CHAPTER 2
ASSESSMENT OF POTENTIAL RISKS AND OPPORTUNITIES ASSOCIATED WITH THE SUSTAINABLE DEVELOPMENT OF THE AGRICULTURAL SECTOR OF THE ECONOMY

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Introduction. The agricultural sector is traditionally one of the riskiest types of economic activity, which confirms the need for systematic risk assessment as a key prerequisite for their effective minimization and a component of strategic planning. That is why the issue of risk management is at the center of attention of scientists and practitioners. In the context of modern climate change, globalization, and the unstable socio-political situation in the world, the ability to predict, assess, and control risks is becoming a determining factor in ensuring the stability and profitability of agricultural production.

For Ukrainian farmers, the situation is complicated by the consequences of martial law in 2022–2025, which will have a long-term impact on the industry. This makes timely and flexible reassessment of economic risks particularly relevant. At the same time, the most difficult challenges face those producers who seek to attract financing and enter international markets, where special attention is paid to ESG principles.

Current investors, credit institutions and business partners are increasingly focusing on the compliance of enterprises with the requirements of sustainable development, considering the process of making investment and commercial decisions. Therefore, the agricultural producer must not only identify and analyze potential risks, but also correlate methods of managing them with ESG criteria.

While large Ukrainian agrarian corporations have already accumulated some experience in this area, small and medium-sized enterprises are only beginning to adapt to new requirements. Most representatives of this segment are still only partially familiar with the ESG concept and do not always realize its importance for business competitiveness and integration into the European economic space. Thus, the formation of effective risk assessment mechanisms and their coordination with the principles of

sustainable development is becoming one of the key tasks of modern agribusiness.

2.1. Sustainable Development Risks for Enterprises in the Agricultural Sector of the Economy: Characteristics and Classification

Modern global economic systems are facing complex challenges which require a new approach to management focused on sustainable development. This new model must balance environmental, social and economic problems by overcoming challenges such as climate change, population growth, resource scarcity and overcoming hunger. The transition to the principles of sustainable development in the agrarian economic system is not just one way of doing business, but a necessity for ensuring a prosperous future for agriculture and the world. Agrarian economics has evolved significantly over time, reflecting changes in social structures, technological progress and philosophical theories. Concerns about resource depletion, the effects of climate change and social justice have transformed the sector. Economic interdependence has emphasized the need for agricultural systems to be resilient to global shocks. At the same time, growing environmental problems, including soil degradation and water scarcity, have highlighted the vulnerability of traditional agricultural models [1].

Sustainable agriculture is characterized by a comprehensive approach that seeks to simultaneously take into account environmental, economic and social aspects. Achieving truly sustainable agricultural development requires a holistic, systemic approach that integrates economic profitability, social equity and environmental well-being. It reconciles agricultural production with long-term economic, social and environmental sustainability. Sustainable agricultural development takes into account the state of the entire agro-ecosystem. Economic sustainability in agriculture means that agricultural enterprises are financially viable and contribute to a stable local, regional and global economy.

To achieve the goals of transition to a low-carbon and resource-efficient economy and ensure its sustainability, a clear sustainable financing policy is necessary, which involves not only a deep understanding of the content of environmental and social risks, but also the presence of an effective system for managing such risks.

Risk management is an important component of enterprise management. This is a subsystem responsible for working with risks, and is traditionally called "risk management". The concept of "risk management" is defined as a decision-making process that helps achieve a planned economic, social or environmental goal at optimal costs using procedures that allow completely eliminating or limiting to an acceptable level all risk groups that threaten its achievement. This means that "risk management" includes a set of measures that lead to a reduction in the threat of risk and minimizing its consequences. Usually, this activity consists in predicting possible threats and accumulating funds that compensate for future losses in the event of a risk.

An analysis of scientific works and publications devoted to the issues of sustainable development of the national economy of Ukraine indicates the multidimensionality of approaches to the interpretation of this concept and ways of its practical implementation in modern conditions. The theoretical foundations of the formation and evolution of the concept of sustainable development are thoroughly revealed in the study of Pyatnytska G.T. and Hryhorenko O.M. [2], which focuses on key management strategies aimed at transitioning to an innovative economic model based on digitalization, ecological transformation and inclusive growth. The issue of implementing the Sustainable Development Goals in modern economic conditions is highlighted in the study of Bokovykova Yu.V. [3] and Serov I.V. [4].

A significant contribution to the study of sustainable development issues, ensuring energy independence of agricultural enterprises by obtaining energy resources from biowaste and using inexhaustible energy sources was made by scientists of the National Academy of Agricultural Sciences – Kaletnik G.M., Honcharuk I.V., Yemchyk T.V., Tokarchuk D.M., Chikov I.A. and others. [5-10].

Scientific works of Shpykuliak O.H. and scientists of the National Scientific Center "Institute of Agrarian Economics" [11-16] prove that sustainable development of the agricultural sector of the economy is ensured by the implementation of environmentally oriented management models, confirmed by international practice.

In the scientific literature of foreign researchers, there is an increased interest in the development of non-financial reporting standards and their integration into the agricultural sector. International organizations and the

scientific community emphasize the effectiveness of the application of such generally recognized approaches as GRI, TCFD and SASB, which are considered as universal tools for ensuring the transparency of enterprises, building stakeholder trust and strengthening competitive positions in the global market. Their adaptation to the specifics of agricultural production is interpreted as a necessary condition for increasing the sustainability of business models and harmonizing business practices with modern principles of sustainable development [17-22]. This indicates that the integration of sustainable development principles is one of the priority vectors of modern scientific exploration.

Sustainable development of agricultural enterprises is impossible without a timely, continuous and economically justified risk identification process, which depends on a number of factors that ensure the implementation of goals over time [22]. The main factors of uncertainty in sustainable development are shown in Figure 2.1.

