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Adaptation strategies of agriculture to climate change and natural disasters

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► **Abstract.** Climate change and agricultural production are processes characterised by substantial mutual influence. Global warming threatens the productivity of agricultural production and food security on a global scale. The purpose of the study is to develop practical adaptation strategies for the impact of climate change and natural disasters on agro-economic processes. The study uses general scientific methods of cognition: system analysis and synthesis, concretisation, deduction, generalisation, abstraction, and formalisation. In the course of the study, the main factors of the impact of climate change on the agro-economic sector of production are identified, preventive measures and measures to level climate risks are systematised. Based on the conducted research, a system of tools is developed as part of the strategy for adapting agriculture to climate change and natural phenomena, and the main approaches to assessing the cost of natural disasters for agro-economics are recommended. The main measures to optimise the ecological and economic situation in the agronomic sector in the context of global warming and effective measures to prevent large-scale losses are developed. The results obtained can be used to conduct research on the dynamics of economic processes during global climate change, develop an appropriate adaptation strategy at the regional and national levels, and form an integrated approach to assessing the cost of natural disasters

► **Keywords:** potential risks; food security; agriculture; agroclimatic conditions; drought

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► Introduction

Climate change and weather conditions substantially affect the development of agricultural production. Many papers by researchers are devoted to the issue of the impact of climate change on the agro-economics and the development of adaptation strategies to such changes. However, in the light of acute urgency, the problem arose in the context of increasing frequency and strength of natural disasters and anomalies as consequences of the global warming process.

In a study by N. Davydenko *et al.* (2021), L. Malytska & V. Balabukh (2020), it is established that the main negative consequence of global climate dynamics is a decrease in agricultural production productivity. Therewith, B. Basok & Y. Baseiev (2020) argue that a sharp increase in the frequency and severity of natural disasters threatens the functioning of the agricultural sector on the principles of sustainable development, stability, and resource-saving in the long term. Modern researchers S. Ivaniuta *et al.* (2020), I. Krasnova *et al.* (2021) consider the consequences of weather and climate impact on agro-economics in the context of globalisation processes, and researchers V. Latysheva *et al.* (2021) focus on the risks to the environment.

Researchers M.H. ur Rahman *et al.* (2022) highlighted the features of the modern strategy of adaptation of agro-economics to climate change in a recent publication, considering the prevention and insurance of risks, maximum levelling of primary and secondary consequences of natural disasters and asset regeneration based on the assessment of the cost of natural disasters.

Modern Ukrainian researchers L. Malynka & I. Morhun (2020) show that, with a high probability, warming can contribute to an increase in the yield of many crops (in particular, winter wheat). Therewith, regional differences play a decisive role. However, excessive and rapid accumulation of heat resources reduces the growing season, initiates premature maturation of some crops, leading to a decrease in yield indicators.

Researchers E.S. Lilyk *et al.* (2021) the paper justify the expediency of using modern satellite data capabilities to identify locations of possible weather and climate anomalies, with the aim of timely development of optimisation measures. Therewith, researchers focus on the defining role of agro-economic management and hybrid forecasting in the prevention and elimination of negative consequences for agriculture, considering global climate processes.

Notably, in the modern scientific search for solutions in the field of the negative impact of extreme weather events and climate change on agro-economics, the main attention of researchers is focused on the issue of increasing production productivity. Therewith, there is a shortage of papers that could offer a comprehensive solution for strategic adaptation of the agricultural sector, considering technological, economic, and environmental risk factors. Certain aspects of the development of measures to mitigate the consequences of climate change are identified in the works of Ukrainian researchers V. Kolosovska (2020), O. Pohorielova (2022), however, the current situation requires an in-depth methodological approach and the development of practical measures on the problems of preventive risk management in the agro-economics from

natural disasters and climate change, minimising the consequences of such impact and regeneration measures for potential possible scenarios of consequences.

The purpose of the study was to develop an effective system of management and technical-economic preventive decisions on the impact of climate change and weather and climate disasters on agro-economics and examine modern approaches to estimating the cost of natural disasters. The paper is aimed at developing a practical adaptation strategy of agro-economics to climate change.

