consumption, seed damage and operating costs [15]. An experiment was conducted on the injury of melon seeds during their selection, the studied characteristics were the percentage of peeled and not broken seeds, peeled but broken seeds, unpeeled seeds and unpeeled but broken seeds [16]. Research was also conducted on post-harvest processing of vegetable seeds [17]. However, the issue of implementing a seed separator for vegetable and fruit crops as part of the technological line is insufficiently researched.

The purpose of the article is to substantiate the implementation of the improved design of the vegetable and melon seed separator as part of the technological line, to conduct comparative tests of the basic and experimental separators according to the main indicators of the technological process to confirm the effectiveness of the introduction of the sample into the technological line.

STUDY OF THE FUNCTIONING OF THE DESIGNS OF SEPARATING DEVICES

When conducting theoretical and experimental studies of various designs of separating devices, it was found that when the sieve is placed horizontally, when the angle between its working surface and the horizontal is zero, differential movement should be reported to it. That is, during one period of oscillations, the sieve must have different accelerations and speeds in order to obtain the movement of the separated mass in the desired direction. However, in further theoretical analysis of the separation process, the authors make the following assumptions:

– all types of separators moving horizontally are reduced to one kinematic scheme with a symmetrical speed diagram;

– the force of inertia acting from the side of the working surface on the crushed mass is neglected;

– to intensify the separation process, instead of optimizing the kinematic and dynamic modes, it is suggested to use a stream of water sprayed through nozzles.

The main disadvantages of oscillating flat sieves include:

– high speed of movement, which requires high-quality execution, careful care and lubrication of parts;

– due to the movement of large swinging masses, inertial separators must be carefully balanced;

– compared to other types of separators (rotary and roller), they are more energy-intensive, requiring more energy to set them in motion.

The advantages of inertial separators include: sieves that oscillate horizontally take up relatively little space; convenient for maintenance and repair – replacing the sieves when switching to processing another crop takes up to 30 minutes.

In the course of the analysis of the designs of inertial separators for the selection of seeds of vegetable and melon crops, it was noted that the final cleaning of the seeds is not carried out, but the selection from the crushed mass of seeds, pulp and pulp. That is, from a technological point of view, all of them are sieves, the product above the sieve is the crust, and the product below the sieve is the seed, pith and pulp. The final cleaning of seeds from impurities is carried out on separate machines located in the technological line after the seed separators.

We propose to use a two-screen system as a separating device for extracting seeds of vegetable crops, in which large particles of bark will come from the first sieve, and seeds from the second; pulp; the pulp and juice will be the by-product of the second sieve. As the analysis of the work of the existing separators showed, the main losses of seeds occur in the output of the "big crust". It is a seed that is not separated from the finely ground seed particles. In order to intensify the process of additional extraction related to the seed crust, the mode of operation of the inertial separator was adopted. When the separated mass slides over the surface of the sieve, it will rub against the edges of the holes and, as a result, the content of seeds associated with the crust will decrease.

Separation of seeds is carried out on the second sieve. At the same time, the seeds are an aboveground product, and the pulp, pulp, and juice are under-ground products. To intensify the process of the passage of the pulp and pulp through the holes of the sieve, it is suggested to use the mode of the vibrating conveyor. In this version, at certain stages, an additional force will act on the pulp and pulp particles, and the total force of normal pressure will be equal to the sum of the force of normal pressure from the force of gravity and the force of inertia. It should also be taken into account that when separating the seeds of melon crops, the ratio of seeds to impurities is 1:9.

The following assumptions were made during the theoretical analysis:

– the separated material moves as a flat particle, the coefficient of resistance to movement does not depend on the thickness of the layer moved along the sieve;

– air resistance, when a particle is detached from the surface of the sieve, does not affect the law of movement of elements of the separated mass;

– the resistance to the movement of both the pulp and the peel, as well as the seeds, is characterized by the coefficient of specific resistance, which is numerically equal to the coefficient of friction of freshly isolated seeds, the sticking of particles of the separated mass is not taken into account;

– when the seeds move, a non-elastic impact of the products is possible (the fall is carried out on the layer of pulp and crust); as well as elastic shock (falling of seeds on the surface of the sieve);

– we neglect the recovery coefficient of the pulp and crust upon impact;

– we neglect the change in the angle of oscillations of the sieve during the rotation of the crank.

Experimental studies carried out in laboratory conditions substantiated the main structural and kinematic parameters of the melon seed separator, in which the quality indicators of the technological process (seed purity, seed injury and seed loss) have optimal values. However, a real pile of seeds differs from products processed in a laboratory. It additionally contains soil particles, small stones, plant remains. In order to justify the possibility of using the proposed

design of the separator as part of the technological equipment for the selection, washing and drying of seeds of melon crops, tests were conducted.

TESTING OF THE IMPROVED DESIGN OF THE SEED SEPARATOR IN VARIOUS TECHNOLOGICAL CONFIGURATIONS

The collection of cucumber seeds and melon crops for seeds is carried out when they reach biological maturity. Due to the differences in mechanical, technological and biological qualities of the fruits of different crops, their harvesting also has some differences. Cucumber fruits are collected using a specialized harvester, which ensures selection of fruits from the windrow, separation of plant residues from seeds, cleaning of the pile from soil particles and loading of products into a vehicle. The harvester has a needle-type working body for pricking fruits, a stem separator, an aspiration cleaning device and a system of conveyors that combine the working bodies into a single technological complex.

A specialized LSB-20 or LSB-30 technological line can be used to separate cucumber seeds, clean them from impurities, and dry them. This technological line can be considered basic, and the equipment configuration may vary depending on the needs of manufacturers and product processors.

Harvesting of such melon crops as watermelon, cantaloupe, and pumpkin is also carried out in one continuous way. Before the start of harvesting, the fruits are rolled with a UPV-8 stacker-roller. The seeds of melon crops are collected from the swath with a pick-up machine PBV-1. The pick-up consists of a frame resting on running wheels, on which a mesh drum with a fruit cutter and an unloading cellular conveyor are installed.

Moving along the swath, the harvester unloads the seed fruits inside the cellular drum, which moves them to the unloading conveyor, which ensures the reloading of the products into the vehicle.

In addition, in some farms of Ukraine, obtaining seeds is carried out with the use of machines and equipment manufactured according to individual requests.

Such equipment has low technological reliability, the difficulty of reconfiguring machines during the transition from processing one culture to another, low corrosion resistance of metal structures of machines.

A small annual loading of line equipment should be included among the features of the operation of the equipment for the selection of seeds of vegetable and fruit crops. But for a more complete loading of such technological equipment, farms carry out processing in "conveyor mode", that is, after loading the processing of cucumbers into seeds, they switch to obtaining watermelon, melon and pumpkin seeds.

The analysis of the technology of collecting and processing seeds of cucumber and melon crops, as well as the equipment in use, shows the need to modernize existing and develop fundamentally new machines.

Machines for separating seeds – separators, which are basic in technological lines, require special attention.

In addition, it is necessary to conduct research on the process of interaction of working bodies with a technological product to create effective structures.

The melon seed separator, intended for cleaning seeds from pulp and crushed peel particles, is a component part of the design of seed separators (Figure 1).

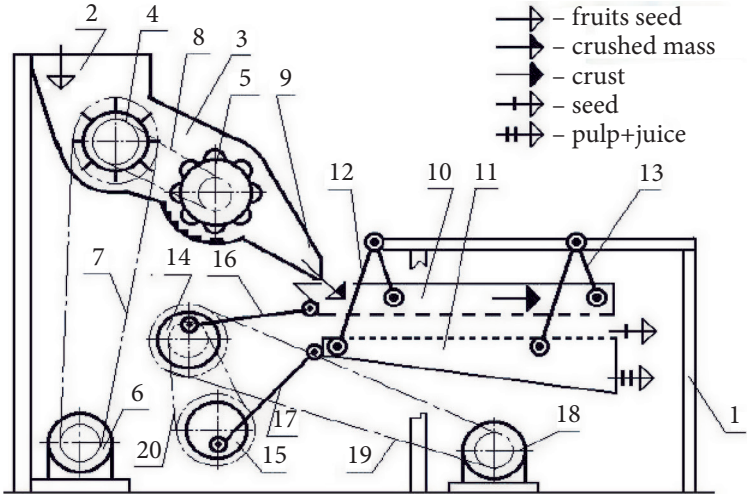

Figure 1. *Design scheme of the experimental sample of seed separators:*
1 – frame; 2 – receiving hopper; 3 – grinding chamber; 4 – grinding drum; 5 – wiping drum;
6 – electric motor; 7 – V-belt transmission; 8 – V-belt variator; 9 – tray; 10, 11 – the last grates;
12, 13 are the last ones pendants; 14, 15 – crank and connecting rod mechanisms; 16, 17 – hinged rods;
18 – electric motor; 19 – V-belt transmission; 20 – V-belt variator

The seed separator includes a receiving hopper for seed fruits 2 mounted on a common frame 1, connected to a crushing chamber 3. Inside the chamber there are grinding 4 and wiping drums 5. The drums are driven by an electric motor 6 through a V-belt transmission 7 and a V-belt variator 8. The crushed mass is removed from the chamber through tray 9. A separator is installed on frame 1 and consists of two screen sieves (10; 11) swinging in antiphase. The screens are suspended on hinged suspensions 12, 13. To provide the screen with oscillating motion, two crank-and-connecting mechanisms 14, 15 are used, kinematically connected to the screens by articulated rods 16, 17. The rotation of the cranks is carried out by an electric motor 18, through a V-belt transmission 19 and a V-belt variator 20. KKU-2A potato harvester variators are used as V-belt variators 8 and 20.

The technological process of seed selection is as follows: the fruits are loaded with a special conveyor into the hopper 2 of the chopper 3. Crushed by drums 4; 5 mass enters the sieve of the separating sieve 10. The dimensions of the cells of the upper sieve for cucumber are 5x15 mm. On its surface, the shredded crust (over-sieve product) is removed from the technological zone. Seeds, pith and small pieces of bark equal in size to the seeds (grated product) fall on the surface of the sieve of the second screen 11 with the size of the holes. Seeds with impurities on its surface are fed for further cleaning, and pulp, juice and other small impurities fall into the pallet and from it into the pump.

During the tests, the screen separator was tested as part of a technological line for the selection of seeds of vegetable and tomato crops, where it was installed in place of the rotary separator; and as part of the experimental line, while cam rollers were used as a shredder. In comparison with the serial model of the line, the pulp wiper, melon seed separator and seed grinder were excluded from its composition. Additional cleaning was carried out on the MOS-300 hydroseparation machine, designed for washing the seeds of any vegetable crops from impurities.

The following adjustments are provided in the separating device:

– the rotation frequency of the cranks and, therefore, the vibration frequency of the rattle was changed by V-belt variators 19; 20;

– the angle of inclination of the grates was changed by adjusting the lengths of hinged suspensions 12; thirteen;

– partitions were installed to change the length of the working part of the separating part of the sieve along the movement of the technological product

The structural and technological diagrams of all three sample lines with an experimental separator are shown in fig. 2-4.

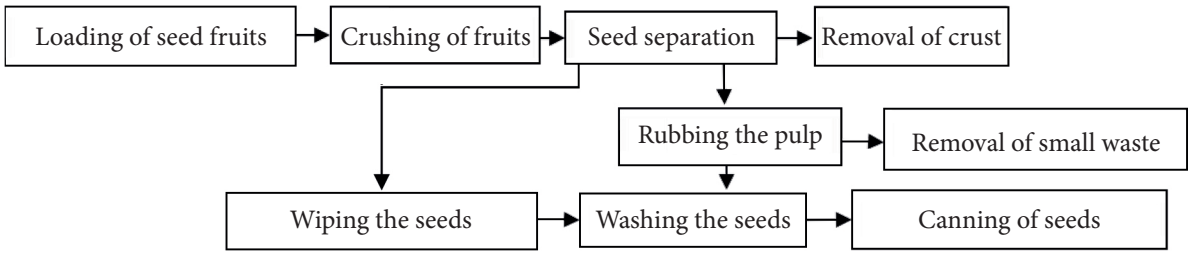

***Figure 2**. Technological line with a serial separator*

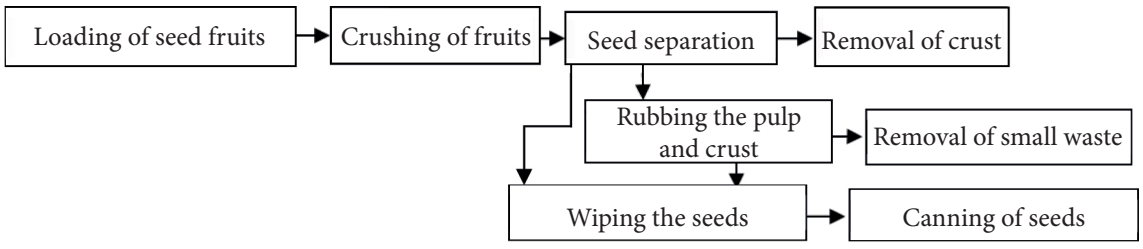

***Figure 3**. Technological line with an experimental separator*

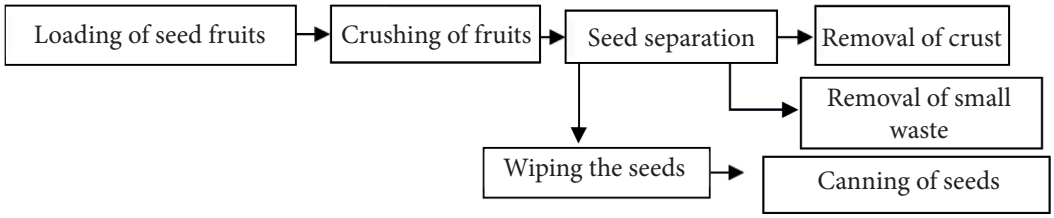

***Figure 4**. Technological line with the MOS-300 machine*

During the tests, the performance and quality of the technological process of both the separator itself and the entire line as a whole were determined.

The comparison was made with a serial sample of the separator. The results of comparative tests of separators are shown in Table 1.

Table 1. Results of comparative tests of separators

Name of indicators	Unit of measurement	The value of indicators			
		serial separator		experimental separator	
Culture		Cucumber	Watermelon	Cucumber	Watermelon
Capacity of the seed separator, kg/s	kg/s	2.625	6.197	3.089	8.778
Output ratio	%	not determined			
crust, flesh				38.2	42.1
seed				4.622.53	
pulp, juice				57.18	55.38
Seed purity in the "Seeds" output	%	75.17	77.73	78.33	82.9
Lose the seeds of everything	%	5.9	5.51	5.0	6.1
in output "crust"		5.9	5.51	5.0	4.5
in the output "pulp; juice"		none	none	none	1.6
Seed crushing	%	3.5	none	2.1	none

Comparative characteristics of a line with a serial separator, a line with an experimental separator, and a line with an experimental separator and additional seed cleaning on the MOS-300 machine in Table 2.