According to Hryb E.S., "the agricultural sector is sensitive to both internal and external fluctuations in market conditions. Negative trends that affect the sustainable development of the sector are: a decrease in aggregate consumption in the food structure and a transition to frugal consumption, an increase in costs for imported goods and raw materials, a decrease in net profit of agricultural enterprises, structural deformation of the agricultural sector, and low activity of the innovation and investment process" [23]. Based on the sources studied and taking into account the existing wide diversity, we propose a classification of sustainable development risks for the agricultural sector of the economy (Figure 2.2).

On the whole, for the agrarian sector of the economy of Ukraine, the most obvious risks of sustainable development are the following:

– instability of the agricultural market, problems of developing and implementing forecasts and plans for the sustainable development of agricultural enterprises;
– changing environmental requirements;
– import resource dependence;
– food quality;
– dependence on natural and climatic conditions;
– globalization of markets;
– concentration of land and production in large agricultural holdings;
– social conditions in rural areas.

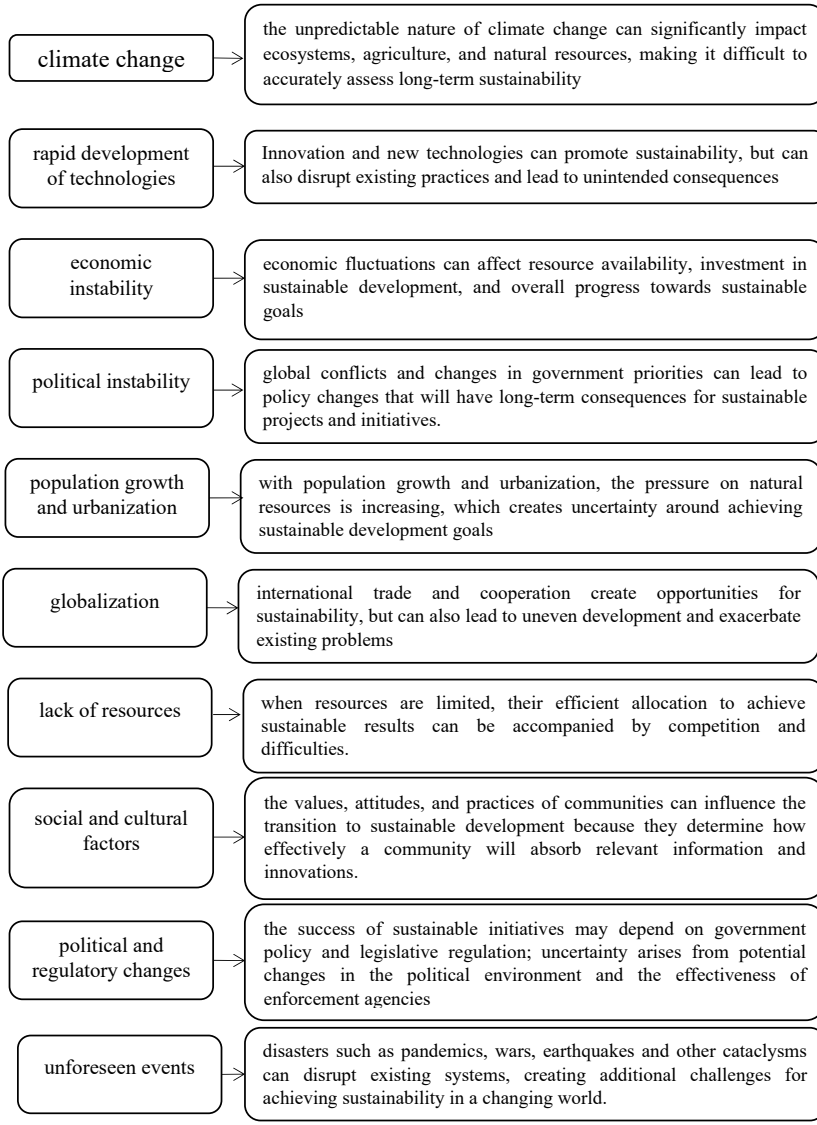

Figure 2.1. The main factors of uncertaint in sustainable development

Source: developed by the authors

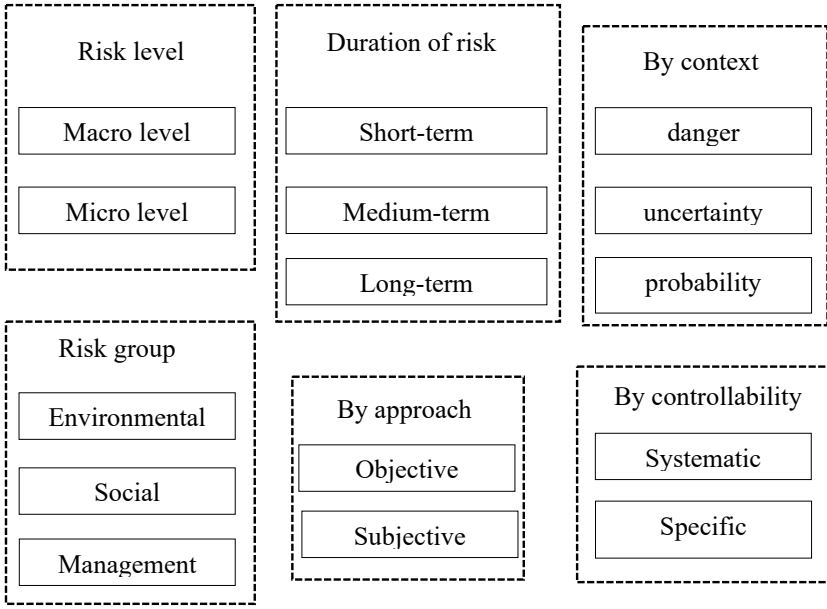

Figure 2.2. Classification of sustainable development risks for the agricultural sector

Source: developed by the authors

To sum up, it is worth noting that the sustainable development of the agrarian sector of the economy is determined by the complex interaction of economic, social and environmental risks, among which risks associated with global and domestic challenges are of particular importance. Agricultural enterprises operate in an environment of increased uncertainty, which necessitates the implementation of systemic risk management as a key tool for ensuring sustainability. The classification of sustainable development risks allows you to structure threats and determine priority areas for their minimization. Therefore, timely identification and management of risks is a necessary prerequisite for the formation of long-term competitiveness of agricultural enterprises and ensuring sustainable development of the industry as a whole.