► Materials and Methods

The paper processed scientific literary sources and publications in industry specialised publications, monographs, and conference materials. The theoretical basis of the research consists of scientific publications on the subject under study (Ogada *et al.*, 2020; Liu & Basso, 2020; Dumrul & Kilicarslan, 2017), statistics from official national sources (Official website of the Ukrainian..., n.d.; Official website of the State Institution..., n.d.), the results of independent observations (Anderson, 2020; Chandio, 2020; Jatuporn & Takeuchi, 2023), practical recommendations on the subject (Tonnang *et al.*, 2022; Habib-ur-Rahman *et al.*, 2022; Tsinda *et al.*, 2019), devices for implementing the adaptation strategy in various climatic and economic conditions (Solomon *et al.*, 2021; Fujimori *et al.*, 2021; Lomba *et al.*, 2020) and analytical materials (Tubeuf, 2022; Eckhardt *et al.*, 2019).

The examination of the impact of global climate changes on agro-economic processes provided for the formation of a system of regularities and features of the object of the study. In particular, the possibilities of optimising the situation and choosing optimal preventive and regenerative solutions using the generalisation method were examined. The method of convergence from abstract to concrete is applied in the context of the transition from general knowledge about the vectors of the negative impact of climate change and extreme weather events on the economy to the essence of consequences for agricultural activities based on which the formation of practical measures for the prevention of destructive consequences and management of ecological and economic risks, and early forecasting, is conducted.

The study also uses methods of system analysis, synthesis, deduction, concretisation, formalisation, and abstraction. In particular, with the help of system analysis, structural connections between the phenomenon's elements are established, and existing approaches to estimating the cost of natural disasters are examined. The synthesis method is used in the study to position the existing system of adaptation to climate change and extreme weather situations in Ukraine, and the management mechanism for risk management. The deduction method is used to highlight the essence of the negative impact of climate dynamics on economic indicators and the ecological state of the agricultural production sector.

Using the general scientific method of abstraction, the concept of a holistic process of monitoring and controlling the parameters of the state of agrocenosis and managing ecological-economic risks arising as a result of direct and indirect consequences of climate change and

natural weather events is formed. The optimal information base of such a process can serve as a basis for developing a system of compensation for losses and effective insurance, early forecasting of extreme situations, and organising a system of emergency response measures.

The concretisation method is used to fix the effectiveness and expediency of urgent preventive measures and regeneration measures within the framework of the adaptive strategy of agro-economics for climate change and sustainable development and to predict possible negative consequences in short- and long-term time sections. In addition, the method of concretisation in the course of the study was used to identify optimal conditions and solutions for levelling the risks of prolonged consequences for agroecosystems, and adapting the existing agricultural management system to the basic requirements of a sustainable economy and preventing climate change.

The formalisation method was applied during the development of priority vectors for the policy of stabilising the state of agricultural territories in Ukraine amid global climate changes. This method was also instrumental in documenting the outcomes of the study, emphasising its active practical integration into the optimisation of climate risk management for agro-economic processes.

► Results

Agriculture is a key sector of the Ukrainian economy, which ensures an adequate level of food security and raw material reserves, but it is a powerful source of greenhouse gas emissions. Currently, the agronomy industry cannot be classified as highly vulnerable to climate change, but there is an increase in the intensity and frequency of droughts, which

may, in the future, lead to desertification in the southern regions of the country and the expansion of the zone of risky agricultural production. With the trend of dehydration in Ukraine's central and northern territories, gross grain production while maintaining the current agricultural technology system may substantially decrease by 20-25% in the coming decades (Malynka & Morhun, 2022).