Table 2. Results of comparative studies of the seed production line with serial and experimental separators

Name of indicators	Unit of measurement	The value of indicators					
		serial separator		experimental separator			
				In the baseline		With the MOS-30 machine	
Culture		Cucumber	Watermelon	Cucumber	Watermelon	Cucumber	Watermelon
Productivity per hour of prime time	t	8.4	21.24	9.8	27.2	not determined	
Seed losses, including return	%	6.7	6.01	5.02	6.15	3.87	5.52
The content of impurities in the final product	%	12.8	12.7	11.2	7.2	2.3	3.7
Seed injury	%	4.4	None	4.1	None	3.5	None

As can be seen from the data in Table 1, both separators have quite high indicators, the values of which are within the limits of agrotechnical requirements and the technical task for the development of technological equipment. However, the experimental sample has a higher bandwidth. In terms of seed purity, the experimental separator also has higher characteristics. The loss of watermelon seeds at the exit of the "rind" in the experimental sample is slightly higher than in the serial one. This is due to the more rigid kinematic mode of operation of the upper screen. However, these losses can be returned to the seeds that are separated from the peel, or in the seed wiper and melon seed separators or in the MOS-300 machine. The test results are given for the "Vognyk" variety watermelon and the "Vognyk" variety cucumber "Competitor". Injury to watermelon seeds, as in the case of laboratory experimental studies, is recognized as statistically insignificant and is within the limits of experimental error.

As can be seen from the data in Table 2, the experimental sample of the line with the MOS-300 machine has the best performance quality indicators of the technological process. The content of impurities in the final product and the amount of losses for this technological option are minimal. This is due to the fact that the cleaning of seeds and their separation from impurities actually takes place in two stages, in the first stage, separation is provided by an inertial, vibrating mechanism, and in the second one, hydroseparation is carried out.

During the operation of the experimental separator as part of the baseline, the improvement of

quality indicators is associated with the optimization of its kinematic modes, and the equipment that provides additional cleaning of seeds after the separator is similar to the serial sample. Therefore, it can be concluded that the wiper, seed separator and grinder have the same effect on the quality indicators of the technological process in both the basic and the new version.

CONCLUSIONS

According to the results of laboratory experiments, two samples of the screen separator were refined and tests were carried out both of the experimental samples themselves and of the separators as part of the seed production lines. At the same time, the productivity was: when working on a cucumber, 8.4 t/h for serial equipment and 9.8 t/h. for experimental. When working on watermelon, productivity values are 21.24 and 27.2 t/h, respectively.

As a result of tests of the screening separator in the composition of various constructions of technological equipment for obtaining seeds of melon crops, confirmation of the correctness of the conclusions made based on the results of theoretical and laboratory experimental studies was obtained. During the design revision of the documentation, it is necessary to provide for the adjustment of the frequency of oscillations of the upper screen (inertial separator) within 25-30 (1/s), and of the lower screen (vibroseparator) at the level of 35-50 (1/s).

During the tests, the expediency of using cam grinding rollers and additional hydraulic cleaning of the seed heap was confirmed. At the same time, it was established that the seeds of the "Vognyk" variety of watermelon are the most suitable for seed processing, and the least - the cucumber of the "Competitor" variety. However, for all processed crops, seed purity after hydroseparation is not lower than 95%, with injury not exceeding 5%. The seed purity is 82.9% for watermelon and 78.3% for cucumber. The content of impurities in the final product is 3.7 and 2.3%, respectively.

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Обґрунтування впровадження сепаратора насіння овоче-баштанних культур у складі технологічної лінії

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Анотація. Спрямування виробництва насіння овоче-баштанних культур може надати можливість впровадження індустріальних та інтенсивних механізмів , які розраховані на комплексну механізацію та автоматизацію виробничих процесів в насінництві. Удосконалення й розвиток царини насінництва овоче-баштанних культур допоможе забезпечити сільськогосподарське виробництво насінням власного виробництва, що суттєво сприятиме зниженню собівартості, збільшенню продуктивності виробництва різноманітних культур. В актуальних умовах створення спеціалізованих господарств-виробників насіння овоче-баштанних культур є складним, водночас отримання власного насіння виробниками, що вирощують баштанні та інші культури дасть змогу знизити витрати на виробництво цих культур. створення сучасних насіннє-відокремлювальних машин і потокових ліній, що відповідають вимогам сучасного виробництва і належать до складних технічних систем, вимагає проведення наукових досліджень щодо взаємодії робочих органів з технологічною масою плодів, закономірностей технологічних процесів. Важливим є обґрунтування принципів дії, конструктивних параметрів і кінематичних режимів машин та їх складових частин. Зважаючи на це, проведення таких досліджень є актуальним та доцільним і вони мають вважливе народногосподарське значення. Таким чином, метою статті є обґрунтування впровадження покращеної конструкції сепаратора насіння овоче-баштанних культур у складі технологічної лінії, проведення порівняльних випробувань базового та експериментального сепараторів за основними показниками технологічного процесу для підтвердження ефективності впровадження зразка в технологічну лінію. Проведено випробування доопрацьованої конструкції сепаратора насіння в різних технологічних комплектаціях на базі технологічної лінії виділення насіння овоче-баштанних культур: з серійним сепаратором, з експериментальним сепаратором, в комплекті з машиною МОС-300. Наведено порівняльні характеристики таких показників, як продуктивність, втрати насіння, вміст домішок в насінні, травмування насіння. Обґрунтовано впровадження сепаратора насіння в технологічну лінію виділення насіння баштанних культур

Ключові слова: овоче-баштанні культури, сепаратор, технологічна лінія, виділення насіння

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The influence of skew and deflection of the rotating shafton force factors arising in gear joints

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Abstract. Important and priority tasks for the industry of Ukraine are the reduction of costs for the creation of the final product, the reduction of the cost of maintenance of the construction of machines and mechanisms, the restoration of the outdated production base and the attraction of new technologies, mechanisms and equipment. That is why, increasing the efficiency, reliability and service life of machine units, which are used in conditions of misalignment of the axes of the connecting shafts, which are caused by the deflection of the rotating shaft in the mechanisms, which are connected to each other by an intermediate shaft with the help of compensating devices, and are intended for the transmission of effective power from the engine to the consumer, and, as a rule, is the most important part of any power plant, is an urgent task, and the further development of the modern machine-building industry depends on its successful solution. At the same time, the effectiveness of machine mechanisms directly depends on the productive work of gear mechanisms that are part of them, namely mechanical gears and gear couplings, which are widely reflected in almost all industries. Thus, the purpose of the work is to assess the influence of the deflection of the rotating shaft on the force factors that arise when the axes are misaligned in the gear joints of machine units. The effect of skew and deflection of a shaft rotating at a high frequency on the force factors for some toothed joints was investigated. It was found that the values of the dynamism coefficients do not exceed 1.05-1.15, and the dynamic components of these power factors can reach 30-50% of the level of their static components

Keywords: rotating shaft, deflection, gear clutch, transmission, misalignment of axes, power factors

INTRODUCTION

The priority tasks for the Ukrainian industry are to reduce the costs of creating the final product, reduce the cost of construction and maintenance of machines and mechanisms, update the outdated production base and introduce new technologies and equipment. Therefore, increasing the efficiency, reliability and service

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life of machine units that are operated in conditions of misalignment of the axes of the connecting shafts, which are caused by the deflection of the rotating shaft in the mechanisms (main engine-reducer), which are connected to each other by an intermediate shaft with the help of compensating devices, and designed to transmit effective power from the engine to the consumer, and is usually the most responsible part of any power plant, is an urgent task and the further development of modern mechanical engineering depends on its successful solution. In turn, the efficiency of machine units directly depends on the reliable operation of the gear mechanisms included in their composition, namely mechanical gears and gear couplings, which have found their wide distribution in almost all branches of industry, such as: shipbuilding, aviation, mining and agriculture, as well as in rolling mills, cranes, lifting and transport mechanisms, mills, crushers, conveyors, agricultural machines and many others. Today, in the global industry, regardless of the type, gear couplings are manufactured with straight side surfaces of the sleeve and clip teeth, or with straight side surfaces of the clip and barrel-shaped (longitudinal modification) side surfaces of the sleeve teeth. As for gears, they are characterized by linear engagement of involute teeth. For a long time, it was believed that gears with linear contact of involute teeth have no alternative and cannot be manufactured with point meshing of teeth, which, on the one hand, is due to the inaccuracy of calculations that were carried out according to the Hertz formula, which is true for linear contact, but cannot to be used for point contact, and on the other hand, the difficulty of manufacturing such gears on commonly used machines (at present, the production of teeth with point contact is possible due to the use of high-precision tooth grinding machines of the German production type "Pfauter" or "Hoffler") [1-7]. However, at the moment, the influence of the deflection of the rotating shaft on the force factors arising from the misalignment of the axes in the toothed connections of machine units is not sufficiently clarified and is usually not taken into account when implementing new technology.

When the axes of the connecting shafts of machine units of power plants are misaligned, additional force factors in the form of elastic bending moments arise in gear joints. The effect of these moments is that they tend to return the bent shafts to their original position. The bending moments arising in the toothed connection overload the supports of the mechanisms connecting the shafts (intermediate, output and input shafts of the engine and gearbox, respectively), support bearings, spline and bolt connections, as well as other elements, negatively affecting on their performance, which in turn negatively affects the reliability, durability and maintainability of machine units, and can lead to their failures and unscheduled stops for repairs. In turn, the deterioration of reliability indicators leads to a decrease in reliability, an increase in additional costs and repair costs, as well as an increase in the probability of emergency situations of machine units, and as a result – power plants, in which they are operated. Thus, the problem of the negative influence and deflection of the rotating shaft on the force factors arising in gear joints is a relevant and integral part of existing scientific programs and tasks in almost all branches of modern mechanical engineering. To the greatest extent, the specified problem concerns the transmissions of machine units operated in the mining, aviation, shipbuilding and agricultural industries. The most complete research on the specified problem is presented in [1-15]. The study of cases of shifting of shaft axes due to installation inaccuracies, errors in the manufacture of power parts and operating conditions showed that when the gear half-coupling axis is skewed relative to the bearing axis, a centrifugal force acts on the rotating curved shaft, which increases its static deflection [8-13].

In works [8; 14; 15], the main attention is paid to theoretical and experimental studies of elastic bending moments that occur under static and dynamic loads, as in traditional gear couplings (that is, the teeth do not have any modification, or the teeth of the sleeve have barrel-shaped teeth of constant curvature, and the teeth of the clip are made straight), as well as gear couplings of new designs, i.e. with modified teeth.

The causes of misalignment of the axes of connecting shafts of machine units are shown in a structured form in the work [7]. The influence of the specified misalignments of the axes on the reliability parameters of machine units and power plants, in which they are operated, is shown on the example of ship power plants and highlighted in [4; 6; 7]. Ways to reduce the influence of misalignment of the axes of connecting shafts and methods of eliminating their negative impact on the operation of machines and mechanisms, in the composition of which they occur, are shown in works [3; 4; 6; 7; 8; 10]. In work [5] it is shown that increasing the efficiency of machine units with misalignment of the axes of their connecting shafts is possible by using new designs of gear couplings protected by patents of Ukraine.

However, scientific works [2; 4; 6; 7; 10; 11; 12; 13; 15] did not take into account the influence of skew and deflection of the rotating shaft on the force factors arising in gear joints, but from the analysis of publications [1; 2; 8; 9; 10], it is evidently necessary to pre-estimate the effect of the dynamics coefficients on the force factors acting in them when designing gear joints of rapidly rotating shafts.

The purpose of the work is to evaluate the influence of the deflection of the rotating shaft on the force factors that arise when the axes are misaligned in the gear joints of machine units.

STUDY OF THE INFLUENCE OF SKEW AND DEFLECTION OF THE ROTATING SHAFT ON FORCE FACTORS ARISING IN GEAR JOINTS

Misalignment of the axes (misalignment) is a violation of shaft alignment, i.e. a deviation from the nominal location of the axes in any direction (Fig. 1). These deviations are called shifts, and they, in turn, are divided into longitudinal, radial, angular and combined. It should be noted that angular displacements are also called fractures.

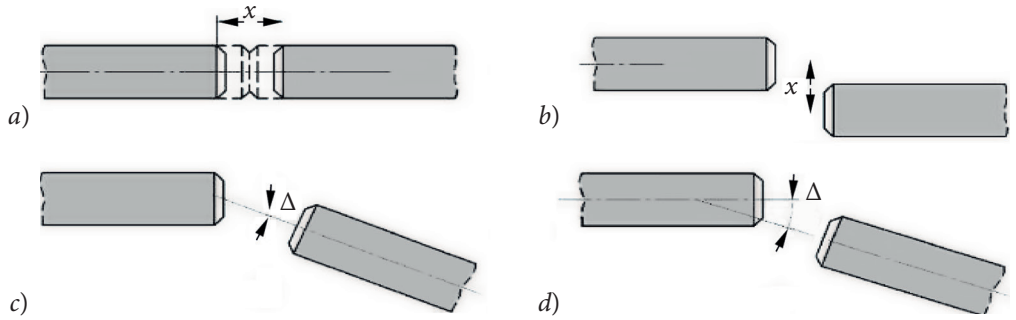

***Figure 1**. Displacement of the axes of the connected shafts of machine units: longitudinal (a), radial (b), angular (break) (c), combined (d)*

In high-speed, heavily loaded transmissions of power plants during operation, distortions and displacements of their axes inevitably occur [1; 2; 8; 9; 3-6]. The magnitudes of axis misalignments during the periods of operation of power plants depend on a number of structural, technological and operational factors (unreliable foundation, expansion in pumping equipment, non-compliance with installation recommendations, etc.), in addition, there are combined and specific factors, but they are not considered . As a rule, misalignment of axes and their breaks are the values of misalignments caused by deviations in manufacturing technology, for example ship power plants and their elements (Fig. 2-5).