2.2. ESG Risk Management of Enterprises in the Agricultural Sector of the Economy

Climate, environmental and social risk management is a system that allows for the ongoing identification, measurement, monitoring, control, reporting and mitigation of environmental and social risks. Such a risk management system is an obligatory component of a sustainable development policy, important for financial institutions, their clients (borrowing enterprises), as well as for investors.

To manage ESG risks of enterprises in the agricultural sector of the economy, a system, a model (Figure 2.3) is required that would solve certain tasks. The effectiveness of risk management directly depends on the integration of such activities into the institution's management process, including decision-making, and requires support from management at all management levels. The implementation of risk management requires the participation awareness of stakeholders, which will allow covering uncertainty, the possibility of future events and their impact on achieving the established goals (mission), objectives, and tasks of the institution. Assessment of the effectiveness and efficiency of risk management activities can be carried out by periodically reviewing the actual state of such activities to determine whether they are sufficient to achieve the established goal, objectives and tasks of the institution.

The principles of risk management activities provide an understanding of the characteristics of its effectiveness and efficiency, explaining the value, intentions and goals. These principles are the basis, should be taken into account when developing the structure and processes of risk management and allow the institution to manage the effects of uncertainty on the achievement of its established goal (mission), objectives and tasks, including:

– integration and continuity – risk management is an integral part of all activities of the institution, risk identification and assessment are carried out continuously;

– structure and completeness – a structured and comprehensive approach to consider the capabilities and actual resources in the institution. Risk identification is impossible without prior definition of strategic and operational objectives;

– adaptability – the structure and process of risk management are adjusted and correspond to the external and internal environment of the institution, related to its goals and objectives;

– economy and efficiency – achieving maximum results at minimal costs, i.e. the costs of risk management actions should be less than those that could arise when it occurs or is accepted;

– involvement – appropriate and timely participation of stakeholders allows taking into account their knowledge, skills and perceptions, which leads to an increase in the level of awareness and validity of risk management activities;

– dynamism – risks can arise, change or disappear as the external and internal environment of the institution changes; risk management predicts, identifies, confirms and responds appropriately to these changes and events in a timely manner;

– systematicity and comprehensiveness – taking into account all possible sources of risk and using methods of responding to them, developing measures necessary to avoid or reduce the risk.

– information availability – the initial data for risk management are based on reported and current information, as well as on future expectations;

– information must be reliable, sufficient, timely, understandable and accessible to relevant stakeholders;

мfactors related to corporate culture – people's behavior significantly affects all aspects of risk management in the institution as a whole;

– monitoring and continuous improvement – monitoring and control of the results of risk management activities is carried out constantly, risk management activities are improved through training and learning from experience;

– increasing the competitiveness of products and the enterprise, continuous personnel development, transition to an innovative development model [24].

All this forms 3 projections of the ESG risk management system (Figure 2.4).

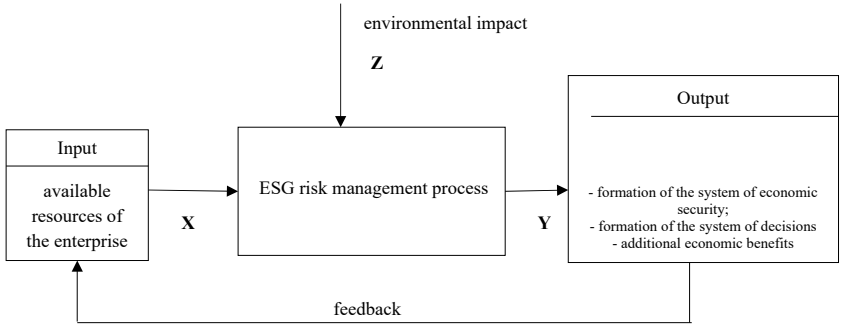

Figure 2.3. ESG risk management model for enterprises in the agricultural sector of the economy