Climate change is a condition in which the gradual substantial dynamics of the global climate model lead to the phenomenon of instability of temperature indicators, the occurrence of extreme weather conditions, seasonality shifts, and substantial fluctuations in precipitation (Fig. 1). Climate changes have a negative impact on the agricultural sector, and the determining factor is not only the increase in the average annual air temperature, but also the direct consequences of the process – violation of the duration of the growing season, the frequency of frosts, an increase in the likelihood of extreme weather conditions, etc. Elevated temperatures accelerate the growth of plants, and therefore, the content of trace elements in crop tissues decreases due to the slowdown in synthesis processes. In addition, the incidence and pest damage substantially increase, because increased temperature indicators reduce active immunity, which usually blocks the spread of phytopathogens, and also stimulates transpiration processes. Of all the natural disasters, droughts and floods have the most substantial negative impact on agriculture in Ukraine. 83% of the damage caused to the agronomy sector by natural and climatic anomalies is caused by droughts, while both crop and animal husbandry suffer losses (Malynka & Morhun, 2022; Official website of the State Institution..., n.d.).

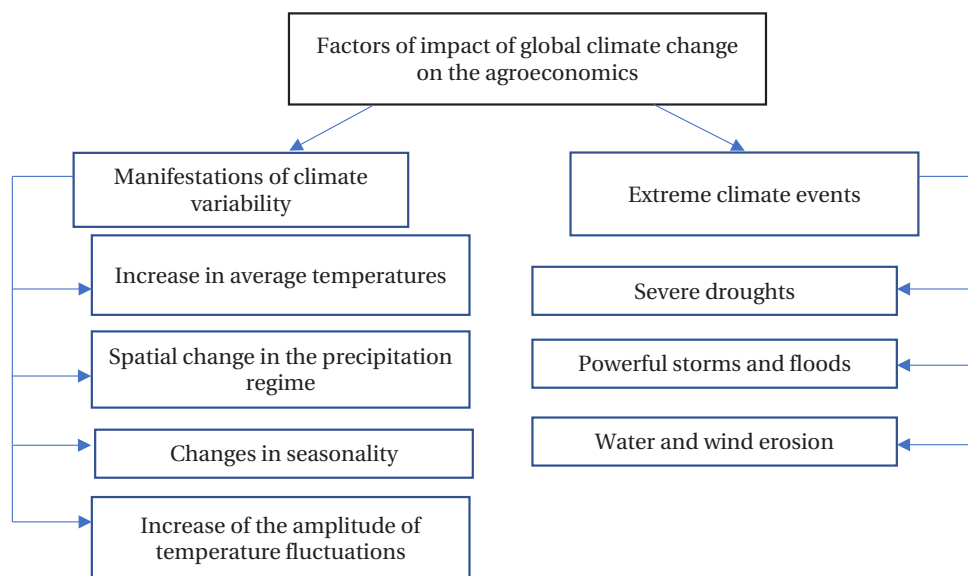


Figure 1. The main consequences of global climate change for agro-economic processes

Source: compiled by the authors

The factor of climate change and weather anomalies has a substantial impact on the chain of food pricing policy formation, affecting the volume of products produced, the production process and reserves. According to the Ukrainian hydrometeorological centre (Official website

of the Ukrainian..., n.d.), since the 2010s, the frequency of natural meteorological phenomena has substantially increased (up to 200 per year). Therewith, statistics show that every 10 years, the number of natural phenomena and natural disasters in Ukraine increases by approximately

4% (Official website of the Ukrainian..., n.d.). They cause soil erosion, erosion processes, flooding, and washing away of crops.

Disruption of metabolic processes, minimisation of humus reserves in the soil cover and changes in the rate of its mineralisation are direct consequences of substantial climate changes. According to the results of long-term statistics (Official website of the State Institution..., n.d.), every five years there is a loss of 0.05% of humus in the soil. In monetary terms, over twenty years, the equivalent amount is about 450 billion UAH. In addition, substantial losses are provoked by salinisation processes, and wind and water erosion phenomena. Loss of yield can lead to an increase in prices for agricultural products and have a destructive impact on the agricultural sector and food security on a global scale.