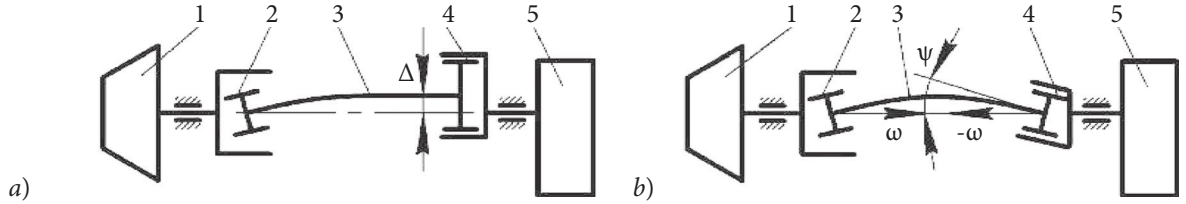

***Figure 2**. Beating (a) and misalignment (b) of the teeth of the gear clutch: 1 – propeller turbine; 2, 4 – toothed bushings; 3 – shaft; 5 – reducer*

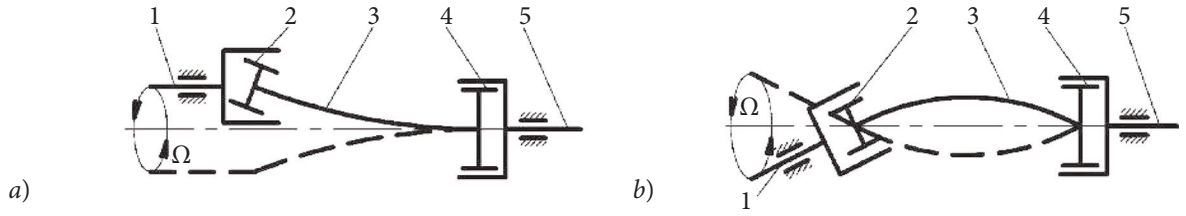

***Figure 3**. Runout (a) and misalignment (b) of the axis of the gear bushing: 1 – shaft; 2, 4 – toothed bushings; 3 – spring; 5 – drive mechanism shaft*

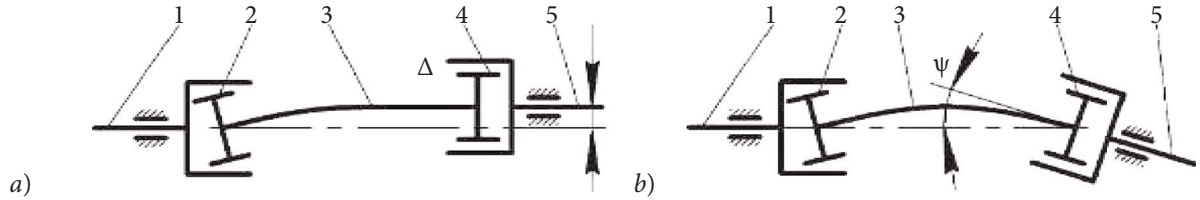

***Figure 4**. Displacement (a) and misalignment (b) of the axis of the gear mechanism: 1 – motor shaft; 2, 4 – toothed bushings; 3 – spring; 5 – drive mechanism shaft*

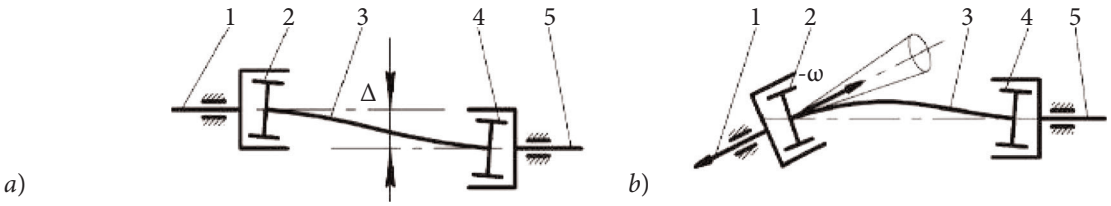

Figure 5. *Shift (a) and misalignment (b) of the engine axis:*
1 – engine shaft; 2, 4 – toothed bushings; 3 – spring; 5 – drive mechanism shaft

In order to eliminate the negative impact of misalignment of the axes of the connecting shafts of machine units and, as a result, to ensure the performance of the specified functions, the installed equipment of the installations provides for the control of alignment, i.e. checking the alignment of the axes of the connecting shafts of engines and drive mechanisms. This method is associated with a complete shutdown of the power plant, and the re-centering itself is quite time-consuming and expensive. Another method involves compensating the harmful effects of the specified misalignments of the axes, due to the use of compensating devices, but today, the influence of the static deflection of the rotating shaft on the force factors arising in their toothed joints, as already indicated, is almost not taken into account.

The study of the cases of shifting of shaft axes [1-8; 9; 14], caused by installation inaccuracies, errors in the manufacture of power parts and operating conditions, showed that when the gear half-coupling axis is skewed relative to the bearing axis by an angle θb (Fig. 6*a*) on a rotating curved shaft there is a centrifugal force that increases its static deflection.

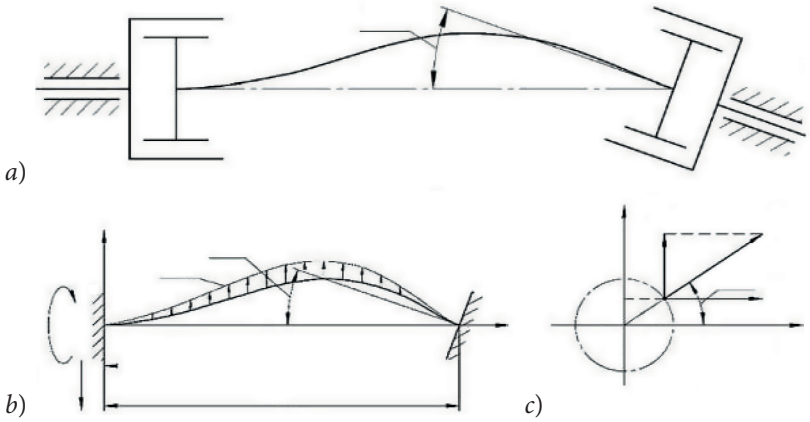

Figure 6. *Scheme of shaft deflection: a – at the angle θb; b, c – under the action of centrifugal force*

In the article, an attempt is made to take into account the influence of the specified deflection of the rotating shaft on the force factors that occur when the axes are misaligned in gear joints. When determining the dynamic shape of the deflection of the rotating shaft, which is under the action of centrifugal forces Рц (Fig. 6 *b*, *c*), the theory of constant forced bending vibrations of the beam, developed by O.M. Winged

Centrifugal force acts on the rotating bent shaft, which increases its static deflection. At the same time, the projections of the centrifugal force Рц acting on each element of the curved shaft are equal to:

$$Py=Рц sin\omega t;\ Pz=Рц cos\omega t,$$

where ω is the angular speed of the shaft.

The indicated projections Py and Pz cause forced oscillations of the shaft in the plane of action y_0z.

The movement of the shaft cross-section at any moment in time can be expressed by the following dependencies:

$$Y=Yдин sin\omega t;\ Z = Yдин cos\omega t,$$

and the resulting movement of the shaft cross-section represents movement along a circle, the radius of which is equal to:

$$Y=Yст+Yдин. \quad (1)$$

The output static deflection of the shaft in this scheme (Fig. 1 *a*, *b*) has the form:

$$YCT(x) = \theta BL\left[\left(\frac{X}{L}\right)^2 - \left(\frac{X}{L}\right)^3\right]. \quad (2)$$

Thus, the rotating shaft will be acted upon by a disturbing (centrifugal) force determined from the expression

$$P(x,t) = \frac{\gamma F}{g}\,\omega^2 Y_{CT(x)}\,sin\,\omega\,t \quad (3)$$

Where γ is the specific weight of the shaft material, H/m$_3$; *F* – cross-sectional area of the shaft, m$_2$; *g* – acceleration of gravity, m/s$_2$; *L* – shaft length, m;

θ_B – angle of misalignment of the axis of the toothed semi-coupling with respect to the axis of the bearing, rad.

The equation of forced bending vibrations of a beam of constant cross-section will have the form:

$$EJ\frac{\partial^4 Y_{(x,t)}}{\partial X^4}+\frac{\gamma F\partial^2 Y_{(x,t)}}{\partial t^2}=P_{(x,t)} \quad (4)$$

where E is the modulus of elasticity of the shaft material, Pa; J is the moment of inertia of the shaft section, kg.m$_2$

Since the minimum critical revolutions for a number of analyzed structures are significantly higher than the operating revolutions, to solve this problem it is sufficient to consider only the steady forced oscillations of the shaft with the frequency ω. Then we look for the solution of equation (4) in the form

$$Y(x, t)=Y(x)sin\omega t, \quad (5)$$

where $Y(x)$ is the shape of the dynamic deflection of the rotating shaft.

Entering the dimensionless coordinate ξ=X/L and substituting expressions (3) and (5) into equation (4), we get the equation for the shape of the dynamic deflection of a rotating shaft:

$$Y\frac{IV}{\xi}-\alpha 4Y(£)=\alpha 4\theta_B L(\xi 3-\xi 2) \quad (6)$$

where

$$\alpha 4=\frac{\gamma F}{g}\omega^2\frac{L^4}{EJ} \quad (7)$$

We solve equation (6):

$$Y_{(\xi)}=\overline{Y}_{(\xi)}+\overline{Y}_{(\xi)}, \quad (8)$$

where $\overline{Y}(\xi)$ is the solution of equation (6) without the right-hand side; $\overline{Y}(\xi)$ is a private solution, which is determined by the form of the right-hand side by the method of undetermined coefficients.

Equation for $Y(\xi)$:

$$\overline{Y}(\xi)=C_1V_{1(\alpha\xi)}+C_2V_{2(\alpha\xi)}+C_3V_{3(\alpha\xi)}+C_4V_{4(\alpha\xi)} \quad (9)$$

where $V_{1(\alpha\xi)}$, $V_{2(\alpha\xi)}$, $V_{3(\alpha\xi)}$, $V_{4(\alpha\xi)}$ – Krylov's functions, which for the calculated value of α according to (7), are selected according to [2, 9].

The final solution is equal (8) to the improvements (9) in the future will look:

$$Y_{(\xi)}=C_1V_{1(\alpha\xi)}+C_2V_{2(\alpha\xi)}+C_3V_{3(\alpha\xi)}+C_4V_{4(\alpha\xi)}-\theta_B L(\xi^3-\xi^2) \quad (10)$$

The constants C_1, C_2, C_3 and C_4 are determined from the boundary conditions according to the scheme of laying the shaft.

According to the diagram (Fig. 1*b*), it is ξ=0, $Y_{(0)}$=0; $Y'_{(0)}$=0, and at ξ=1, $Y_{(\xi)}$=0; $Y'_{(\xi)}$=0

Then, subjecting equation (10) to the written boundary conditions, it is found C_1=C_2=0; $C_3V_{3(\alpha\xi)}$+ +$C_4V_{4(\alpha\xi)}$=0; $C_3V_{2(\alpha)}$+$C_4V_{3(\alpha)}$=0, where

$$C3=-\theta B\frac{L}{\alpha}\frac{V_{4(\alpha)}}{V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}}; \quad (11)$$

$$C4=-\theta B\frac{L}{\alpha}\frac{V_{3(\alpha)}}{V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}}. \quad (12)$$

At the same time, the dynamic shape of the deflection of the rotating shaft according to expression (10) is equal to:

$$Y=\theta B\frac{L}{\alpha}\left[\frac{V_{3(\alpha)}V_{4(\alpha\chi)}}{V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}}-\right.$$
$$\left.-\frac{V_{4(\alpha)}V_{3(\alpha\chi)}}{V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}}-\alpha(\xi^3-\xi^2)\right] \quad (13)$$

The total shape of the deflection of the rotating shaft, taking into account (1), will take the form:

$$Y\Sigma=\theta B\frac{L}{\alpha}\left[\frac{V_{3(\alpha)}V_{4(\alpha\xi)}}{V_3^2-V_2V_4}-\frac{V_{4(\alpha)}V_{3(\alpha\xi)}}{V_3^2-V_2V_4}\right] \quad (14)$$

To find the force and moment in the front gear coupling, the equations for $Y''_{\Sigma(0)}$ and $Y'''_{\Sigma(0)}$ are determined when using (14):

$$M\Sigma(0)=EJY''_{\Sigma(0)}=\theta B\frac{EJ}{L}\frac{\alpha V_{4(\alpha)}}{V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}} \quad (15)$$

$$Q\Sigma(0)=EJY'''_{\Sigma(0)}=\theta B\frac{EJ}{L}\frac{\alpha^2 V_{3(\alpha)}}{V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}} \quad (16)$$

On the other hand, $M_{\Sigma(0)}$ and $Q_{\Sigma(0)}$ can be represented as $M_{\Sigma(0)}=K_mM_{ст(0)}$; $Q_{\Sigma(0)}=K_QQ_{ст(0)}$. Dependencies for $M_{ст(0)}$ and $Q_{ст(0)}$ based on the form of static deflection (2) have the form:

$$Mст(0)=-\frac{2EJ}{L}\theta B, \quad (17)$$

$$Qст(0)=-\frac{6EJ}{L^2}\theta B, \quad (18)$$

After considering equations (15), (16) and (17), (18), we will obtain the final form of the formulas for the dynamism coefficients:

$$KM=\frac{\alpha V_{4(\alpha)}}{2\left[V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}\right]} \quad (19)$$

$$KQ=\frac{\alpha^2 V_{3(\alpha)}}{6\left[V_{3(\alpha)}^2-V_{2(\alpha)}V_{4(\alpha)}\right]}. \quad (20)$$

On the basis of the obtained dependencies (19) and (20), an analysis was carried out for a number of toothed connections [4, 5, 9], which showed that the values of the dynamics coefficients do not exceed 1.05-1.15, and the dynamic components of the force factors can reach 30-50% of the values of the static components of the shaft rotating at high revolutions.

CONCLUSIONS

1. The analysis of the obtained solutions for toothed joints showed that the values of the dynamic coefficients do not exceed 1.05-1.15, thus, it was established that the dynamic components of the force factors are approximately an order of magnitude lower

than the static loads. 2. It was established that the dynamic components of power factors can reach 30-50% of the values of the static components of a rotating shaft with high revolutions due to an unfavorable combination of dimensions, wear of contacting surfaces, manufacturing errors and other reasons. 3. When designing toothed connections of rapidly rotating shafts, it is necessary to preliminarily assess the influence of dynamic coefficients on the force factors acting in them.

