Study of conditions for further development of high-tech agro-industrial production in Ukraine

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Abstract. *The article presents the results of a study of the conditions for further improvement and development of high-tech agricultural production in Ukraine. The purpose of this study is to define conceptual approaches to the technical and technological modernization of the agro-industrial complex as a key element of sustainable development of the real sector of Ukraine's economy and strategic directions of research in agricultural science. The study found that in the context of inevitable climate change, the basis for the formation of highly automated agriculture will be flexible environmentally friendly technological processes in agricultural production, built on fundamentally new technical and technological principles, namely: intellectualization, digitalization, integrated automation and robotization. A concept for the development of high-tech agricultural production in Ukraine based on the principles of sustainable development and the innovative concept of Industry 4.0 was also developed, which will ensure high and sustainable economic growth of the agro-industrial complex, development of domestic agricultural engineering and related sectors of the economy. The strategic tasks for agricultural science in the development of the technical and technological base of highly automated agricultural production are outlined. The study of modern trends in the development of economies of advanced countries and their effectiveness give grounds to assert that the identified strategic directions of technical and technological modernization of the agricultural sector will be the basis for the formation of an effective model for the development of high-tech agro-industrial climate-oriented production in Ukraine.*

KEYWORDS: *CLIMATE CHANGE, HIGH-TECH PRODUCTION, AGRICULTURE, TECHNOLOGY, INTELLECTUALIZATION, AUTOMATION, ENGINEERING*

1. Introduction

Global climate change is forcing humanity to reconsider its consumer attitude towards nature and the planet's fossil energy resources. International organizations and governments of the world's leading countries are developing programs to reduce the industrial burden on the environment and increase the share of alternative energy in the energy balance of countries. Environmentally responsible production is becoming a trend in economically developed countries, and Ukraine does not stand aside from these processes.

Greening and intellectualization are becoming fundamental components of the development of the latest agricultural production technologies that implement the strategic objectives of the transition to highly automated agriculture, since the sustainable development of modern agro-industrial production is based on the complex automated operation of the human-machine system in close harmony with living objects.

The problems of formation, use and renewal of the material and technical base of agriculture are given considerable attention in the studies of Adamchuk V.V., Pidlisetskyi H.M., Sabluk P.T., Sytnyk V.P., Bilouskyi Y.K., Ivanyshyn V.V., Lupenko Y.O., Zakharchuk O.V., Mykhailov M.G. and others [1-8].

However, in order to achieve the goals of sustainable rural development, the transition to which Ukraine declared to the international community in the National Report "Sustainable Development Goals: Ukraine" [9], it is necessary to accelerate the transformation of the domestic economy in the direction of the innovative concept "Industry 4.0" and to develop a strategy for updating the technical and technological base of agricultural production, which outlines the guidelines and priorities of domestic engineering for the agro-industrial complex.

Taking into account global technological trends, to define conceptual approaches to the technical and technological modernization of the agro-industrial complex as a key element of sustainable development of the real sector of Ukraine's economy and strategic directions of research in agricultural science.

The following methods were used in this study: monographic, system analysis, abstract and logical.

2. Results and discussions

The world's leading countries are demonstrating a long-term trend of industrial development based on the Industry 4.0 concept, which involves process automation, rationalization of logistics and production, intellectualization of enterprises and accelerated implementation of scientific and technological progress.

The current stage of global economic development is characterized by a decrease in the need for human resources, which are being replaced and modified by robotics, artificial intelligence and remote access technologies. Instead, there are growing requirements for the qualifications of employees who are tasked with managing the latest automated equipment and systems.

Industries are actively adapting to new conditions, and agriculture is no exception. Already today, agricultural enterprises are actively using multicopters, unmanned tractors and machine-tractor units, robots and various information technologies.

It is not surprising that analysts predict fundamental changes in the agricultural sector of advanced countries over the next 10-20 years due to the intensive implementation of artificial intelligence, robotics and automation technologies, which will turn the industry into a high-tech business, ensure rapid productivity growth and reduce unproductive losses.