The phenomenon of global warming causes changes in the agroclimatic conditions of agricultural production productivity in Ukraine. Since the beginning of the 2000s, there has been a substantial increase in average temperatures in winter, an increase in the heat supply of the growing season, a change in the duration of seasons and the development of natural processes, a decrease in soil fertility, and an increase in the frequency of extreme events (Kolosovska, 2020). According to the results of long-term statistical observations, for the period from 2010 to 2022 in Ukraine, the number of days a year with high daytime air temperatures almost doubled (Official website of the Ukrainian..., n.d.). This fact explains the tendency to increase the duration of active vegetation of crops, which can cause premature maturation and a decrease in the yield of agricultural plants. In addition, climate change provokes the dynamics of another important agroclimatic indicator – the humidification regime. In 2021-2023, Ukraine is experiencing an increase in the frequency of droughts, uneven precipitation during the growing season, and a reduction in precipitation in winter. Accordingly, the regional specifics of water supply form the distribution areas of agricultural crops, which are substantially narrowed for moisture-loving agricultural plants. As of today, industrial cultivation of some traditional crops (corn, sunflower) in the southern steppe region is becoming economically impractical.

One of the consequences of global climate change is a shift in habitual seasonality. As a result of these dynamics, uncharacteristic temperature contrasts occur in regions where such a phenomenon has not previously been observed (Official website of the Ukrainian..., n.d.). The damage caused by temperature stress can be expressed in cellular abnormalities and problems with seed germination, improper adaptability of crops, and loss of yield indicators.

Among other negative consequences of climate change for the agro-economics, it is worth highlighting the most substantial: reduced grain quality; violation of the vegetation regime of crops due to intense droughts; the problem of soil moisture in the southern regions of Ukraine; intensification of humus decomposition; violation of the process of complete vernalisation of grain crops; an increase in the number of pests due to favourable wintering conditions; the spread of water and wind erosion phenomena; increased risk of freezing of winter crops due to lack of proper snow cover. Solving a number

of problems caused by climate variability and climate extremes requires consistency of management policies, agronomic programmes and practical means of their implementation. In order to implement an effective adaptation strategy, synergy of efforts in all aspects is necessary, which provides for comprehensive risk management and the introduction of methods for improving the sustainability of agricultural systems in the short, medium, and long term (Rahman, *et al.*, 2022; Ogada *et al.*, 2020). Therewith, it is important to consider the limitations of individual vectors of adaptation under existing economic conditions, and substantial positive dynamics can often be achieved only in the context of radical changes in the existing agronomy sector. The adaptation strategy can be effectively implemented only considering local specifics, in the conditions of creating a system for predicting climate extremes, developing preventive and regenerative measures, and developing opportunities in the field of risk management.

Modern approaches to estimating the cost of natural disasters for agro-economics separate direct physical damage from indirect production costs and additional or secondary consequences. These types of losses are inter-related and can become material or non-material, and the categorisation of potential losses supports the distinction between direct, indirect and secondary losses as a result of natural disasters (Kolosovska, 2020). Direct losses occur as damage as a result of a weather and climate catastrophe. Therewith, they can cause indirect losses, which in turn lead to secondary consequences. The latter have a prolonged impact and are usually felt throughout the entire recovery stage. In addition, their characteristic feature is the ability to form prerequisites for further vulnerability. In particular, a decrease in production and employment opportunities due to direct and indirect losses in the agricultural sector can provoke secondary losses due to a reduction in production capacity, a decrease in demand and investment volumes, etc.

The assessment of the cost of the impact of natural disasters in the field of agro-economics is influenced by the size and structure of the socio-economic background and the nature of the natural disaster. Therewith, it is necessary to consider the fact that a small and poorly diversified agricultural economy with spatially concentrated production assets is extremely vulnerable to natural disasters that occur in synergy with economic shocks (Tonnang *et al.*, 2022). Notably, if direct losses can be minimised, then indirect and secondary effects can also be levelled or reduced.

The trend of climate change makes it necessary to revise traditional plant protection technologies in favour of increasing the frequency of treatment with plant protection products, adapting the timing of agricultural manipulations. Therefore, it is necessary to avoid increasing the concentrations of chemical treatment of crops because this can lead to pathogen resistance, the need to develop new means of protection and an increase in the cost of agricultural products produced. The substantial impact of climate change on the agricultural economy requires substantial efforts aimed at minimising the impact, levelling negative consequences, and forecasting in a timely manner. Such goals can be achieved by developing an optimal adaptation strategy (Fig. 2).