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Вплив перекосу і прогину обертового вала на силові фактори, що виникають у зубчастих з'єднаннях

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Анотація. Важливими та пріоритетними завданнями для галузі промисловості України є зменшення витрат на створення кінцевого продукту, зменшення собівартості обслуговування побудови машин та механізмів, реставрації застарілої виробничої бази та залучення нових технологій, механізмів та устаткування. Саме тому, підвищення працездатності, надійності і терміну служби машинних агрегатів, які застосовуються в умовах перекосів осей з'єднувальних валів, що обумовлені прогином обертового вала у механізмах, які з'єднані між собою проміжним валом за допомогою компенсувальних пристроїв, та призначені для передачі ефективної потужності від двигуна до споживача, і, як правило, є найбільш важливою частиною будь-якої енергетичної установки, є актуальною задачею і від її вдалого рішення залежить наступний розвиток сучасної машинобудівної сфери. Водночас, дієвість машинних механізмів безпосередньо залежить від продуктивної роботи зубчастих механізмів, які входять до їх складу, а саме механічних передач та зубчастих муфт, які знайшли своє широке відображення майже у всіх галузях промисловості. Таким чином, метою роботи є оцінка впливу прогину валу, що обертається, на силові фактори, які виникають при перекосі осей в зубчастих з'єднаннях машинних агрегатів. Досліджено вплив перекосу і прогину валу, що обертається з великою частотою, на силові фактори для деяких зубчастих з'єднань. З'ясовано, що значення коефіцієнтів динамічності при цьому не перевищують 1,05-1,15, а динамічні складові цих силових факторів можуть досягати 30-50% від величин рівня їх статичних складових

Ключові слова: обертовий вал, прогин, зубчаста муфта, трансмісія, перекіс осей, силові фактори

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Plant components in the technology of meat products production

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Abstract. Meat and meat products are a necessary source of a significant list of biologically active substances with high bioavailability, they are enriched with essential amino acids, vitamins, macro- and microelements. That is why the invention of new types of meat-based food products and the improvement of existing technologies for their production is an important task for scientists and specialists in the meat processing industry. A necessary direction in the production of new types of meat products is the synthesis of raw materials of animal and plant origin. Such a technological mechanism makes it possible to obtain food products that are enriched with organic nutrients that positively affect the functioning of the organs and systems of the human body and contribute to the rational use of raw materials of animal origin, which makes it possible to expand the range of products. Scientists and researchers of this field studied the possibility of adding various plant components to the composition of meat products and found their positive influence on structural-mechanical, organoleptic, functional-technological properties and biological value. Thus, the purpose of the study is to substantiate the use of a plant component, namely couscous groats from durum wheat varieties in the production technology of meat semi-finished products. The article substantiates and experimentally proves the possibility of using couscous groats in the production technology of chopped semi-finished products. According to the results of the study of functional-technological and organoleptic indicators of model minced meat, it was established that it is rational to add no more than 9% of prepared couscous to the recipe of meatballs made of beef and pork. According to the quality indicators, the semi-finished products meet the requirements of the current regulatory documentation

Keywords: couscous, chopped semi-finished products, meatballs, functional and technological indicators, organoleptic assessment

INTRODUCTION

Meat and meat products are an important source of a significant list of biologically active substances with high bioavailability - these are essential amino acids, vitamins, macro- and microelements, etc. Therefore, the development of new types of meat-based food products and the improvement of already existing technologies for their production is an urgent task for scientists and specialists in the meat processing industry.

A promising direction in the production of new types of meat products is the combination of raw materials of animal and plant origin. This technological method allows you to obtain food products enriched with natural nutrients that have a positive effect on the functioning of organs and systems of the human body and contribute to the rational use of raw materials of animal origin, which allows you to expand the range of products. Scientists have investigated the possibility of introducing various plant components into the composition of meat products and proved their positive effect on structural-mechanical, organoleptic, functional-technological properties and biological value [1-6]. Due to the biological features of growing farm animals, the chemical composition of meat raw materials can vary under the influence of

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many factors. Recently, the most pronounced impact on these processes has been observed due to the introduction of intensive technologies of fattening and keeping animals, which affects the mass fraction of fats and proteins in meat, as well as the values of functional-technological and organoleptic indicators. This, in turn, leads to a change in the quality characteristics of finished meat products, a decrease in the content of essential substances and nutritional values [7]. Therefore, another direction that can be solved by combining plant and animal raw materials is the possibility of balancing the chemical composition of the products according to the content of essential ingredients.

Specialists note a steady growth in the demand for meat semi-finished products. Urbanization of the population, the desire to save time for cooking, and an increase in the share of working women have a significant impact on this process. In addition, the features of industrial freezing contribute to the preservation of useful nutrients and guarantee the high safety of finished products. Thus, the demand for frozen meat semi-finished products, despite the crisis phenomena, will grow and will require the expansion of the range due to the use of ingredients that diversify the organoleptic indicators [8].

The most expedient when developing new recipes for meat products is the use of components that have a low cost and meet the national stereotypes of the Ukrainian consumer's diet. Authentic Ukrainian cuisine is known for the combination of meat or lard with a variety of cereals: buckwheat, buckwheat, groats. Recently, new products have appeared in the diet of Ukrainians that do not require complex cooking before consumption, have a low cost and have good taste properties. One such ingredient is couscous. According to the authors [9], the nutritional content of couscous is very similar to buckwheat, it has a high content of B vitamins and minerals; the energy value of 100 g of dry groats is 376 kcal, the mass fraction of proteins is 12.76%, fats are only 0.64%, carbohydrates are 77.43%, including fiber 5%. The glycemic index of couscous is 69 [9-11].

However, it should be noted that in the world there are several technological approaches to the production of couscous and its ingredient composition, but the most biologically valuable is couscous grain from durum wheat varieties (Triticum durum) [12].

The culture of couscous consumption has long existed in the world and, thanks to globalization, this cereal has spread from the African continent to Europe. The world production capacity of couscous is about 430 thousand tons per year [11]. Currently, in Europe, the most couscous is consumed in Italy and France, whose population has a balanced approach to choosing food products and combining them, which is confirmed by the classification of the Mediterranean diet (Italy) and the Gastronomic Art (France) into the intangible heritage of UNESCO in 2010 [13-14].

In Ukraine, the consumption of couscous is increasing every year, which is explained by its culinary features and the possibility of combining this cereal as a side dish with mushrooms, greens, stewed vegetables and meat. Couscous is currently not used in the industrial production of food products in our country.

The purpose of the study is to substantiate the use of couscous from durum wheat (Triticum durum) in the technology of semi-finished meat production. To achieve the goal, the following tasks were set:

– to investigate the influence of adding couscous on the change of functional and technological indicators of meat systems based on beef and pork;

– based on the change in the dynamics of organoleptic indicators, to investigate the permissible range of partial replacement of meat raw materials with pre-prepared couscous cereal in the production of chopped semi-finished products;

– evaluate the quality indicators of finished semi-finished products in accordance with the requirements of regulatory documentation.

MATERIALS AND METHODS

For conducting experimental studies, grade 1 beef meat with a content of visible connective and fatty tissues of no more than 6% was used, according to DSTU 6030:2008; semi-fatty pork meat with a fatty tissue content of 30...50% according to DSTU 7158:2010; couscous groats, according to TU U 15.6-30150670-001:2005; fresh onion, according to DSTU 3234-95; ground black pepper, according to DSTU ISO 959-1:2008; table salt, according to DSTU 3583:2015; drinking water, according to DSTU 7525:2014.

The mass fraction of moisture was determined according to DSTU ISO 1442:2005, pH – DSTU ISO 2917:2001, mass fraction of fat – DSTU 8380:2015, mass fraction of table salt – DSTU ISO 1841-2:2004,

The pressing method (the method of Grau and Hamm in the modification of V.L. Volovynska) was used to determine the moisture-binding capacity (MBC). The test sample of the product was thoroughly crushed and mixed. After that, a weight weighing 0.3 g (to the nearest 0.01 g) was taken and transferred to an ashless filter located on a glass plate. The top was covered with the same plate and a 1 kg weight was placed on it for 10 minutes. After that, the filter was released with a ruler, and then the outline of the spot around the pressed meat and adsorbed moisture was drawn with a pencil. The area of the formed spots was measured with a planimeter.

The mass fraction of tightly bound moisture in the sample was calculated using the formula:

$$X^1 = \frac{(A-(8{,}4F))\ 100,}{m} \cdot 100\%, \qquad (1)$$

where X_1 is the mass fraction of bound moisture in the sample, % to the mass of meat; 8.4 – amount of

moisture absorbed by 1 cm^2 of ashless filter, mg; *F* – wet spot area, cm^2; *A* – total moisture content in this sample, mg; m – weight of the sample, mg; 100 is a multiplier for conversion in %.

$$A=m\varphi, \quad (2)$$

where φ – moisture content in the sample in fractions of a unit.

Ultimate shear stress (USS) was determined using an automatic PMDP penetrometer. The minced meat sample was placed in a mold and the surface was leveled with a spatula. The device was connected to the electrical network, a form with a prepared sample of the product was placed on the object table of the device.

Pressed the "Network" button, then the "60s" button and the "Start" button. When fixing the penetration value on the digital scoreboard, remove the penetration value from the scoreboard and wait for the cone to return to its initial position. Based on the found value of the immersion depth, the ultimate shear stress was calculated according to the formula of P.A. Rebinder for plastic-viscous bodies:

$$\Theta = \frac{k_\alpha F}{h^2},$$

where Θ – the ultimate shear stress, Pa; k_α – a cone constant that depends on the angle at its apex; *h* – the immersion depth of the cone, m

$$F=mg, \quad (4)$$

m – mass of the cone with a rod and an additional load, kg; *g* – acceleration of free fall, m/s.

Heat treatment losses were determined by the gravimetric method, weighing product samples before and after heat treatment. Cooked samples were weighed after cooling to a temperature below 40°C.

The formula was used to calculate losses during heat treatment

$$TO = \left(\frac{M_1 - M_2}{M_1}\right) \cdot 100, \quad (5)$$

where *TO* – losses during heat treatment, %; M_1 – mass of raw material or semi-finished product prepared for heat treatment, kg; M_2 – mass of raw material or semi-finished product, after heat treatment, kg; 100 is a multiplier for conversion in %.

The stability of minced meat emulsion was determined using the method developed by R.M. Salavatulina, S.A. Aliyev, and V.M. Lyubchenko. Minced meat samples weighing 180…200 g were placed in hermetically sealed cans No. 3, weighed and cooked in a water bath at a temperature of 78…80°C for 1 hour, then cooled to a temperature of 12…15°C. After that, the cans were opened, the broth, together with the separated fat, was transferred into pre-weighed aluminum containers. And the remaining cooked minced meat was dried with filter paper and weighed.

The stability of minced meat emulsion (SMM, % by mass of minced meat) was calculated according to the formula

$$SMM = \frac{m_c}{m} \cdot 100 \quad (6)$$

where m_c – mass of cooked minced meat after heat treatment and drying, g; *m* – the weight of minced meat before heat treatment, g; 100 – a multiplier for conversion in %.

To determine organoleptic indicators, a 9-point scale according to DSTU 4823.2:2007 and [15] was used.

RESULTS AND DISCUSSION

The object of research is the production technology of chopped semi-finished products (meatballs).

According to DSTU 4437:2005, meatballs are a frozen semi-finished product made of minced meat with the addition of other components (according to the recipe) in a spherical shape weighing 7…9 g. The components of the recipe can be vegetable components (onions, cereals, legumes, etc.) . According to the requirements, meat semi-finished products must contain at least 50% of meat raw materials, and meat products – at least 40%. These requirements were taken into account when conducting research and developing the recipe for meatballs with couscous.

At the initial stage, a study of the influence of couscous introduction on the dynamics of changes in functional and technological indicators (FTI) and structural and mechanical properties of systems based on meat raw materials was carried out.

For this purpose, a series of model mincemeats was prepared with the addition of pre-prepared couscous groats, because it is impossible to obtain the desired structure of mincemeat that will form well, keep its shape and have good organoleptic indicators when dry groats are introduced. Therefore, dry couscous groats were previously poured with hot water at a temperature of 80…90°C so that the water level was 1 cm above the groats. After that, they were brought to a boil and left to swell and cool. Cooled groats were used to prepare model minced meat.

Pork and beef (separately) were chopped on a small grater with a diameter of 3 mm. Next, in a mixer for preparing a series of model mincemeats, each type of meat was mixed with cereals for 8 minutes. The mass share of prepared groats in model minced meat was up to 18% with a step of 3%. Raw meat without additives was used as a control sample.

The results of the study of the dynamics of changes in the mass fraction of moisture W, (%), MBC (%) and USS (Pa) of model minced pork and beef are shown in fig. 1-3.

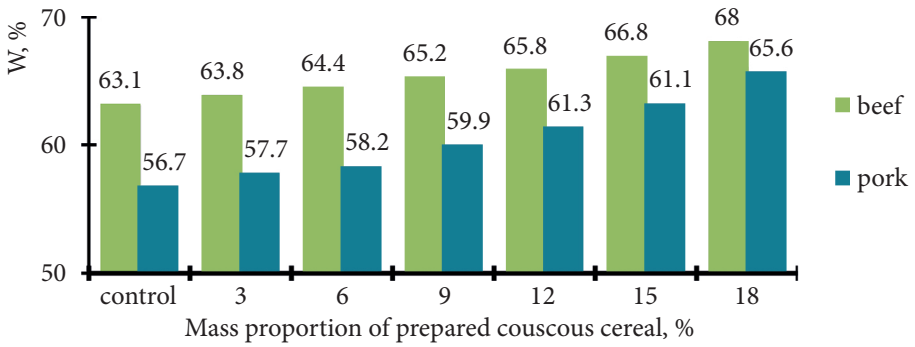

***Figure 1**. The influence of the introduction of prepared couscous cereal on the change in the mass fraction of moisture in model minced meat samples*

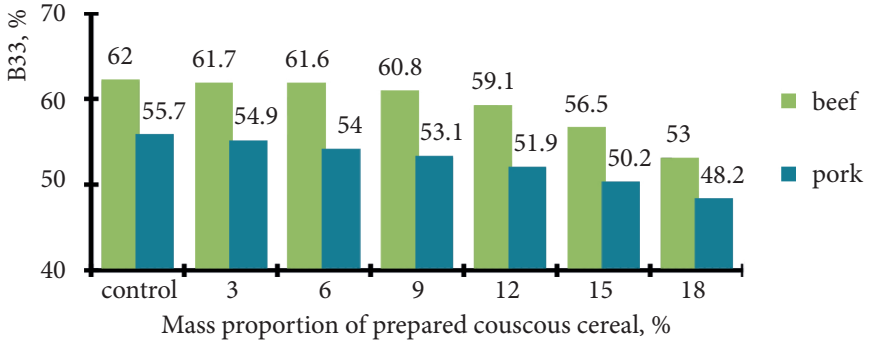

***Figure 2** The influence of the introduction of prepared couscous cereal on the change of MBC in model minced meat samples*

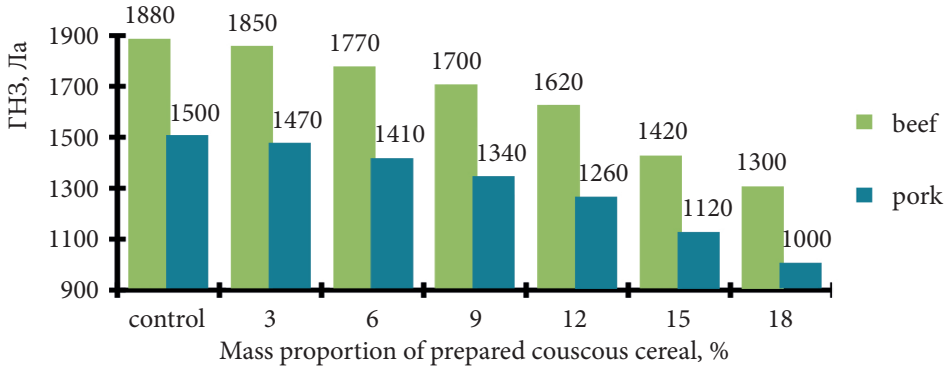

***Figure 3** The influence of the introduction of prepared couscous cereal on the change of USS in model minced meat samples*

The experimentally obtained data show that the addition of prepared couscous grain leads to an increase in the mass fraction of moisture in the system by 4.9...8.9% with an increase in the grain content, while the MBC indicator decreases by 7.5...9%. These changes are not critical, but may affect the provision of stable quality of finished products when using beef and pork meat. After all, the decrease in the MBC indicator occurs due to a decrease in the protein content of muscle tissue, so the system's ability to retain free moisture also decreases. Instead, an increase in the mass fraction of moisture occurs due to the introduction of a significant fraction of moisture with the prepared couscous cereal. The data are correlated with the values obtained in the USS study. These indicators can affect the tenderness and juiciness of finished products, as well as cause an increase in losses during heat treatment.