Source: compiled by the authors

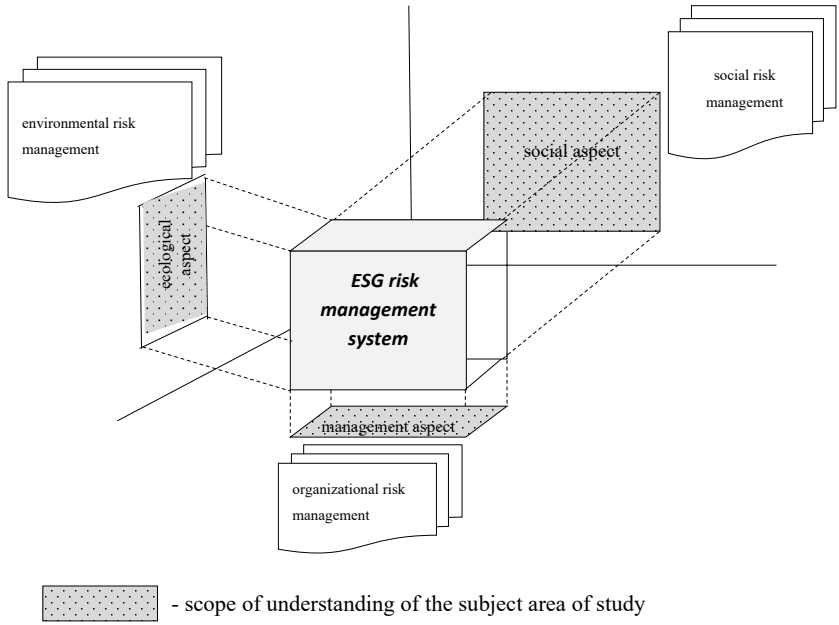

Figure 2.4. ESG risk management system projections

Source: constructed by the authors

ESG risk management is a complex problem combining financial, managerial and socio-economic aspects of enterprise activities. ESG risks are expediently defined as potential financial and non-financial losses caused by the impact of environmental, social and managerial factors on the activities of borrowers and bank counterparties. Unlike traditional financial risks (credit, market, operational), ESG risks have specific sources, a long-term nature and often manifest themselves through complex scenarios covering entire sectors of the economy. ESG risks have a number of key features:

– long-term and systemic nature, which makes forecasting difficult due to the remoteness of the consequences in time;

– close interrelationship with traditional financial risks, when ESG factors are transformed into market, operational or reputational risks;

– high level of information asymmetry, due to incompleteness, fragmentation or unreliability of data on environmental impact, social responsibility or transparency of management of counterparties [25].

Effective risk management is carried out through a consistent cycle of identification, assessment and analysis, management, monitoring and control of all possible risks that an enterprise may encounter in its activities (Figure 2.5).

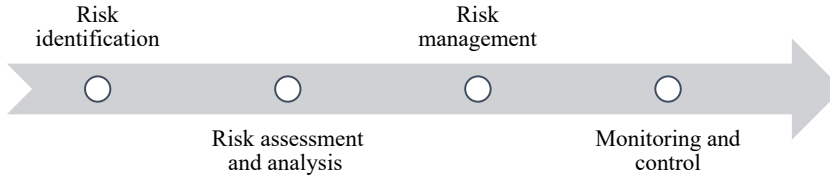

Figure 2.5. Stages of risk management

Source: compiled by the author based on processed sources

Stage 1. Risk identification (identification of sources of risks to which the enterprise is exposed, analysis of potential and actual losses of the enterprise in the event of risk realization, analysis of the completeness of risk identification, determination of risk types and development of a list of key categories of risks to which the enterprise is exposed).

Stage 2. Risk assessment and analysis (study of the risk profile, evaluation of methods and approaches to assessing the magnitude and potential impact of identified risks, analysis of the probability of risk occurrence, assessment of the potential impact of risks on achieving the goals set for the enterprise, as well as financial condition, profitability, reputation, analysis of the applicability, accuracy and relevance of methodologies and models, as well as risk indicators/indicators).

Stage 3. Risk management (analysis of the effectiveness of the implementation of the risk management strategy and reduction, determination of the risk limit that the enterprise is ready to accept, formation of decisions on limiting or optimizing risks and associated costs).

Stage 4. Monitoring and control (assessment of the adequacy and effectiveness of risk reduction methods, analysis of policies, procedures and means of enterprise risk management, assessment of the quality of internal control processes for risk management).

During martial law, Ukraine managed to find strength and stabilize its economy by encouraging companies to introduce ESG practices, as well as change established approaches to management. Companies' compliance with ESG requirements is a pass for cooperation with international partners and participation in the country's post-war reconstruction. We also emphasize that the use of compliance risks in analyzing the financial condition of domestic enterprises, non-financial companies, and financial institutions is a kind of driver for the use of ESG risks. We believe that the use of ESG risks in harmonious combination with compliance risks will lead to more transparent financial reporting, reduced corruption, and targeted use of investment funds, which will have a positive impact on the country's economy as a whole and improve the social level of the population [26].

According to Tiurina A.A. and Hryshchenko A.O., considering the identified barriers and growing requirements for business transparency, a phased but systematic strategy of action is needed for the effective implementation of the ESG approach in the Ukrainian agricultural sector of the economy. First of all, it is advisable to focus on forming the internal motivation of enterprises, which will be based on the awareness of economic benefits, such as risk reduction, access to preferential financing, participation in international support programs. The first step should be

the introduction of voluntary ESG reporting for small and medium-sized agricultural enterprises, which will help agricultural enterprises gradually master approaches to collecting, structuring and publishing relevant non-financial data. This requires templates adapted to the specifics of the agricultural sector, taking into account the scale of production and available resources. The development of a national ESG register or integration into existing databases would allow centralizing information and ensuring its accessibility for potential investors and partners. A prerequisite is also the development of educational programs and advanced training of specialists who can accompany the process of implementing ESG in enterprises. These can be both training courses for managers and special programs for agricultural universities and colleges [27].

The latest research results obtained by the software company Workiva [28], conducted in March 2024, in which more than 2,000 employees and sustainability managers were interviewed, indicate the following:

– global ESG regulations are starting to come into force: 87% of ESG specialists believe that it is difficult to adapt their reporting processes to the new regulations;

– integrated reporting is becoming the new gold standard: 81% of companies not subject to the CSRD nevertheless intend to comply with it;

– 88% of ESG specialists believe that confidence in ESG data increases the likelihood that a company will achieve its goals;

– key challenges undermine existing trust: 98% say they are confident in the accuracy of their ESG data, but 83% also agree that collecting accurate data to meet CSRD requirements is a challenge for their organization;

– reporting professionals are transforming reporting processes: 92% of companies are investing in technology to improve collaboration within reporting teams.