To ensure economic balance and competitiveness in the markets, it is extremely important for Ukraine to develop a strategy for the development of agricultural production and machine building as key participants in the restoration and development of the state in the postwar period. The paradigm for the formation of high-tech agricultural production should be based on the synergy of the conceptual directions of sustainable development and the tasks of intelligent automation in the format of the innovative concept "Industry 4.0" (Fig.).

From the early 90s of the 20th century to the present, the tasks of sustainable agricultural development have gradually evolved – there has been a shift in emphasis from increasing food production in a sustainable way and ensuring food security to ensuring the social welfare of the population without depleting ecosystems, climate change, and causing environmental damage under the condition of economically efficient production [10].

Sustainable development is a complex, dynamic, manageable and multi-level process of balancing economic, social and environmental benchmarks aimed at ensuring the well-being of the population.

The social vector of sustainable development is aimed at ensuring a high standard of living and working conditions for the company's personnel. Therefore, the strategic direction of the sustainable development concept is to create comfortable living and working conditions, which involves building social infrastructure in rural areas, ensuring high employment and remuneration, social guarantees and environmental protection.

An important component of the sustainable development of the agricultural sector is the environmental block, which includes two components. Firstly, it is the greening of agricultural production and secondly, solving the problems of physical, chemical and biological pollution of rural areas.

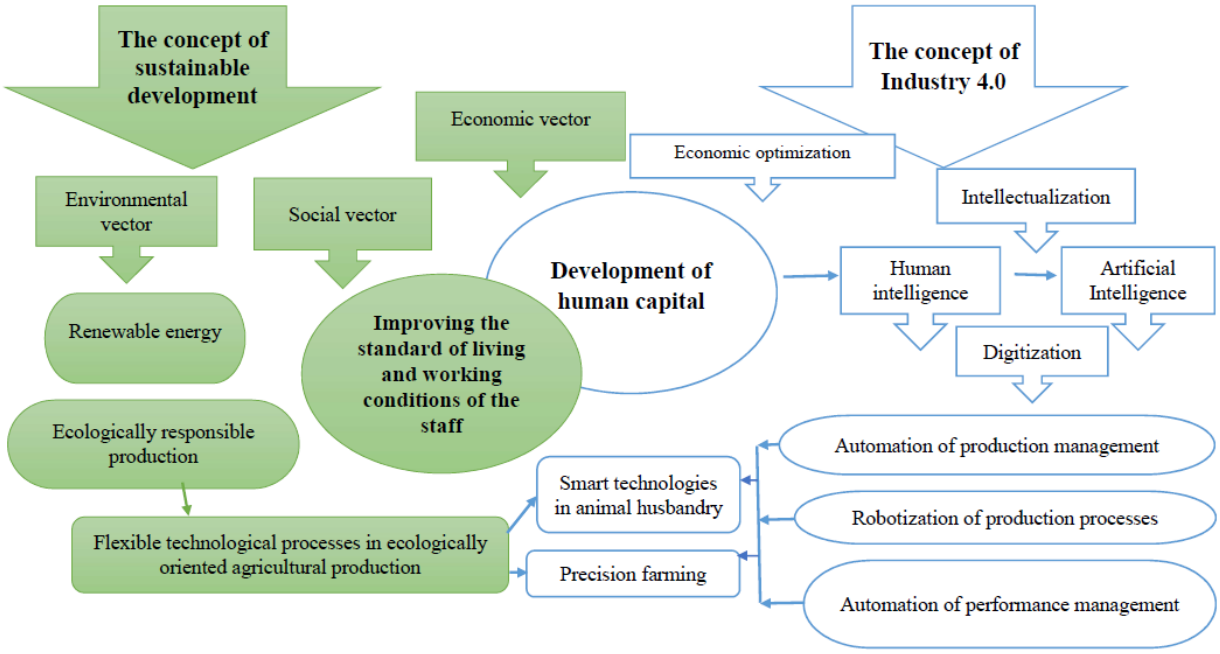

Figure. *Concept of development of high-tech agricultural production of Ukraine*

Intensive agricultural production methods have resulted in a violation of the ecological balance between economic activity and the natural environment. This has resulted in degradation processes in agroecosystems that cause a number of environmental problems and threats. Therefore, the transition of agricultural production to the biosphere model of nature management, preservation of the integrity and viability of natural ecosystems for future generations are becoming a fundamental part of the sustainable development strategy. This strategy is a long-term forecast of a comprehensive solution to the problem of environmentally balanced development of the agricultural sector and improvement of agroecosystems.