Chopped semi-finished products are traditionally sold in a frozen form with a temperature in the center of the product no higher than -10°C, so another important indicator that must be taken into account when using new recipe components is determining their effect on the change in the value of active

acidity – pH. After all, significant fluctuations in the values of this indicator can affect the structure of native proteins of meat raw materials, changing their solubility and hydrophobicity. The influence of the addition of couscous on the pH of the model minced meat is shown in Fig. 4.

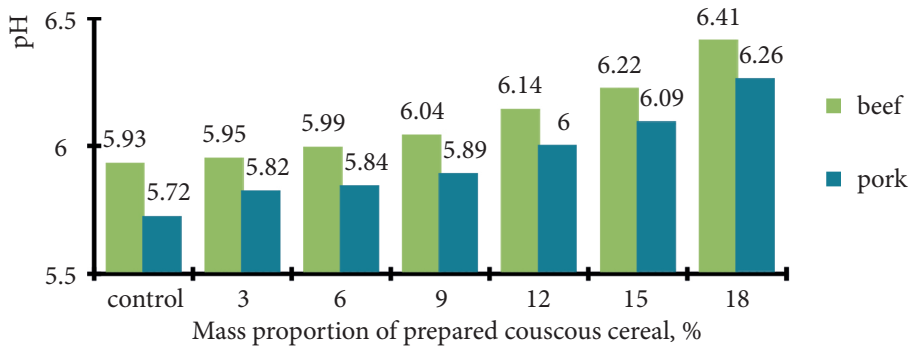

Figure 4 *The influence of adding prepared couscous cereal on the pH change of the model minced meat samples*

The obtained results demonstrate an increase in the pH value by 0.48…0.54 units with an increase in the proportion of the additive in the system. Such dynamics can be evaluated as positive, because it indicates the accumulation of soluble myofibrillar proteins in the system, which contribute to the strengthening of the minced meat structure during heat treatment.

To determine the possible value of losses during heat treatment, all model minced meats were subjected to heat treatment. Namely, round-shaped products weighing 7…9 g were formed and steamed to reach a temperature in the center of 72±2°C. The products were weighed before and after cooking. The results of the study of losses during heat treatment (HT, %) are shown in fig. 5.

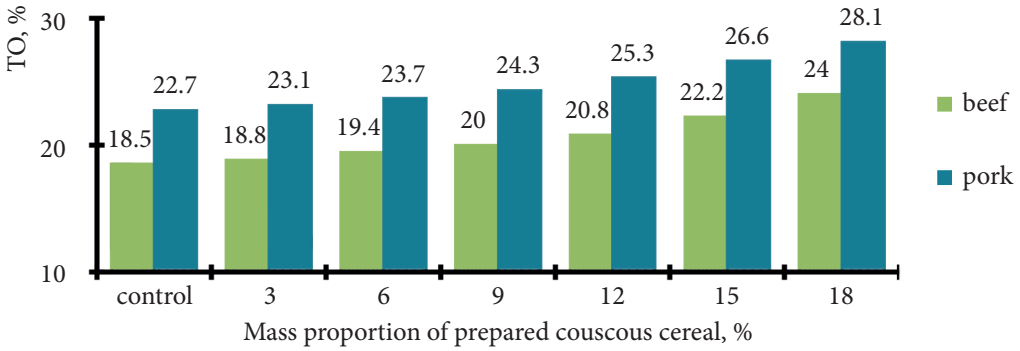

Figure 5 *The influence of adding prepared couscous cereal on losses during heat treatment of model minced meat samples*

The obtained data (Fig. 5) demonstrate that the model mincemeats with the introduction of prepared couscous grits lose 0.3…5.4% more during heat treatment, compared to the control samples. More significant indicators of losses during heat treatment were established in samples with a mass fraction of couscous of 12…18%, the dynamics of losses is higher in minced meat based on pork.

Thus, after examining the functional and technological indicators of model minced meat with the introduction of prepared couscous groats, it can be stated that it is rational to add up to 12% of prepared couscous groats to the composition of new types of meatballs, because a higher content of vegetable raw materials leads to a decrease in MBC, USS indicators, contributes to an increase content of unbound moisture and reduces yield. The basis of the recipe should be beef meat, because fattier pork meat with such a combination has a significant effect on the change in FTI, and, accordingly, on the quality indicators of the finished product. Paying attention to the color, the presence of deformations and tears. When evaluating the species on the section, attention was paid to the uniformity of the distribution of components, according to the formulation, the color from dark to light pink. The smell in the raw form should be characteristic of good-quality raw materials and spices, in the cooked form, the taste and smell should be characteristic of the given product, without extraneous aftertaste and smell. The consistency of culinary processed semi-finished products is juicy, tender, not fragile. The results of the study are presented in the form of a profile in fig. 6.

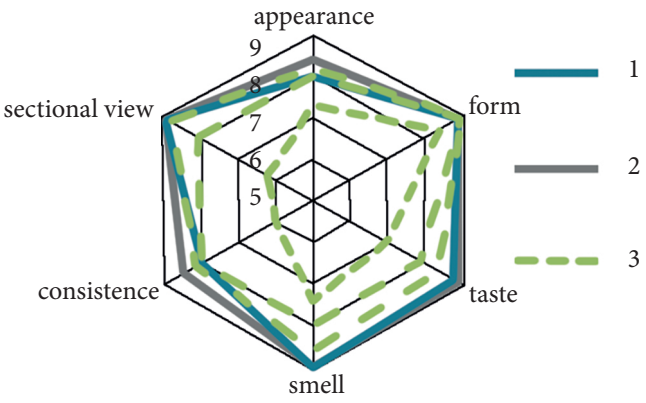

Figure 6 *Profilogram of organoleptic evaluation of control and test meatball samples*

The received sensory evaluation data show that, in general, all samples meet the requirements of the regulatory documentation in all indicators and do not differ significantly. However, the smallest area in the sensory evaluation is occupied by the profile of the fifth sample, which is characterized by a less pronounced taste and aroma, has a soft consistency, and when evaluating the appearance on the section, the tasters noted the presence of significant visible inclusions of couscous, which was the reason for the reduced organoleptic evaluation of this sample. Thus, taking into account the results of the tasting evaluation, it is recommended to add no more than 9% of prepared couscous to the meatballs. Another important indicator that determines the quality of chopped semi-finished products is the stability indicator of minced meat emulsion, which characterizes the mass fraction of bound moisture and fat. The results are presented in fig. 7.

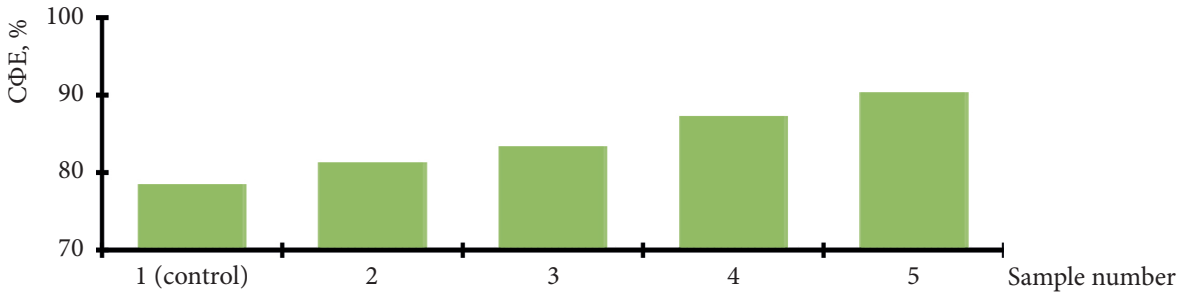

Figure 7. *The value of the stability index of minced emulsion of control and experimental samples of chopped semi-finished products*

At the next stage of the research, the organoleptic parameters of the samples of meatballs with the addition of prepared couscous cereal were determined. After all, it is the organoleptic properties of food products, including meat products, that directly affect the choice of the product by the consumer and objectively

All test samples show higher SMM values, compared to the control, which can be explained by the fact that the control sample contains more fat, which is less well connected to other components of the minced meat and is therefore easier to separate during heat treatment. In the test samples, the SMM value increases by 2.8...11.9%, compared to the control, which indicates a better binding of moisture and fat in the experimental samples and characterizes their consistency as denser. This can be explained by the fact that couscous contains gluten, which has high elasticity and is able to retain a significant amount of moisture when it is separated from meat proteins during heat treatment. This study also confirms the expediency of using couscous groats in the production technology of chopped semi-finished products. At the next stage, the organoleptic and physico-chemical parameters of meatballs containing 9% couscous groats and their compliance with the requirements of regulatory documentation were investigated. For this, two batches of meatballs were made according to the traditional recipe, according to DSTU 4437:2005 and according to the experimental recipe. Then they were divided into two parts: one part was frozen to a temperature in the center no higher than 10°C and these products were evaluated in the frozen state; the second - was boiled in boiling water for 15 minutes, removed from the water, cooled to a temperature of 40°C and organoleptic indicators were evaluated. Physico-chemical indicators

were evaluated in raw semi-finished products. The obtained results are presented in the table. 1. All test samples show higher SMM values, compared to the control, which can be explained by the fact that the control sample contains more fat, which is less well connected to other components of the minced meat and is therefore easier to separate during the heat treatment process. In the experimental samples, the value of the SMM indicator increases by 2.8...11.9%, compared to the control, which indicates a better binding of moisture and fat in the experimental samples and characterizes their consistency as denser. This can be explained by the fact that couscous contains gluten, which has high elasticity and is able to retain a significant amount of moisture when it is separated from meat proteins during heat treatment. This study also confirms the expediency of using couscous groats in the production technology of chopped semi-finished products.

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Table 1. Quality indicators of meatballs with couscous grains

Name of the indicator	Control sample (according to DSTU 4437:2005)	Test sample
Organoleptic indicators		
Appearance	Not stuck together, not deformed. The shape of one piece is spherical. When shaking the packaging unit, they make a clear, distinct sound.	
Sectional view	The minced meat is evenly mixed, from dark red to light pink in color.	
Consistence	In boiled form - juicy, tender, not fragile.	
Taste and smell	In raw form, they are characteristic of good-quality raw materials and spices. In boiled - characteristic of this product. Without extraneous taste, smell.	
Physico-chemical parameters		
Mass fraction of moisture in minced meat, %, not more than	66.92	68.35
Mass fraction of fat, %, not more than	10.92	8.14
Mass fraction of table salt, %	1.82	1.67
Mass of one piece, g	8±1	8±1

The results of the conducted research demonstrate that the partial replacement of grade I beef with prepared couscous grits and raw fat with semi-fat pork will allow to obtain products with stable functional and technological properties and good taste characteristics. The quality indicators of such products meet the requirements of regulatory documentation. This product will make it possible to rationally use raw materials of animal origin and reduce the cost of production.

CONCLUSIONS

Theoretical and experimental research made it possible to generalize the following:

1. Couscous grits are a promising ingredient for use in the recipes of chopped semi-finished products.

2. It was experimentally established that the introduction of prepared couscous cereal up to 12% has an insignificant effect on the change of functional-technological and structural-mechanical indicators, and an increase in the mass fraction of the plant component up to 18% is inappropriate due to a drop in MBC, USS and an increase in losses during heat treatment.

3. Organoleptic evaluation of the line of experimental samples made it possible to establish that it is advisable to use no more than 9% of couscous grains in new types of chopped semi-finished products.

4. In the experimental samples, organoleptic and physico-chemical quality indicators are determined, which fully meet the requirements of DSTU.

It is advisable to direct further research to the establishment of product storage parameters, the assessment of the economic effect and the development of regulatory documentation for the introduction of the technology into industrial production.

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Рослинні компоненти у технології виробництва м'ясопродуктів

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Анотація. М'ясо та м'ясні продукти є необхідним джерелом вагомого переліку біологічно активних речовин з високою біологічною доступністю, вони збагачені незамінними амінокислотами, вітамінами, макро- і мікроелементами. Саме тому винайдення нових видів харчових продуктів на м'ясній базі і покращення вже наявних технологій їх виробництва є вагомим завданням для науковців і спеціалістів м'ясопереробної галузі. Необхідним напрямком при виробництві нових видів м'ясопродуктів є синтез сировини тваринного і рослинного походження. Такий технологічний механізм дозволяє одержувати харчові продукти, які є збагаченими органічними нутрієнтами, що позитивно впливають на функціонування органів і систем людського організму та сприяють раціональному застосуванню сировини тваринного походження, що дає змогу розширити асортимент продукції. Вченими та дослідниками цієї сфери було вивчено можливість внесення до складу м'ясопродуктів різноманітних рослинних компонентів і виявлено їх позитивний вплив на структурно-механічні, органолептичні, функціонально-технологічні властивості та біологічну цінність. Таким чином, метою дослідження є обґрунтування використання рослинного компоненту, а саме крупи кускус із твердих сортів пшениці в технології виробництва м'ясних напівфабрикатів. У статті обґрунтовано і експериментально доведено можливість використання крупи кускус в технології виробництва посічених напівфабрикатів. За результатами дослідження функціонально-технологічних і органолептичних показників модельних фаршів встановлено, що до рецептури фрикадельок із яловичини і свинини раціонально вносити не більше 9 % підготованої крупи кускусу. За показниками якості напівфабрикати відповідають вимогам діючої нормативної документації

Ключові слова: кускус, посічені напівфабрикати, фрикадельки, функціонально-технологічні показники, органолептична оцінка

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COVID-19 pandemic and innovative agrarian economy

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Abstract. The COVID-19 pandemic has had and continues to have a profound effect on all areas of our lives. One of the main areas affected by the pandemic is agriculture. The article emphasizes the need to apply science-intensive technologies and expand innovative activities to ensure sustainable development of agriculture in the current pandemic. The importance of new generation technologies in accelerating the innovative development of the agricultural sector is also studied. Positive results have been obtained on issues that need to be solved when organizing and developing an economy based on an innovation system in the agricultural sector in a pandemic

Keywords: agricultural sector, innovation, COVID-19 pandemic, entrepreneurship, digital transformation, economic activity

PROBLEM STATEMENT

Various economic processes in the modern world, as well as the great disaster pandemic Covid-19, have harmed all sectors of the economy on a global scale. Such an undesirable event has affected our Republic as well. It should be noted that due to the outbreak of the Covid-19 pandemic, oil prices in world oil markets in 2020 fell significantly. Unlike other sectors, there is no visible demand for fuel and energy in agriculture.