One of the biggest challenges for sustainability and compliance professionals is the sheer volume of regulations that need to be addressed. In addition, there is the challenge of having to comply with multiple global sustainability standards (e.g. GRI, IFRS). However, sustainability reporting offers significant opportunities for businesses. In particular:

1) Competitive differentiation: An overwhelming 88% of professionals agree that detailed ESG reporting gives their organizations a competitive advantage. This belief is reinforced by the fact that 89% of companies

indicate that they are giving ESG reporting a higher priority than in previous years.

2) Investor appeal: This strategic priority is also reflected in capital market attractiveness. This is particularly true for companies planning an IPO. Here, 46% of companies planning an IPO see a clear advantage in strong ESG reporting compared to only 37% of private companies not planning an IPO. This data highlights the importance for investors that companies can provide reliable and consistent ESG reporting;

3) Increased value and better decisions. Eight out of ten respondents agree that integrated financial and ESG/sustainability data enable better decisions and positively impact the creation of long-term value for the company;

4) Improved corporate reputation: Effective CSR reporting can improve the perception of a company by external stakeholders, such as customers, potential employees and the general public. Companies that transparently communicate their sustainability and social responsibility commitments can significantly enhance their brand strength and reputation;

5) Risk management: Sustainability reporting allows companies to better identify and manage risks, especially those related to environmental, social and corporate governance issues. This helps to minimize long-term operational and legal risks;

6) promoting innovation: the need to achieve the Sustainable Development Goals can stimulate innovation in products, services and business models that simultaneously reduce anthropogenic impact on the environment and offer social benefits.

The implementation of ESG practices, assessment and management of risks associated with sustainable development is becoming an integral part of modern business. These practices allow companies not only to improve their financial performance, but also contribute to solving global challenges, such as climate change, social inequality and instability in the markets. The growing interest in sustainable investments and the active participation of international organizations in regulating ESG practices indicate that this trend will continue to strengthen in the coming years, becoming a key factor in shaping successful business strategy at the global level.

2.3. Key Areas for Mitigating Climate Risks for the Sustainable Development of Agricultural Enterprises

When assessing global risks affecting the global economy, it is worth considering the overall geopolitical climate, which is characterized, first of all, by Russia's invasion of Ukraine and the wars raging in the Middle East and Sudan. In addition to geopolitical tensions, there is also a growing risk of geoeconomic confrontation (sanctions, tariffs, investment screening), which is also driven by inequality, social polarization and other factors. Understanding the complexities of an interconnected but increasingly divided world highlights the critical importance of recognizing and managing geopolitical risks for global business.

Tectonic shifts in the distribution of power, economic centers and trade are currently underway. New trade alliances and investment centers are rethinking the global dynamics of power. The previous geopolitical era, which began at the end of the Cold War and ended with the global financial crisis, was characterized by a high level of global cooperation. As a result, countries were able to integrate economically and globalization gained momentum. After about 20 years of largely free and unrestricted globalization, there is still interdependence and economic integration between countries. However, potential changes in the existing trade policies of many countries could change this dynamic further. As countries increasingly compete rather than cooperate, crises are spreading more intensely, especially for globally integrated enterprises. As geopolitics shifts towards a more mercantilist model, powerful countries are expected to use their weight, becoming more transactional and focusing on their economies and national interests.

Climate change poses a constant threat to food security and agricultural production systems. The agricultural sector of the economy faces serious challenges in achieving the Sustainable Development Goals due to the direct and indirect effects of ongoing climate change. While many industries are suffering from climate change, the impact on agriculture is enormous. Irrational changes in weather have caused inevitable public concern, as adequate food production and supply are under constant threat. Food production systems are negatively threatened by changing climate patterns, which increases the risk of food poverty. This has led to an alarming state of affairs regarding global food patterns, especially in countries where agriculture plays a significant role in their economies and levels of well-

being. The main focus is on overcoming the consequences of climate change, with a major emphasis on the agricultural sector of the economy and on how changing climate patterns affect food security directly or indirectly. Climate change and the associated changes in temperature ranges have threatened the survival and population of many species, which has exacerbated biodiversity loss through gradual fluctuations in ecosystems. Indirect impacts of climate change lead to poor quality and rising costs of food, as well as inadequate food distribution systems. All this indicates the importance of implementing policies aimed at mitigating the effects of climate change, both at the regional and global levels.

Disinformation and false information, as well as social polarization, remain key current risks for the agricultural sector of the economy. Given the growing spread of false or misleading information, it is not surprising that these two risks occupy such a high place in the activities of business entities.

The main directions of agricultural activities to ensure the mitigation of climate risks and sustainable development of the agricultural sector of the economy are shown in Figure 2.6.

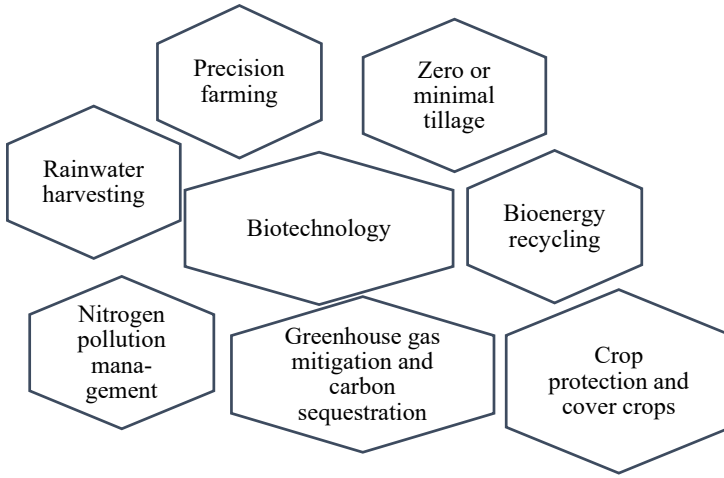

Figure 2.6. Main directions for mitigating climate risks for the sustainable development of enterprises in the agricultural sector of the economy

Source: compiled by the authors on the basis of the researched sources

Bioenergy recycling of agrobiomass and agricultural waste involves the use of organic waste for the production of biofuels and energy. Crop waste has bioenergy potential, in particular, it can be used for the production of solid biofuels (pellets and briquettes) by crushing and pressing (straw, corn and sunflower stalks and leaves, garden prunings, etc.). For the production of biogas, certain types of crop waste can be used, but, as a rule, in combination with animal waste.