Greening of the agricultural sector implies transition of business entities to environmentally responsible production and development of renewable energy to replace fossil fuels, which will have a positive impact not only on the environment but also increase Ukraine's energy independence as a component of its national security. Under such conditions, bioenergy is becoming a strategic industry whose priority tasks are to find cheap energy bio-raw materials, effective technical and technological solutions for their cultivation and processing, and to create the necessary logistics infrastructure, etc.

Environmentally responsible production involves the creation of agroecosystems capable of maintaining their stability under existing levels of anthropogenic pressure, realizing their internal development potential while reducing the levels of this pressure, and maintaining a favorable state of the environment. The task of eco-oriented agricultural business is to preserve and restore soil fertility by minimizing tillage, combating soil compaction, applying crop rotations with active use of green manure and ground cover crops, balanced application of organic and mineral fertilizers, preserving biodiversity, etc.

The economic component of sustainable agricultural development involves ensuring the economic sustainability of production by increasing its productivity and profitability, diversifying production and markets to generate guaranteed profits.

The algorithm for economic optimization in highly developed countries has become the innovative concept of Industry 4.0, which requires the development of human capital and deepening the intellectualization of production to transition to a new technological mode.

It is the intellectualization of production that is the main condition for the formation of high-tech agriculture in Ukraine and is achieved through the development of human capital, the use of artificial intelligence technologies, the introduction of the latest equipment, IT technologies, etc.

Automation is one of the most important ways to further develop productive forces in agricultural production. This is the basis on which, given the high level of mechanization and electrification of production, it is necessary to improve agricultural machinery and increase its performance. Without the creation of new automated agricultural machinery and its technical systems, the transition to flexible precision farming technologies will remain an unfulfilled dream.

The development of agricultural automation should be based on the rich experience of the industry. However, the automation equipment required for agricultural production has specific requirements due to the specific conditions of its use.

Automation of production in the agricultural sector should take place in three areas:

– automation of production management through digitalization, automated information systems, artificial intelligence, database creation, etc;

– automation of production processes through robotization, use of autonomous machines and automatic technical systems;

– automation of productivity management, which involves the introduction of precision farming systems and adaptive technologies in livestock production.

Automated information systems allow to automate all types of accounting in an agricultural enterprise, carry out operational and strategic planning, optimize the structure of production and costs, logistics, material and technical support, audit and control of all financial and production activities.

The main feature of agricultural production is the inextricable link between machinery and biological objects (animals and plants), which are characterized by the continuity of product formation processes and the cyclical nature of their production. The level of realization of the potential of biological objects and their productivity depends on the timeliness and quality of technological operations. In this regard, automation in agricultural production must be highly reliable, since such processes cannot be interrupted in time and it is almost impossible to make up for lost time by intensifying the next period. For example, automation in livestock farming should ensure that technological operations are performed cyclically throughout the day, regardless of weather conditions and other factors.

Precision farming is a new stage in the development of the agricultural sector, involving the use of global positioning systems,

on-board computers, management and executive mechanisms that can provide tillage methods, fertilizer application rates, chemical ameliorants and plant protection products, taking into account the heterogeneity of the field background. The main task of the precision farming information system is to map fields, collect and accumulate various data on field history, process and analyze them to improve production efficiency. Precision farming technologies will contribute to a sharp increase in crop yields and production efficiency.