It should be noted that in most of the developed countries of the world, about 20-25% of the labor force is employed in the field of high technologies, science, and education. For example, Switzerland, Sweden, and the United States ranked first in the 2020 Global Innovation Index. Azerbaijan ranks 82 nd in this rating. In Switzerland, which ranks first in the ranking, a highly skilled workforce plays an important role in the country's economic development. Research funded by the public and private sectors further improves the business environment in the country and stimulates support for new projects. The bulk of the financial support is provided by the private sector.

The purpose of the innovation is to change the object of management, to achieve a new scientific, technical, economic, and social effect. Innovation is assessed as the commercialization of scientific knowledge, embodied as new or improved products (services), techniques, technologies, organization of production, and management, and has various effects. [4, p. 8]

Under current conditions, the whole world is trying to further strengthen the innovation environment and transform itself into a digital economy. It should be noted that:

1. digitalization, which today penetrates all life spheres that is digital transformations are taking place under the influence of a pandemic;
2. we have to look actually at digital transformation, which we recognize as a process of broad integration of digital technologies into business, in a broader sense today due to the pandemic.

ANALYSIS OF ACTUAL RESEARCH

Preliminary analysis showed that innovative activity in the agricultural sector brings the following benefits: economic, social, environmental, technical, technological, trade, budget, etc.

There are three mutually and interdependent ways of innovative development of agriculture in current conditions:

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1. Investment in human capital - priority development of agrarian education, fundamental and applied research organizations, creation of a database on innovations, as well as the creation of an information and consulting system serving agricultural producers;

2. Investment in biological resources - increasing soil fertility and productivity of agricultural production through the application of innovative methods;

3. Investment in new technology is the investment in the development of technologies. They can improve the technical and technological potential of agriculture, dramatically increase labor productivity and efficiency of agricultural activities through the use of energy conservation equipment and resource-saving equipment, and high technologies [5, p. 77-81].

Azerbaijan is one of the two countries in the world that offer Mobile Residency. Mobile Residency, provided through the Digital Commerce Hub, is a public-private partnership project that allows anyone to access many e-services from wherever they are.

Digital transformations are the focus of the top government. On January 6, 2021, the President of the Republic of Azerbaijan signed a decree on the establishment of the "Center for Analysis and Coordination of the Fourth Industrial Revolution" under the Ministry of Economy. The UN appeal in March 2020 stated that the use of digital technologies in the fight against Covid-19 is inevitable. Many countries have tightened control over their crushing space-time neutron (media).

The development of new regulations is on the agenda. As a digital technology, the Internet of Things (IoT) provides a platform that allows health authorities to monitor the Covid-19 pandemic.

It is no coincidence that cloud services are considered a necessary factor for sustainable online activity during the pandemic. These factors include: "channel capacity in the home network, the capacity of the Internet channel depending on the server equipment, software, cloud service capabilities".

In the West, "Online Nation 2020 Report: 88% of current news on social networks is dedicated to the coronavirus. They want to increase the confidence in distorted news by using mathematical statistics. In the Western media, the figures for the coronavirus were exaggerated 142 times last year compared to official statistics [7].

The reality is that the relevant legal framework is being formed and developed in developed countries. For example, in France, the law "On Confidence in the Digital Economy" has been in force since 2004. The law regulating digital economic relations in the UK has been in force since 2010. In 2017, in addition, the law " On Digital Economy" was adopted. These examples can certainly be multiplied. Thus, in developed countries, the relevant legislation has been enacted. The European Union is currently working to unify the relevant legal norms. unify the relevant legal norms.

The purpose of the article. In the context of the ongoing Covid-19 pandemic in the global economy, the main goal is to identify the problems that need to be solved when organizing and developing the agricultural sector in the country based on an innovation system.

PRESENTATION OF THE MAIN MATERIAL

Innovation means new scientific and technical ideas, new products, new technologies, new production processes, the opening of new markets. Innovation is the result of scientific and technical activity in the form of a new or improved product (good or service) or technology. The main feature of the innovation is its application. A new or improved product is considered an innovative product only after it enters the market [8].

Innovation as a social category lies in the fact that almost all inventions are aimed at reducing the cost of energy, human labor, attracting new productive forces in production, increasing the efficiency of labor and production, and improving product quality. It leads to increased production and consumption, helps to improve the quality of life, helps maintain a balance between supply and demand, production and consumption by improving product quality, reducing costs, and improving production.

Giving preference to the institutional context of innovation, K. Freeman noted that the National Innovation System (NIS) is a network of institutional structures that create, change and promote the diffusion of new technologies, activities, and interactions in public and private sectors of the economy. These institutions (institutions) include both the organizations responsible for conducting the research and "copies of activities that help organize and manage the resources available at the enterprise and country level".

In accordance with the Decree of the President of the Republic of Azerbaijan dated December 19, 2018, the liberalization of the provision of the agricultural sector with machinery has been carried out. Techniques from different companies are leased to farmers with certain discounts (40%). The application of innovations, digitalization is under the influence of the pandemic.

The impact of the Covid-19 pandemic on a digital transformation can be summarized as follows:

1. as quarantine conditions are tightened, the use of digital technologies is expanding and activities in the digital environment are intensifying. This tendency is also found in public life;

2. the situation is different in the economic environment;

3. the doubts we have noted, of course, are reflected in the pace and proportion of the formation of the digital economy;

4. however, there are more fundamental trends in the development of the digital sector of the economy, driven by intrinsic motives;

5. these trends have more to do with economic interests than with conditions created by the pandemic [1].

Factors of economic activity play an important role in economic processes occurring in a pandemic:

1. It seems that the current processes in the world economy are maneuvering between economic activity and human health.

2. It is taken into account that prohibitions contrary to economic laws usually do not work effectively. Therefore, economic activity factors are taken into account in decisions on pandemic-related restrictions.

3. It is not difficult to see that such a situation expands the scope of digital technologies.

It should be noted that the article "Digital Transformation: 4 Ways to Plan a Normal Life After a Pandemic" by a very experienced expert like Bernie Gracy suggests the following:

– proper finance;
– correct tools;
– correct selection of staff;
– the right decisions on the brand" [6].

The author recommends that the correctness of finances, tools, staff, and decisions be assessed in terms of the pandemic impact of digital transformations.

As a result of the successful, purposeful policy pursued in Azerbaijan, which has chosen the path of active integration into the world economic system, the formation of the economy has created favorable conditions for further business activity, the rapid development of the oil and non-oil sectors, poverty reduction, reliable social protection. has significantly improved the situation.

However, given the Covid-19 pandemic, the global economic crisis, and other ongoing economic processes, the organization of an innovative economy to ensure the competitiveness and sustainability of the agricultural sector, which is an important sector of the Azerbaijani economy, is a requirement of the day.

One of the priorities of the economic policy of the Azerbaijani government is to accelerate the transition to an innovative economy in modern times, the application of the most advanced technologies in our country in line with the line of modernization and, consequently, the implementation of regional programs. This is one of the most important issues in the creation of an innovation system in the agricultural sector. Because recently special attention is paid to the development of the agricultural sector in the country. The country's strategic plans include the development of the agricultural sector, increasing food production, and ensuring food security. Achieving the development of the agrarian sector is one of the main directions of the country's economic diversification strategy.

The economic reforms implemented are proof of this. "The share of the agricultural sector in the country's labor market is more than 35%. However, the share of this sector in the country's GDP per capita is low (6.0%)" [9]. It should also be taken into account that the innovative system in the agricultural sector, unlike other areas, is applied in a unique way. Such a difference is mainly due to the need for a special approach to the field. As mentioned above, food security in the country is directly dependent on this area, the share of workers in this area in the labor market is high, and so on. factors can be cited as the main reasons for this. Ensuring the innovative development of Azerbaijan's agricultural sector can make a positive contribution to the development of the non-oil sector as a whole. This factor will also increase the share of the agricultural sector in GDP per capita.

There are a number of problems in the agricultural sector. So that:

– infrastructure and production technologies are at a low level;
– access to local products to world markets is limited;
– poor coordination between producers and those involved in this activity;
– poor coordination of the market of agricultural products;
– there are few highly qualified, specially trained, and experienced personnel in the agricultural sector;
– depending on the size, enterprises do not cooperate.

The agrarian strategy implemented in Azerbaijan requires a comprehensive study of various issues of increasing the role of entrepreneurship in the agrarian sector, creating favorable conditions for the effective use of intensive and innovative development factors. From this point of view, it is very important to assess the role of business entities in the field, to determine the features of their strategic management, to coordinate the policy of protection and liberalization of international trade in the national agricultural sector, to justify the effectiveness of the existing system of regulation.

The basis of the development strategy of the agrarian sector should be the issues of stimulating the application of the latest achievements of scientific and technological progress. Scientific and technical progress in the XXI century will not be limited to new means and objects of labor, machines, and technologies, but will include the productive forces, including man himself, on the other hand, new production relations, primarily organizational forms and methods of farming. The highest efficiency of scientific and technical progress in agriculture will be ensured through the use of its latest directions and factors [3, p. 141].

For more effective cooperation between science, public and private sectors in our country, it is necessary to create appropriate legislation and institution, as well as effective implementation of activities. In addition to financial support in the agricultural sector, the organization will assist in conducting monitoring and further increase the knowledge of entrepreneurs

in the field of business. Such an approach will have a positive impact on the development of the agricultural sector by increasing its export potential and will further accelerate the formation of an innovative agricultural economy.

In our republic, the Innovation Agency was established under the Ministry of Transport, Communications and High Technologies of the Republic of Azerbaijan, and the Innovation Center was established under the State Agency for Citizen Services and Social Innovations under the President of the Republic of Azerbaijan. In addition, the vital importance of the agricultural sector has led to innovation activity here. "Thus, 12 agricultural research institutes operating in the country, including 7 research institutes included in the structure of the Center for Agrarian Science and Innovation of the Ministry of Agriculture, Agrarian Research Center, Araz Scientific Production Association (Nakhchivan Autonomous Republic), A large part of the 8 regional centers of agrarian science and innovation and about 40 experimental and production bases of research institutes make a valuable contribution to the innovative development of this field" [2, p. 18].

It should be noted that such highly specialized institutions have a direct impact on the development of innovation in the agricultural sector. These bodies manage research and dissemination of results, and coordinate research structures related to the agricultural sector.

Realization of opportunities to increase the economic efficiency of agrarian entrepreneurship in the conditions of development of public-private partnership and diversification of activity is possible only in the conditions of creation of specialized subjects of innovative development in the regions.

The effectiveness of innovative entrepreneurship in the agricultural sector depends on the establishment of specialized entities to carry out innovative activities in the country, including innovation centers, agro-parks, technology parks, and incubators, etc., which implement product and process innovations. depends on the network capacity and distribution area. Thus, the subjects of specialized innovation activities promote the increase of innovation activity in the agro-food industry by strengthening technological, organizational, and information support.

Cluster development is based on criteria such as efficient use of resources and infrastructure, including joint logistics systems, improvement of labor resources (staff training), and joint innovative production activities, aimed at realizing the comparative advantages of agro-industrial integration and specialization. Given that the market orientation of innovations is one of the main conditions for its sustainability, the important role of agro-industrial clusters in promoting entrepreneurship should be emphasized. On the other hand, joint production and commercial activities place quite specific and longterm requirements for the infrastructure of intellectual development. Cluster initiatives, which envisage the realization of resource conservation opportunities, modernization of production infrastructure, and active application of high technologies, create favorable conditions for the development of innovative entrepreneurship in the agricultural sector. These conditions should be conducive to minimizing losses in the movement of resources and finished products.

At present, our country is at the initial stage of innovation development. As we have noted, the main priority of the economic policy of our country is to develop the non-oil sector of the economy.

Due to the priority of strengthening coordination between institutions or organizations engaged in innovative activities, it is very important to promote and produce innovative products based on science, to stimulate free access to the market and their application in production, especially in agricultural production. Of course, the above can be done in exchange for improving the regulatory framework.

Some production factors inhibit and support innovation in agricultural production and processing plants and research centers:

A. Production factors hindering innovation

1. low level of innovation potential;
2. lack of staff;
3. ignorance of technological innovations;
4. ignorance of the markets for new products.

B. Factors of production that support innovation:

1. state procurements;
2. prices;
3. subsidy;
4. information consulting services;
5. coordination in the implementation of innovative programs.

Unfortunately, there are no official or unofficial statistics on how much investment was made in innovation in general and in the agricultural sector before and during the pandemic. We can provide only the following indicators (Table 1).

The development of the agricultural sector in Azerbaijan, the satisfaction of the country's food needs, and the export of agricultural products to foreign markets are some of the priorities of economic policy. Therefore, the achievement of technological advances in the agricultural sector and the training of highly qualified personnel is one of the most important issues. Regarding the consideration of innovation in the agricultural sector as a systematic approach and the creation of an innovation system, it was noted that our country has great potential and opportunities in the agricultural sector. Based on the experience of other countries, we can say that the application of innovations in the agricultural sector and its development brings a lot of benefits to the country's economy as a whole.

Table 1. Structure of the use of investments in fixed assets by main types of production activities (in percent)

	Years						
	2005	2010	2015	2016	2017	2018	2019
Agriculture	0.7	4.4	2.2	2.1	3.5	4.4	4.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Investments in fixed assets in agriculture. million manats	40.7	431.0	355.4	325.1	617.8	764.4	769.5

***Source**: author own elaboration on the basis of materials [9]*

At present, the American, Western European, Israeli and Japanese experience of innovative activities in the agricultural sector is considered to be more advanced. At the same time, according to international experts, the experience gained by Australia, China, and some Latin American countries in various areas of agriculture deserves special attention. At a time when the tendency of agriculture to become a kind of industry is intensifying, the innovation of agrarian entrepreneurship depends on the intensity and stability of inter-sectoral relations, especially on the sustainability of agro-industrial relations, in other words, the level of integration.

The world's economic power centers are also known as areas with a high level of innovative activity in various fields, including the agro-food sector. It is no coincidence that almost 80 percent of the market for innovative products is at the disposal of developed countries.

In Japan, where there is a high level of support for agricultural producers, there have been significant changes in food production policy due to the transition to international diversification. Thus, Japan has had a significant impact on the structure of agrofood development in a large region to ensure national food security by investing heavily in the establishment of joint agro-industrial enterprises, innovative agricultural production, and agroprocessing in developing countries.