The development of alternative energy in Ukraine will enable real structural changes: reduce energy consumption, increase energy efficiency and energy conservation; modernize energy and energy supply; implement in practice the principles of sustainable (environmentally oriented) type of economic growth; rid the national economy of traditional energy dependence and increase the competitiveness of national production, provide energy resources for social infrastructure and energy autonomy of agricultural enterprises on the basis of sustainable development [6].

– Precision farming can allow farmers to use technology to manage crops in specific areas. They can receive real-time data on crops, soil types and moisture levels to adjust the application rates of inputs such as seeds, fertilizers, crop protection products, water, etc. This allows them to manage resources more efficiently, reduce carbon emissions and improve biodiversity. Precision farming methods set precise rates for fertilizer and crop protection products depending on the needs of each segment of the field. Differential fertilization involves applying fertilizers to different areas according to a pre-established field map, which is developed based on various types of information: soil differences, soil analysis, yield maps, relief, soil conductivity map, NDVI, plots by potential, etc. Applying the right amount of product in the right place helps to effectively use the potential of each heterogeneous field area and input resources and achieve additional economic benefits.

– No-tillage or minimal tillage is a conservation technology that can combat climate change in three ways. It minimizes the use of machinery such as tractors, which in turn saves fuel. It helps the soil store carbon (carbon sequestration) instead of releasing it as greenhouse gases. It helps the soil retain moisture better, thereby minimizing the need for more water.

Zero-tillage, seed and fertilizer adjustment levers, and seed tubes are just some of the technological innovations that make this possible. Minimal

tillage is a highly effective agro-ameliorative technique for retaining and conserving soil moisture from precipitation. Its annual moisture storage effect is equal to 30–50 mm of precipitation. As a result, it stabilizes agriculture, especially during severe droughts.

Minimal tillage of black soil can provide stable yields in crop rotation even in the first years of its use, provided that increased rates of organic and mineral fertilizers are used, as well as effective plant protection products. It has been established that the longer systematic minimal tillage is used, the higher the yield of agricultural crops.

– Modern science-intensive biotechnology plays an important role in the implementation of strategic goals formulated in the new global program for a sustainable future, in particular: in the environmental aspect, increasing the adaptation of natural and changed ecosystems under anthropogenic pressure, preserving biodiversity, improving the quality of nutrition through the production of safe and useful functional products. In the context of promoting sustainable agricultural development, the use of environmentally safe biological products makes it possible to increase the resistance of crops to biotic and abiotic stresses, increase yields and improve the quality of the resulting products, reduce the pesticide load on ecosystems, and achieve bioremediation of contaminated lands. Biotechnologies of resource recovery and recycling, utilization of agrobiomass and organic waste with the production of renewable energy sources contribute to sustainable development and expansion of the resource base. In this sense, biotechnology is a means of improving the manipulation of biogeochemical cycles.

– The spread of pests caused by climate change threatens food security and is one of the main factors in the loss of biodiversity. Protecting crops with safe and environmentally friendly herbicides, fungicides, and insecticides can significantly solve this problem.

Cover crops are another proven way to combat pests and diseases. Cover crops can also slow soil erosion and regulate soil moisture. Preserving uncultivated soil under the crop residues of the previous crop is an important step in protecting the soil from erosion. The presence of cover crops in a field stops or reduces erosion through two main actions. The first is related to root development/growth; the second, related to the absorption of wind and water, is related to the development of the above-ground part of the plants.

The use of green manure helps to eliminate crop pests (e.g. nematodes, using biocidal plants), contributing to the development of conditions necessary for increased biodiversity. In addition, cover crops grow quickly, thus intercepting sunlight and competing with weeds for water and nutrients. Some crops, such as rye, produce certain organic substances that can inhibit the germination of weeds, thus reducing their numbers.

The use of crop protection technologies, such as automated spraying of agrochemicals using drones and robots, is also gaining popularity in the fields. Agrodrones are an effective solution for agribusiness, helping farmers to process crops and fertilize them in a timely and efficient manner with minimal use of resources. They have already created their own ecosystem and are working to ensure food security and achieve the Sustainable Development Goals. It has been proven that the application of protection products by agrodrones requires 90-95% less water and fuel, and, thanks to the ultra-low volume application, helps reduce the required number of pesticides by 30%. Moreover, due to the absence of technological tracks, trampling and the ability to work in hard-to-reach places, agrodrones are ultimately able to produce up to 10% additional yield per hectare [29].

– Extreme weather conditions, increased precipitation due to climate change and nitrogen input from more intensive agriculture can lead to nitrogen pollution. While nitrogen is an essential nutrient for crops, too much of it can contaminate soil and water, which can reduce yields. Farmers can limit nitrogen pollution by implementing organic farming practices such as crop rotation, crop diversification, the use of organic matter, and composting plant and animal waste. Precision farming technology is another powerful approach to managing nitrogen in agriculture.