Based on the analysis of the peculiarities of agricultural production processes and their requirements for technical support, it is established that the strategic directions of research on the development of agro-industrial production in Ukraine on the basis of flexible technological processes and automated technical systems are as follows

– continuous improvement of agricultural production and technological processes, increasing their adaptability and flexibility to specific production conditions and suitability for automation;

– scientific generalization of the world experience of automation of agricultural production processes and technical means for their implementation;

– determination of static and dynamic characteristics of agricultural automation objects;

– mathematical description of objects of control of production processes and technical means;

– determination and establishment of functional dependencies between the controlled parameters of soil and agricultural technological materials and their physical properties (electrical, optical, acoustic, thermal, mechanical, etc.) in order to use them for the construction of measuring instruments and converters specific to agriculture, non-electrical quantities into electrical ones;

– development of technical means for agriculture, taking into account their suitability for automation and interaction with foreign analogues;

– improvement of methods for optimal engineering and calculation of automation equipment, taking into account the expansion of their functional tasks and improvement of hardware and operational reliability.

Successful research and development in these areas will accelerate the transition to agricultural production based on SMART technologies.

3. Conclusion

The study of modern trends in the development of economies of advanced countries and their effectiveness give grounds to assert that these strategic directions of technical and technological modernization of the agricultural sector will be the basis for the formation of an effective model for the development of high-tech agro-industrial climate-oriented production in Ukraine.

4. References

1. System of technical and technological support for the production of plant products / edited by V. Adamchuk. Kyiv: Agrarian science, 2012. 416 p.

2. Zakharchuk O. Problems of material and technical support of agricultural enterprises of Ukraine. – Economy of agro-industrial complex, no. 7, 2014, pp. 91 99.

3. Adamchuk V., Gritsyshyn M., Perepelytsya N. Material and technical base of the crop branch of Ukraine: state and prospects of development. – Mechanization and electrification of agriculture, no. 2 (101), 2015, pp. 246–254.

4. Adamchuk V., Grytsyshyn M., Perepelitsa N. Technical and technological support as the main factor of sustainable development of agro-industrial production. – Mechanization and electrification of agriculture, no. 8 (107), 2018, pp. 198–208.

5. Mikhailov M. Innovative and investment development of the material and technical base of agrarian enterprises. – Kyiv: NSC "IAE", 2019, pp. 142–178.

6. Ivanishin V. Innovative maintenance of updating of technical and technological base of enterprises of agrarian and industrial complex. – Economy of agroindustrial complex, no. 1, 2010, pp. 128–133.

7. Material and technical support of agriculture in Ukraine: manual / Lupenko Y., Zakharchuk O., Vyshnevetskaya O. [and others]. – Kyiv: NSC IAE, 2015, 144 p.

8. Zubets M., Tyvonchuk S. Development of innovative processes in agro-industrial production. – K.: Agrarian science, 2004, pp. 21.

9. National report "Goals of sustainable development: Ukraine". URL: https://ukraine.un.org/sites/default/files/2020-06/SDGs_NationalReportUA_Web_1.pdf (access date: 13.06.2023).

10. Mykhaylenko O. G. Sustainable development of agriculture: theoretical aspects. Bulletin of Dnipropetrovsk University. – Series "World Economy and International Economic Relations", issue 7, 2015, pp. 48-57.

11. Savytskyi E. E. Precision farming as a result of informatization of management systems in agribusiness. – Economics and entrepreneurship; coll. of science Proceedings of KNEU, vol. 38, 2017, pp. 174-181.

12. Amosha O.I., Zaloznova Yu.S., Bryukhovetska N.Yu., Buleev I.P. Intellectualization of enterprises of the real sector as a promising direction for the development of the modern economy (conclusions and recommendations based on the results of the scientific and practical online conference)/ – Herald of economic science of Ukraine, no. 2 (41), 2021, pp. 218-222.

13. Berezovskyi S., Dyachenko O. Intelligent automation – perspective of agriculture. – International Scientific Journal of Engineering and Agriculture, vol.1, no.3, 2022, pp. 117–132. URL: https://isg-journal.com/isjea/article/view/20 (access date: 13.06.2023).