Among the People's Republic of China, extensive reforms have been carried out to support state-owned agricultural enterprises and agrarian enterprises in a fully justified selection process. The known results of these reforms can be instructive for post-Soviet countries. The point is that to minimize the negative consequences of "shock therapy", it is the latest experience of the transition from a centralized economy to civilized market relations that is useful for promoting innovative and sustainable entrepreneurship in agriculture.

The experience of different countries in this direction can be listed. Azerbaijan can also achieve high results using the experience of these countries.

CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The current crisis caused by the Covid-19 pandemic has once again proved that the creation and development of an innovative agrarian economy should be considered as one of the main directions for the country. In this regard, it is very important to increase and support the number of innovative institutions in the country, to promote and give preference to innovative products, as well as to apply for certain tax benefits.

It can be concluded that the following issues are important for the organization and development of the economy in the agricultural sector based on an innovative system:

– creation of an effective legislative framework for the innovation system of the agrarian sector of the republic;

– establishment of an organization to coordinate institutions engaged in innovation activities in the agricultural sector;

– formation and improvement of public-private partnership in the field of innovation application;

– provision of financial support and tax incentives by the state to institutions engaged in innovation and research;

– private sector support for institutions involved in these activities;

– support for the application of innovative – improving the higher education system of the methods and scientific research in the agricultural republic following the developed modern education sector. At the same time, increase production system and training highly qualified personnel for the efficiency and further strengthen logistics links; agricultural sector.

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Пандемія COVID-19 і інноваційна аграрна економіка

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Анотація. Пандемія COVID - 19 має глибокий вплив на всі сфери нашого життя. Однією з основних областей, порушених пандемією, є аграрний сектор. У статті наголошується на необхідності застосування наукомістких технологій і розширення інноваційної діяльності для забезпечення сталого розвитку сільського господарства в умовах нинішньої пандемії. Також вивчається важливість технологій нового покоління в прискоренні інноваційного розвитку аграрного сектора. Отримано позитивні результати з питань, які необхідно вирішувати при організації та розвитку економіки на основі інноваційної системи в аграрному секторі в умовах пандемії

Ключові слова: аграрний сектор, інновація, пандемія Covid-19, підприємництво, цифрова трансформація, економічна активність

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Evaluation of the role of intellectual capital in innovative economic growth in the framework of knowledge economy

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Abstract. The article analyses the role of intellectual capital in innovative economic growth within the knowledge economy. To this end, the essence of social capital phenomena, one of the modern concepts of human capital and institutional economy, which are the main components of intellectual capital, is explained, as well as the impact of research and development activities on economic growth, one of the main indicators of scientific development

Keywords: knowledge economy, intellectual capital, human capital, social capital, research and development, economic growth

PROBLEM STATEMENT

The knowledge economy is a new social and economic era in which knowledge is the most important and basic economic resource, knowledge production and communication are widespread, the number of people working in the field of knowledge is higher than in other fields, and sustainable education and development. In this society, the production, distribution, exchange, use and development of knowledge are the main characteristics of public life. The production, collection and sale of knowledge have led to the emergence of new areas of work in the information (knowledge) society. Knowledge is both the main raw material and the most important product of the modern economy. The elements of capital necessary for wealth, prosperity, and power, physical labour, smoky industrial machinery, factories, and plants have given way to knowledge.

In the post-industrial society, information and knowledge become a key factor in the development of modern society. In the modern post-industrial economy, knowledge is not only the main source of added value, but also a key factor in ensuring competitiveness. Economies in the world that rely on cheap raw materials and cheap labour are already struggling to compete with economies based on knowledge and high technology. The production of knowledge and information products play an extremely important role in the development and competitiveness of countries moving from the stage of industrial development to the post-industrial stage.

In other words, the development of countries in modern times depends on the development of science-based industries, including technological innovations and new technologies.

Thus, the main source of value in knowledge-based economies is innovation. Innovation is based on intellectual capital. Unlike physical and financial capital, the creation of intellectual capital makes this organization a competitive advantage. Intellectual capital includes knowledge, experience, work habits, intangible assets, software, databases, and trademarks of specific people. In other words, intellectual capital is a system of characteristics that determines the abilities of a person (in other words, the quality of the workforce of an individual, enterprise, firm, company, the country's total labour force) that materializes or arises in the labour process.

In the post-industrial economy, the role of knowledge as an economic resource is growing and the importance of intellectual capital in ensuring economic development is observed. Intellectual capital is a

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system that gives organizations a lasting intellectual advantage in the market. The economic literature identifies three components of intellectual capital: human capital, organizational (or structural) capital, and customer capital.

The analysis of the economic literature shows that in its simplest form, intellectual capital consists of three parts: human capital, organizational (or structural) capital, and customer capital (Fig. 1). Each of them can be borrowed or personal [14, p. 46].

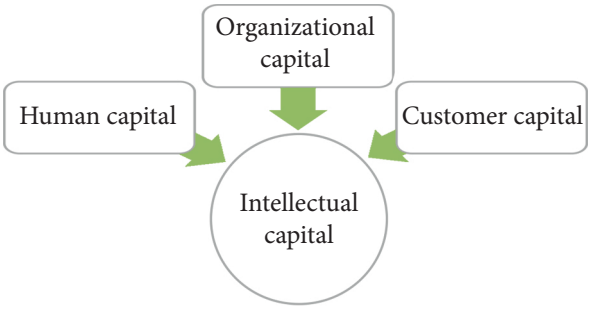

Figure 1. *The simple structure of intellectual capital*

Human capital is the most important factor in socio-economic development. But economic development does not depend only on the quantity and quality of knowledge and other economic resources. Thus, in the modern market economy, there are many events and processes of uneconomic nature that the economic system cannot solve, which ultimately seriously affects the results of the system. The solution of monopolies, asymmetric information, income inequality, external effects, the problem of people without tickets, etc., which are among the problems that arise during collective activities, in fact depends on the level of cultural, ethical and psychological development of the social environment. The level of development of socioethical norms in society and the degree of trust between people can be assessed by the concept of social capital. Social capital is one of the basic concepts of modern institutional economy. Economic development can be achieved in countries through the development of both human capital and social capital.

ANALYSIS OF ACTUAL RESEARCH

In the knowledgebased economy of the new century, intellectual property and intellectual capital accumulated in it play the role of the main currency. Intellectual property assets have already surpassed material assets and created a new stage in the world economy. Over time, the "concrete and iron-based economy" has become a "knowledge-based", "digital", "creative" economy, as a result of which the phenomenon of intellectual capital, which has been overshadowed for many years, has become the focus of public attention and analysis.

In modern times, human knowledge is the main source of enrichment of the national economy and economic growth. Knowledge comes to the fore from capital, labour and natural resources, which are other components of the production factors.

While labour and capital were the main factors of production in an industrial society, in the postindustrial society more knowledge and intellectual capital came to the fore. In developed countries, the leading sector of the economy is the sector that provides intellectual services.

In conclusion, we can say that the analysis of the following issues related to intellectual capital in the knowledge economy is very important:

– to reveal the socio-economic essence of intellectual capital;

– to analyse the structure of intellectual capital on the basis of different models;

– comment on existing methods for assessing intellectual capital;

– to assess the impact of human (individual) capital, structural capital, technology and social capital, which are components of intellectual capital, on economic growth and economic development;

– to study the stages and features of the process of intellectual capital formation, as well as the factors that directly affect the total intellectual capital of the country;

– to show the relationship between intellectual property, knowledge economy, innovative economy and creative economy;

– to study the experience of advanced countries in the formation of intellectual capital;

– improving the system of protection of intellectual property rights and the mechanism of state support for the development of intellectual capital;

– to determine the main directions of the state policy on the formation of intellectual capital, etc.

The purpose of the article: The main purpose of the study is to analyse and evaluate the potential of intellectual capital to increase innovation in the knowledge economy and ensure innovative economic growth.

PRESENTATION OF THE MAIN MATERIAL

The concept of intellectual capital was first introduced to science in 1969 by the famous economist J.K. Galbraith. Galbraith wrote that "one of the factors

accelerating industrial society is money. But the factor that accelerates and strengthens the post-industrial society is knowledge. In modern times, new classes have emerged with and without knowledge. This new class does not derive its power from money or goods, but only from knowledge [5, p. 8].

Before defining intellectual capital, it is necessary to explain the concept of "intellectual". Intelligence is a set of characteristics attributed to an individual according to his various abilities, knowledge and skills [1, p. 31].

Intellectual capital participates in the creation of new values. At the macro level, national intellectual capital is perceived as an important part of the knowledge, skills, professionalism and economic growth of the country's population.

P.H. Sullivan, one of the well-known researchers of intellectual capital, noted that intellectual capital covers such important concepts as knowledge, intelligence, thinking and innovation [7, p. 40].

Scientific sources have a relatively expanded model of intellectual capital proposed by A. Brooking (Fig. 2).

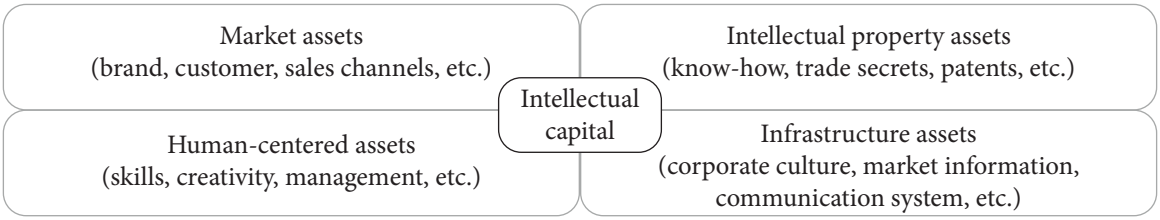

Figure 2. *A Brooking's model of intellectual capital*

Recent scientific research has also found an brand (customer) and structural capital. According to approach called the "Integrated Intellectual Capital the new model, the structure of intellectual capital Model" (Fig. 3). According to this approach, includes social, spiritual and technological capital intellectual capital does not consist only of human, [12, p. 17].

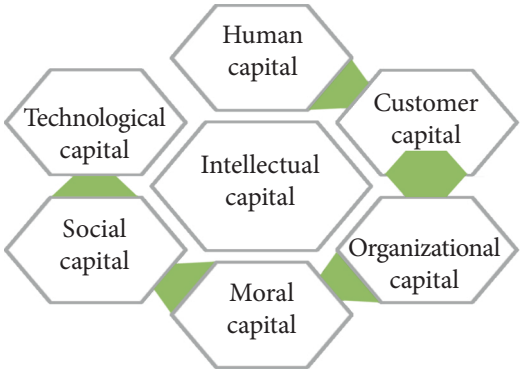

Figure 3. *Integrated Intellectual Capital Model*

Researchers studying the impact of intellectual competitiveness at both the micro and macro levels, capital on the innovative economy at both the micro especially at the macro level, creates great and macro levels have concluded that increasing opportunities for economic growth and economic development.

Knowledge-based economic activities lead to the rapid enrichment of countries, as they allow the production of products with higher added value and higher productivity. There are several key elements of intellectual capital that affect innovative economic growth and sustainable economic development (Fig. 4).

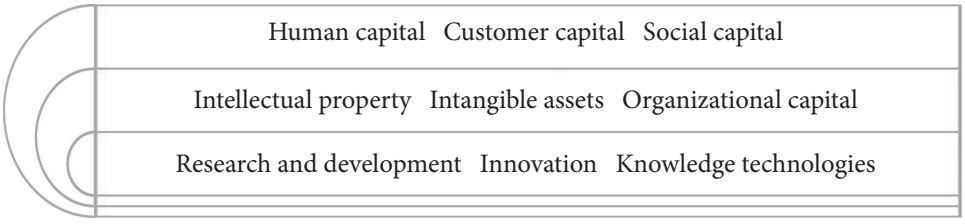

Figure 4. *The main elements of intellectual capital that affect economic development*

Let us now analyze the impact of intellectual capital on innovative economic growth in three areas:

1. The impact of human (individual) capital on economic growth.
2. The impact of social capital on economic growth.
3. The impact of research and development activities on economic growth.

According to J. Fischer, R. Dornbusch and R. Schmalensee, investments in human capital gradually return in the form of higher wages or as a result of activities that bring more income through this ability [17].

Studies show that the United States, Finland, Germany, Japan, Switzerland, etc. human capital accounts for about 80% of national wealth in developed countries and 60-75% of national wealth in developed countries as a whole. In these countries, 80-85% of GDP growth is due to the development of knowledge. G. Becker analyzed the economic efficiency of investment in education by comparing income with expenditure and determined that investment in education allows to earn 12-14% per year [2, p. 49].

Approaches to the impact of human capital and technological progress on economic growth manifest themselves primarily in economic growth models. To date, three main models of economic growth are known: neo-Keynesian (Domar-Harrod), neoclassical (Cobb-Douglas) and modern models of endogenous technological progress. The current stage of economic growth is based on the efficient use of knowledge and information resources. The introduction of new technologies will help to overcome crises and depressions, create new production opportunities and the transition to sustainable economic growth. Human capital is one of the key factors in modern economic growth models. In Solow's model of economic growth, technical progress was taken as a condition for basic economic growth. However, this factor was mainly exogenous. Recent researchers G. Mankiw, D. Romer and R. Lucas have tried to clarify and supplement the Solow model, taking into account the important role of the human factor, in overcoming these shortcomings. In the models of economic growth worked by the above-mentioned authors, the Solow model was proposed to expand it by introducing the human factor into its new quality – human capital. The impact of human capital on economic growth in the following years was studied by C. Jones, R. Barro, D. Jorgensen and others through various models [11].

The World Bank uses the "Human Capital Index" to assess the level of human capital development in countries. The Human Capital Index measures the education, skills and health status (health) of the world's population. The index rates countries from 0 to 1. The entire population of a country with a maximum (HCI=1) result reaches the age of 60, while children under the age of 14 receive a full and high level of free education, and no child suffers from malnutrition. The table below shows the HCI rankings for 2020.

Table 1. Ranking of some countries of the world according to the "Human Capital Index"

Rank	Country	Score
1	Singapore	0.88
2	Hong Kong	0.81
3	Japan	0.80
4	South Korea	0.80
5	Canada	0.80
6	Finland	0.80
41	russia	0.68
48	Turkey	0.65
53	Ukraine	0.63
75	Iran	0.59
83	Azerbaijan	0.58
85	Georgia	0.57

***Source**: table prepared by the author is based on data from the World Bank*

According to the World Bank, between 2012 and 2018, Azerbaijan was able to rise from 0.56 to 0.60 on HCI. In Ukraine, the HCI was 0.647 for 2017, 0.642 for 2018 and 0.631 for 2020.

Human Capital consists of the knowledge, skills and health that people accumulate throughout their lives and ensure the realization of their potential as productive members of society. Investing in human nutrition, health care, quality education, jobs and skills contributes to the development of human capital, which is essential for the eradication of extreme poverty and the creation of more inclusive societies [9, p. 115-151].