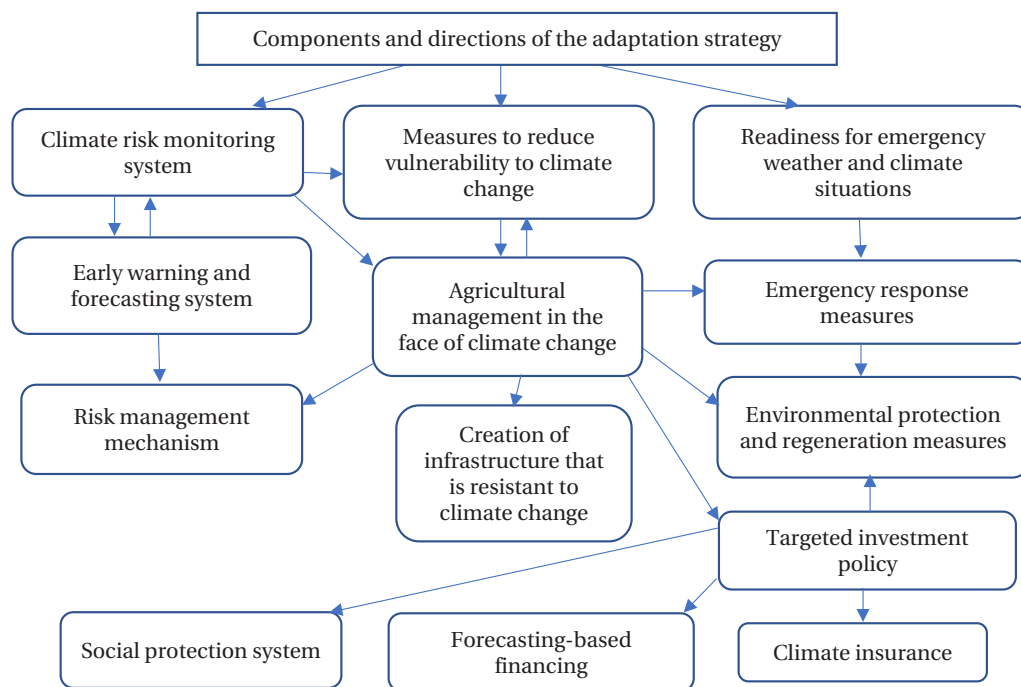


Figure 2. Measures and tools to minimise the impact of climate change on the agro-economics

Source: compiled by the authors

It is evident that the introduction of climate-resistant technologies and strategies for agro-industrial production is relevant today, which can not only mitigate the negative impact of climate change on the functioning of soil cover, water regime and other environmental parameters but also increase the production level under challenging conditions. It is notable that climate change affects the economic sustainability of the agricultural sector both directly and indirectly. Adaptation strategies should include, first of all, optimal dynamic planning of agricultural activities, considering the risks that arise for farmers due to climate change. In addition, selective measures, improving the irrigation system and ensuring soil moisture and biotic environmental strategies are integral (Lilyk *et al.*, 2021).

In some countries, rainwater collection technology is successfully used, which involves retaining excess moisture during the season of excessive precipitation (for example, using dams) and reusing it during the drought season (Tsinda *et al.*, 2019; Solomon *et al.*, 2021). Therewith, this technology allows effectively dealing with the phenomena of erosion. Economical tillage technologies are an integral part of adapting the agricultural economy to climate change, increasing carbon uptake, optimising infiltration processes and reducing soil erosion (Malynka & Morhun, 2022; Pohorielova, 2022). The effectiveness of measures to predict and minimise the risks associated with climate change depends, to a large extent, on the level of awareness of farmers and their motivation regarding the feasibility of strategic adaptation (Lomba *et al.*, 2020; Kharb *et al.*, 2022). Due to the lack of effective early forecasting, agricultural production declines and crop failures are becoming commonplace in the face of climate change.