– Because of global warming, rainfall patterns are becoming increasingly difficult to predict. Both excessive rainfall and prolonged droughts can pose challenges for agricultural producers. Farmers can collect and store rainwater during heavy rains using rainwater harvesting technology. They can use this water during droughts or periods of insufficient rainfall. Rainwater harvesting is also a sustainable alternative source of clean water. Rainwater is not just moisture that falls from the sky. It has unique properties that distinguish it from tap or well water. Its main advantage is its natural purity and softness, which is ideal for plants. Rainwater is distilled by nature. As it passes through the air, it absorbs a minimal number of impurities, making it

almost free of salts, minerals, and chemical compounds that are often found in tap water. Its pH is usually close to neutral (approximately 5.6–6.5), which is ideal for most plants [30].

Analysis of current global challenges shows that geopolitical instability, geoeconomic competition, and the effects of climate change create complex risks for the agricultural sector of the economy. The transformation of trade relations into new forms of global economic interaction, the formation of new economic centers and investment alliances significantly affect the risk management strategies of enterprises, emphasizing the need to adapt to changing conditions in international and national markets. Small and medium-sized agricultural enterprises, which often have limited resources and fewer opportunities for rapid adaptation to extreme climatic and economic factors, are particularly vulnerable to such changes.

The introduction of precision farming technologies, minimal and zero tillage, rainwater harvesting and storage systems, the use of cover crops, environmentally friendly plant protection products and biotechnology contributes to increasing production efficiency, reducing environmental burden and adaptability of agricultural enterprises to climate change. For small and medium-sized farms, accessible digital and cooperative solutions are especially important, allowing to optimize the use of resources, reduce risks and increase their productivity.

The systematic implementation of innovative environmentally friendly practices in combination with effective state policy at the global and national levels is critical for the sustainable development of the agricultural sector of the economy. Such a policy should include support for innovation, development of biotechnology, integration of digital solutions, effective management of natural resources and ensuring food security, taking into account the needs and opportunities of small and medium-sized agribusiness.

2.4. Sustainable Development Opportunities for Small and Medium-Sized Agricultural Enterprises

The agricultural sector of the Ukrainian economy occupies a strategically important place in the state economy, while facing a number of economic, environmental and social problems. Economic difficulties are caused by the instability of the agricultural market, limited investment, high level of production risks and difficulties in accessing financing. Environmental

challenges are manifested in the depletion of soil resources, reduced biodiversity, the use of unsustainable agricultural technologies and the degradation of agro-ecosystems. Social problems are caused by urbanization processes, labor migration from rural areas, logistical difficulties, pollution and withdrawal from circulation of a significant part of agricultural lands as a result of occupation and hostilities, low living standards of the rural population and demographic changes, which are exacerbated by martial law and military aggression.

The agricultural sector forms the foundation for the development of a sustainable and ecologically balanced economy, as it is one of the largest consumers of natural resources, significantly affects the state of the environment and provides a significant contribution to the formation of the country's gross domestic product and its export potential. The activities of agricultural enterprises stimulate investment activity and create new jobs, which, in turn, contributes to the development of related sectors of the economy. Therefore, after the end of hostilities, agriculture can become a key driver of economic recovery, and is currently almost the only stably functioning sector of the country's economy. The integration of sustainable development principles into the activities of agricultural enterprises can contribute to improving the state of agro-ecosystems, strengthening food security, increasing productivity, ensuring fair distribution of income and increasing the share of the middle class [31; 32].

Taking into consideration the current challenges facing the agricultural sector of the economy, small and medium-sized enterprises (hereinafter referred to as SMEs) are given the opportunity to become a driving force for sustainable development of rural areas. In particular, in the context of Ukraine, SMEs can effectively contribute to ensuring food security, developing rural communities and preserving biodiversity.

Small and medium-sized agricultural enterprises have significant potential to contribute to sustainable development of rural areas, ensuring food security and preserving the environment. To achieve these goals, they can introduce environmentally friendly practices, especially precision farming technologies, minimal tillage and the use of cover crops, which contribute to soil conservation, reducing greenhouse gas emissions and preserving biodiversity. A significant role in increasing the resistance of agricultural crops to stress factors is played by environmentally safe biological products

and biotechnology, which reduce the use of chemicals and contribute to the bioremediation of contaminated lands. The implementation of the principles of the circular economy, including waste disposal, production and use of renewable energy sources, allows to optimize production costs and reduce the negative impact on the environment. Additionally, digitalization and innovation, in particular the use of agricultural drones and automated data processing and collection systems, increase the efficiency of resource use and productivity of agricultural production. To support the sustainable development of small and medium-sized agribusiness, state policy is important, which includes the modernization of the agricultural register, the provision of financial instruments and the creation of conditions for the integration of enterprises into a sustainable agricultural chain. An effective measure is to raise awareness of agricultural producers through the organization of trainings and seminars, the development of cooperation with research institutions, universities for the implementation of innovations, investments in logistics and information infrastructure, as well as participation in international projects and initiatives aimed at the sustainable development of the agricultural sector of the economy. The implementation of these approaches contributes to the comprehensive development of SMEs, allows for increasing their adaptability to modern challenges, and lays the foundation for sustainable economic and environmental development of the agricultural sector.

At the same time, it is worth noting the need for small and medium-sized enterprises for state support, which can significantly make their market position more sustainable. State economic instruments in the agricultural sector of the economy are aimed at stimulating the use of environmentally friendly and socially responsible production methods, which contributes to increasing the profitability of agricultural enterprises, expanding access of small farmers to markets and ensuring a fair distribution of resources in the value chain of products.

Strategies for strengthening economic sustainability at the producer level include diversifying sources of income, introducing value-added processing processes, and expanding market linkages. The implementation of such measures allows producers to receive a greater share of the value created within the supply chain and increases their ability to withstand economic fluctuations and market shocks.

Special attention should be paid to supporting small farmers by strengthening their land rights, providing access to markets, credit and insurance products, which increases their financial sustainability. It is also important to implement sustainable production and consumption models at all stages of the value chain, from resource suppliers to end consumers, which stimulates demand for environmentally and socially responsible products.