The World Bank's latest analysis, The Changing Wealth of Nations 2018 (Building a Sustainable Future), shows that human capital accounts for 64 percent of global wealth, about 70 percent of the wealth of high-income countries, and only 41 percent of the wealth of low-income countries (Fig. 5). This underscores the importance of human capital as a stimulus for sustainable economic growth and poverty reduction, as it is more of a stimulus for economic growth than previously understood [9, p. 126].

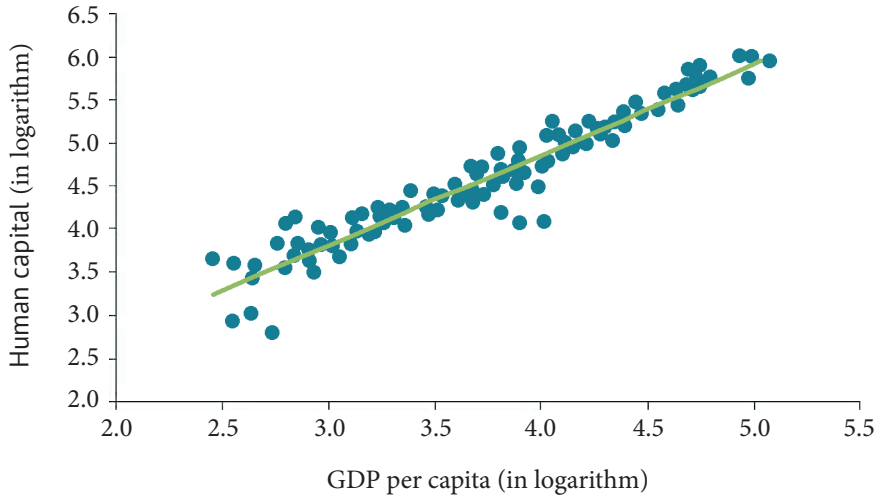

Figure 5. *The relationship between human capital and GDP per capita*

Thus, economic activities based on knowledge and intellectual capital lead to the rapid enrichment of countries. The goal of any economic activity is to further improve the living standards of the population by achieving higher economic growth. Human capital and technology are also the main sources of economic growth in the knowledge economy, where knowledge has become a strategic product. Investments in science and education generate new knowledge and high human capital, which allow for innovations (technologies) and their application to the economy accelerate the latter economic growth, and higher economic growth allows more investment in science and education.

One of the factors influencing the productivity of human capital is social capital. Social capital is the most important informal institution of the institutional environment. Studies show that societies with a wide range of informal institutions have a healthy environment for the spread of technological change. Trust is the most important element of social capital. It has been observed that countries with a lack of social capital suffer from underdevelopment. Behaviours such as corruption, mistrust, opportunistic behaviour, deviant behaviour, loss of moral norms, which can be explained as unethical behaviour, have a negative impact on human capital and, consequently, slow down economic development. Developed countries attach special importance to social capital because they know that social capital is needed for the efficient and effective use of human capital.

According to Francis Fukuyama, social capital is an informal norm that supports relationships between individuals. Researcher Laserson showed that in societies with strong social capital, financial issues are more easily resolved between individuals and even companies. One of the positive features of social capital is the increase in economic efficiency as a result of reduced transaction costs between companies. Arrow (1974) also noted that without a minimum level of trust between economic agents, no economic transaction would take place. Trust facilitates economic transactions by reducing transaction costs [3].

In most economic literature, informal institutions are also characterized as social capital. To sum up, we can say that social capital creates positive external effects for group members, and these positive external effects are formed through trust, common norms and values.

Putnam noted that the main effects of bridge-type social capital in the United States are reducing unemployment, reducing crime, and increasing government efficiency. Thus, Putnam affirmed that there is a positive link between social capital and economic growth. In contrast, in countries with low levels of social capital, maintaining law and order and protecting property rights requires significant additional transaction costs. This is evident in the spread of special protection, the height of fences and additional costs on other issues [15].

Putnam explained the link between social capital and economic growth with four main arguments: Strong social capital increases coordination and cooperation for mutual benefit; creates solidarity among the team; ensures the public interest (reduces selfishness); reduces incentives for personal gain [16].

Table 2. Ranking of some countries of the world according to the "Social Capital Index"

Rank	Country	Score
1	Iceland	65.37
2	Norway	64.96
3	Sweden	61.64
4	Finland	61.57
5	Switzerland	61.00
6	Austria	60.89
60	Azerbaijan	47.87
65	Georgia	47.38
82	Ukraine	44.40
91	Iran	43.06
95	Turkey	42.84
99	russia	41.97
109	USA	41.39

***Source**: table prepared by the author is based on data from the World Bank*

Thus, social capital has a positive effect on the efficiency of human capital as it increases trust (institutional trust) between people and between people and between people and institutions. The table below shows the "Social Capital Index" rankings for 2020.

There is no universal methodology for measuring the level of development of institutions in the scientific literature. One of the indicators used to measure social capital is the level of confidence in countries. This indicator is based on a survey in the country "Do you trust people?" is calculated as the ratio of the number of respondents who answered positively to the question to the number of respondents who participated in the survey. Although there is a positive relationship between confidence and GDP per capita, this relationship is quite fragmented (Fig. 6).

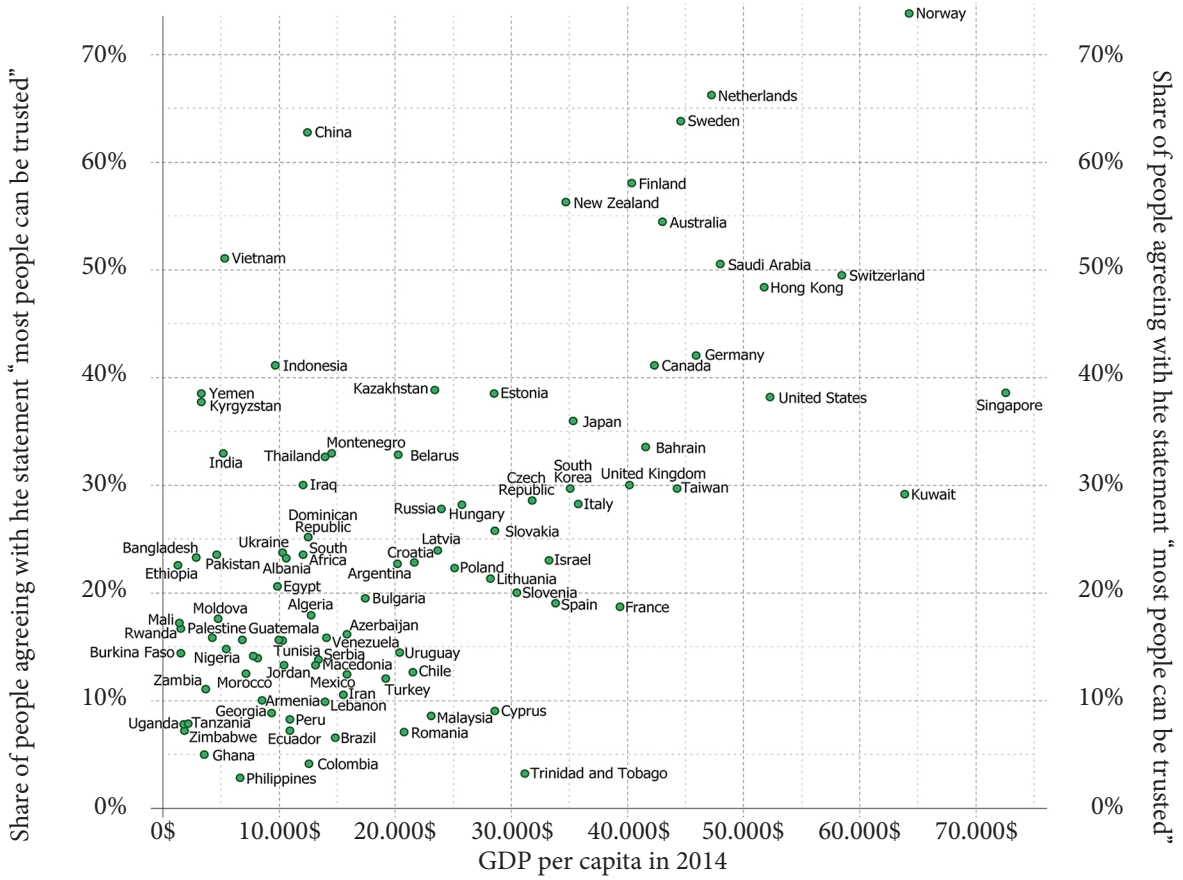

***Figure 6.** The relationship between trust and GDP per capita*

***Source**: World Values Survey*

Thus, as social capital increases trust between people and between people and institutions, it creates favourable conditions for the development of human capital, and in countries with developed social capital, the level of economic development is higher.

Science has a serious impact on the economy only when it acts as a source for innovation and when the commercial realization of scientific knowledge is possible. A scientific product is the result of a long process that begins with fundamental scientific research, followed by applied research, design, production, marketing and sales, and finally to the research and development (R&D) expenditures, to commercial stage. One of the main factors affecting GDP is one of the most important indicators of the intellectual capital is the level of spending on level of development of science and innovation in the scientific research. The ratio of these costs, called country (Fig. 7).

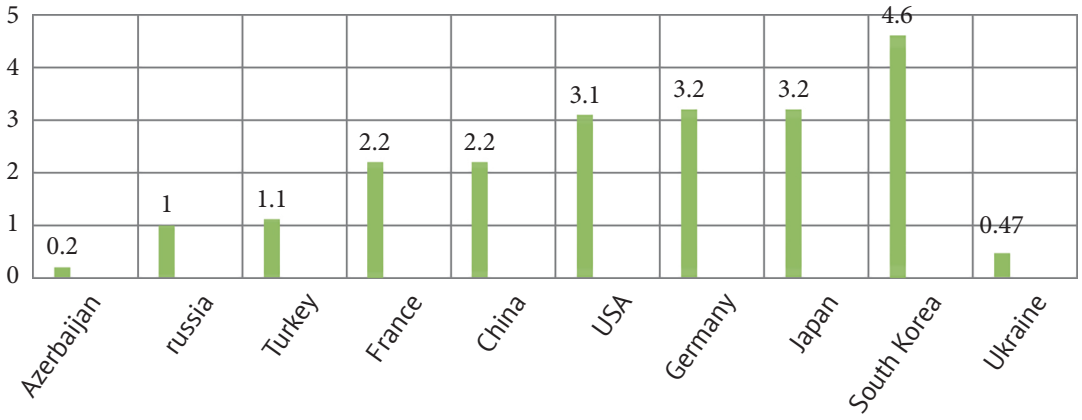

Figure 7. *Share of R&D expenditures in GDP in some countries (as a percentage)*
Source*: Prepared by the author and based on data from the World Bank*

According to 2020 data, the share of research and development expenditures in GDP in Azerbaijan is around 0.2%. If we look at the dynamics of research and development expenditures in Ukraine, we can see that since 2003, the share of research and development expenditures in GDP has been declining (Fig. 8).

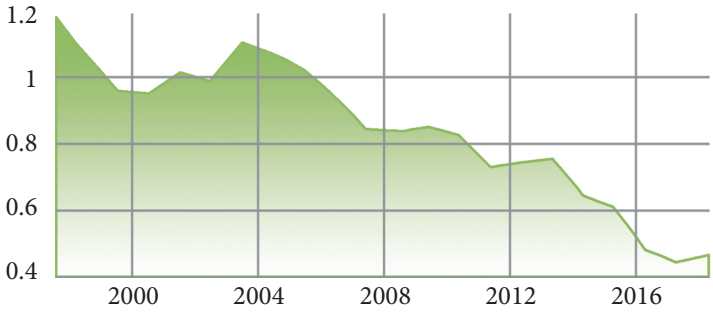

Figure 8. *Share of research and development (R&D) expenditures in GDP in Ukraine (as a percentage)*
Source*: Prepared by the author and based on data from the World Bank*

The impact of research and development spending on economic growth can be simply explained by the following scheme: Studies show that if the allocation of science to GDP is less than 2 percent, science does not have a significant impact on the economy. For this reason, the transition to a new model of economic(Fig. 9)..

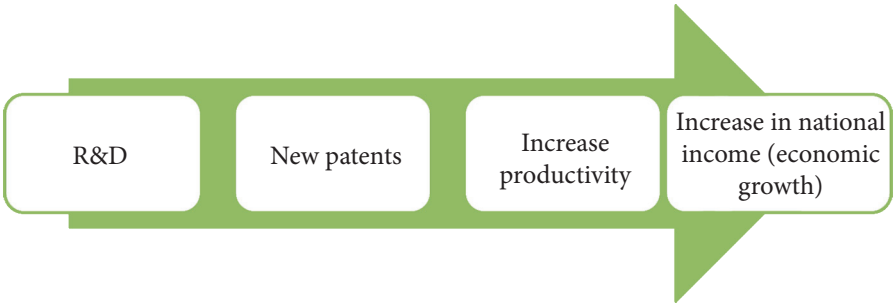

Figure 9. *The relationship between R&D and economic growth*

Studies show that if the allocation of science to GDP is less than 2 percent, science does not have a significant impact on the economy. For this reason, the transition to a new model of economic development based on knowledge can only be achieved by increasing funding for scientific research and thus strengthening science.

Conclusions and prospects for further research. Thus, there is a chain link between the development of intellectual capital and economic growth in the knowledge economy. Therefore, resource-rich economies should strive to build this chain by gradually increasing investment in science and education to ensure the transition to a knowledgebased economy.

The development of human capital is the most important attribute of economic development. Social capital, on the other hand, has a significant impact on an individual's social, educational, health, family and work life and public administration activities by contributing to the productivity of human capital. Research and development activities have a positive impact on innovation and indirectly increase national income.

Evaluation of the development of intellectual capital is the highest priority problem facing the state in the knowledge economy. Undoubtedly, the main role of the state in innovative economic growth in the knowledge economy is, first of all, a high-quality education system, research universities, technoparks, etc., which the private sector cannot do alone, is forming. Another task for the state is to adopt the rules of the free market mechanism and monitor their implementation. While these rules encourage competition, initiative, creativity and innovation, they must also prevent unfair competition. At the same time, the free market environment is a great incentive for carriers of intellectual capital.

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Оцінка ролі інтелектуального капіталу в інноваційному економічному зростанні в рамках економіки знань

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Анотація. У статті досліджено роль інтелектуального капіталу в інноваційному економічному зростанні в рамках економіки знань. З цією метою пояснюється сутність феномену соціального капіталу, однією з сучасних концепцій людського капіталу та інституційної економіки, які є основними компонентами інтелектуального капіталу, а також вплив досліджень і розробок на економічне зростання основних показників розвитку науки

Ключові слова: економіка знань, інтелектуальний капітал, людський капітал, соціальний капітал, дослідження і розробки, економічне зростання

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