Adaptive agricultural production opens up the possibility of optimising the degraded state of resources since it involves minimising the destruction of soil cover,

preserving biodiversity, replacing synthetic means of protection and nutrition with organic ones, and increasing the volume of terrestrial carbon uptake (Fróna *et al.*, 2021; Malhi *et al.*, 2021). It is also necessary to select varieties of crops that would have increased adaptive capabilities to climate fluctuations and be resistant to diseases and pests (Malytska & Balabukh, 2020; Alleyne & Jones, 2022).

Integrated nutrient management strategies, active use of breeding and biotechnologies, and effective pest control can provide optimal prerequisites for sustainable development of the agro-industrial complex even in the face of climate change. In addition, using the capabilities of modern simulation and decision-making systems, a global positioning system, remote sensing, and innovative approaches to forecasting allows developing optimal effective strategies for adapting to negative weather and climate trends and natural disasters.

To adapt to climate change and offset the negative consequences, the concept of implementing the state policy in the field of climate change until 2030 is in force in Ukraine, which provides for reducing anthropogenic emissions, stimulating the processes of greenhouse gas absorption, and also forms an algorithm for the gradual transition to a low-carbon strategy for the country's development (Malynka & Morhun, 2022). Therewith, the main task of institutional support remains to regulate the priority of tasks related to the impact of climate change on the agronomy sector while maintaining a balanced development of all components of the agricultural production system. It is also necessary to take appropriate structural measures regarding the design and location of buildings and other infrastructure elements to minimise the possible consequences of natural disasters. In addition, the adaptation strategy should consider the challenges and opportunities that arise from the growing trends towards

globalisation, which has expanded opportunities for risk diversification.

It is advisable to encourage the private sector of the agricultural economy to raise awareness of the risks associated with natural disasters and climate change and to implement appropriate risk management tools. Together, the proposed measures as part of agricultural management in the context of climate change will reduce the level of vulnerability of the industry to weather and climate anomalies, stimulate economic growth and development, implement deregulation of investments in agriculture, use forecasting opportunities to reduce the impact of climate variability and implement effective financial risk management mechanisms.

► Discussion

Ukraine is currently one of the twenty countries in the world that emit the most greenhouse gases into the atmosphere (Kolosońska, 2020). This fact indicates the inevitability of substantial negative consequences of climate change for the region. The primary result of global warming for the agricultural economy is a reduction in agricultural production, primarily due to a decrease in yield indicators. Overall, climate change has mixed impacts on agriculture, manifesting itself in both negative and positive trends. To date, researchers have recorded an increase in average temperature values in Ukraine by 1-1.5°C, and a trend of further warming characterises the situation (Official website of the Ukrainian..., n.d.).

Researchers R. Anderson *et al.* (2020) note that the most dangerous consequences of climate change are not global warming itself, but the phenomena caused by it: heat, drought, storms, hurricanes, and other natural disasters. Currently, there is an increase in the frequency of abnormal weather conditions. The actual majority of agricultural areas are currently in the zone of risky farming. The daily temperature regime has undergone sharp changes, which is often characterised today by substantial contrasts of night and day temperatures. Researchers claim that adaptive crop systems responsible for tolerance to stressful phenomena do not cope with the task of levelling the ranges of differences, which substantially disrupts plant development. It is hard to disagree with researchers.

In general, among abiotic stresses, M.H. ur Rahman *et al.* (2022), A.A. Chandio *et al.* (2020), M. Habib-ur-Rahman *et al.* (2022) highlight heat stress as the most threatening factor for the sustainable development of agronomy since it can cause changes in the modulation of gene expression, metabolic disorders, activation of oxidative stress, and even destruction of the foundations of genetic structural material. Researchers have proven that the degree of influence of heat stress on the quality of grain crops depends on the variety of crop, but the negativism of the trend persists regardless of agricultural characteristics. In view of the above, the researchers consider it appropriate to include in the strategy of adapting the agro-economics to climate change such measures as, for example, the use of organic antioxidants and osmoprotectors. In this study, identical recommendations are formed – the use of maximum opportunities for preventive safe agricultural measures.