Strategies for increasing social sustainability include ensuring equal access to education and health care, as well as investments in the development of social infrastructure in rural areas and social services. Such measures are aimed at eliminating the main factors of poverty and social inequality in rural areas and provide conditions for inclusive economic growth and human development.

Compared to large agroholdings, small and medium-sized agricultural enterprises have a competitive advantage due to a more decentralized management structure, which ensures shorter decision-making chains and the rapid introduction of new technologies. They are able to adapt production processes to the specific needs of individual market niches, quickly change the product range and test new approaches to sustainable production. Large agroholdings, on the contrary, have an advantage in scale of production and access to capital, but due to the complex organizational and management structure and high operating costs, their ability to flexibly respond to market and technological changes is limited. Thus, the competitive position of SMEs is formed not only through economic resources, but also through structural mobility, speed of innovation and the ability to customer-oriented adaptation, which allows them to effectively implement ESG practices and integrate into a sustainable value chain (Tab. 2.1).

A comparison of small and medium-sized agricultural enterprises with large agricultural holdings demonstrates clear differences in the management structure, flexibility, innovative capacity and ability to implement ESG practices. Small and medium-sized enterprises are characterized by high mobility and the ability to quickly adapt to changing market conditions, which allows them to effectively implement environmental and socially responsible initiatives. The high flexibility of small and medium-sized agricultural enterprises ensures the prompt use of the latest technologies, such as precision agriculture, agricultural drones and biotechnology, which contributes to increasing productivity and optimizing resources.

Table 2.1

Comparison of small and medium-sized agricultural enterprises and large agricultural holdings by key ESG parameters and innovation implementation

Parameter	Small and medium-sized enterprises	Large agroholdings
management structure	decentralized, short decision-making chains	centralized, complex bureaucratic procedures
production flexibility	high, ability to quickly adapt to market changes	limited, large scale makes rapid change difficult
innovative capacity	rapid implementation of new technologies (precision farming, agrodrones, biotechnology)	high potential for technology investment, but slower implementation due to organizational barriers
market adaptation	focus on specific niches, organic and certified products	focus on mass market, less flexibility in changing the assortment
implementation of ESG practices	easily integrate environmental and social initiatives due to flexibility	have a resource base for ESG, but slower to adapt due to scale and complexity of processes
risks	vulnerable to economic fluctuations	less vulnerable to market fluctuations due to scale, but vulnerable to regulatory and reputational risks
financial support	limited financial resources	wide access to domestic and international capital, but more difficult to integrate local support programs

Source: formulated by the author based on the sources reviewed

In contrast, large agricultural holdings have significant financial resources and the potential for investment in large-scale technological solutions, but the centralized management structure and large production scales limit the speed of their adaptation to market and environmental changes. The implementation of ESG principles in large agricultural holdings is slower due to organizational barriers, although the resource base allows for the implementation of comprehensive sustainable development programs.

Thus, small and medium-sized enterprises demonstrate strategic competitive advantages in the speed of adaptation, orientation to specific

market niches and integration of innovations and ESG approaches into production processes, which ensures their high adaptability in modern economic and environmental conditions. Large agroholdings provide scalability and financial stability, but lag behind in speed of response and flexibility, which makes them less competitive in segments where the speed of innovation implementation and local adaptation are valued.

Thus, in Ukraine small and medium-sized agrarian entrepreneurships have significant potential for integrating the principles of sustainable development, covering economic, social and environmental aspects. The market opportunities of small and medium-sized agrarian enterprises are realized through flexible adaptation to changes in demand for environmentally friendly and socially responsible products, which forms new market niches and contributes to increasing competitiveness. Innovative potential is provided by the introduction of precision farming technologies, digitalization, the use of agricultural drones, automated data processing and collection systems, as well as biotechnology, which allows optimizing resource use, increasing productivity and reducing negative environmental impact.

The financial capabilities of small and medium-sized enterprises are determined both by access to government support, grants, preferential lending and international investment programs, and by diversifying income sources and developing value-added processing processes. System integration of ESG principles ensures increased economic sustainability, improved food security, strengthening social infrastructure and preserving biodiversity.

At the same time, effective realization of the potential of small and medium-sized agricultural enterprises requires a comprehensive approach, including state support policies, access to financial resources, development of logistics and information infrastructure, scientific and technical support and involvement in international projects. Special attention should be paid to small agricultural producers through the protection of their land rights, access to markets, credit and insurance instruments, as well as support for sustainable production and consumption models at all stages of the value chain.

Consequently, the comprehensive realization of the market, innovation and financial capabilities of small and medium-sized agricultural

enterprises ensures their increased adaptability to modern economic and environmental challenges, contributes to the integration of the agricultural sector of the economy into sustainable economic development and creates the prerequisites for balanced socio-economic progress at the level of rural areas.

Abstract. This chapter examines the risks and opportunities of sustainable development for small and medium-sized agricultural enterprises in the context of the implementation of ESG criteria. The first section describes and classifies risks covering environmental, social and governance dimensions, emphasizing their impact on the stability and prospects of agribusiness. The second section is devoted to ESG risk management, in particular, the development of monitoring mechanisms, non-financial reporting and the use of adaptation tools to new regulatory and market requirements. The third section highlights areas for mitigating climate risks, including the introduction of resource-saving technologies, the development of organic farming, increasing energy efficiency and attracting green investments. The fourth section focuses on sustainable development opportunities for small and medium-sized agricultural enterprises, including expanding access to financing, integrating into international markets, creating a positive image and strengthening competitive positions. Thus, the section forms a systemic vision of the relationship between risks and prospects for sustainable development in the agricultural sector and justifies the feasibility of applying ESG-oriented strategies in the activities of enterprises.

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