Modern researchers S. Fujimori *et al.* (2021), D. Eckhardt *et al.* (2019) noted that the degree of economic

damage, the indirect effect caused by a natural disaster, depends on the degree of interdependence of economic and production factors. Researchers give an example that as a result of a natural disaster, in the future, agriculture may face the loss of energy supply and communication infrastructure or labour, even if production resources are not damaged. Therewith, research results Y. Dumrul & Z. Kilicarslan (2017) indicate that when assessing the impact of the consequences of disasters in the long term, attention is focused on production volumes and labour productivity. However, given the possibility of severe damage to non-current assets and other resources as a result of a natural disaster, productivity can be substantially reduced due to the disruption of markets and infrastructure. Researchers note that all major types of natural disasters, including drought, can disrupt long-term investment plans. Such conclusions are synergistic with the results of this study.

Researchers Y. Liu *et al.* (2020) are convinced that the damage can be covered by insurance policies. However, it is difficult to agree with researchers, because even in this case, alternative losses are real, and certain types of destroyed assets cannot be replaced. In the long run, the risks associated with natural disasters and natural disasters can contribute to economic instability, limiting investment opportunities. The use of innovative agroecological management systems by farmers, along with traditional management paradigms and the latest opportunities for biodiversity and management of soil and water resources, open up new opportunities for levelling the negative effects of climate change. Climate-resistant technologies provide optimisation of the state of the natural environment involved in the agricultural sector, increase carbon absorption, and minimise erosion phenomena, which in synergy allows forming a sustainable production system in agriculture and neutralises the threat of a food crisis. Therewith, it is considered appropriate to classify the main adaptation methods by resource-saving factor, variability of agricultural technologies, and socio-economic factors. In addition, according to researchers C. Jatuporn & K. Takeuchi (2023), the priority areas in forming an adaptation strategy should be market integration and capacity development, and such conclusions are similar to the results of this study.

Considering the results of the studies, it can be concluded that reducing the level of risks caused by climate change can be achieved in the conditions of developing an optimal adaptation strategy, which should provide for the main primary implementation vectors, including: increasing the resistance of ecological and economic systems; developing an adaptation policy mechanism from regional to national level; balanced resource consumption and environmental management; implementing an effective system for monitoring and forecasting natural and climate dynamics; engaging in cross-border projects on adaptation to climate change; strengthening the institutional capacity to implement state policies to prevent climate change and mitigate negative consequences; increasing the neutralisation and absorption of greenhouse gases through specific land-use measures; implementing medium-term defined low-carbon development strategies and other international commitments (García-León *et al.*, 2021).

In addition, the adaptive concept of reducing the negative impact of global climatic processes on crop

production should provide for the priority of species and varieties of agricultural crops with a short growing season, expanding the diversity of agricultural crops to strengthen the resistance of the agroecosystem to external negative influences; introducing an effective irrigation system; breeding productive varieties with increased drought resistance; effective agronomic monitoring; and managing the optimisation of the nutrient regime and metabolism of crops and the use of insurance opportunities in agricultural production (Basok & Baseiev, 2020; Van Huong et al., 2021; Sangha et al., 2020).

The impact of climate change and natural disasters on factors of long-term economic growth shows an acute consequence shortage of financial resources, which can reduce the pace of agro-economic development. In this regard, researchers A. Lomba et al. (2020) emphasise the need to disclose the risks associated with dangerous weather and climate phenomena while highlighting the most important among the prerequisites – substantial opportunity costs associated with diverting resources to recovery from natural disasters. Researchers argue that natural and climate disasters negatively impact both the short and long term, and the agro-economic situation today refutes the established belief in minimising the vulnerability of agriculture to natural disasters as the economy grows. Thus, natural disasters create negative trends for both short- and long-term prospects for the development of the agricultural economy. It is necessary to thoroughly assess the risks to agricultural production associated with natural hazards and include the results of such an assessment in the development strategy and policy of Agricultural Management. It is essential to be aware of the differences between potential short-term and long-term impacts, and possible trade-offs between them, considering the totality of relationships (Eckhardt et al., 2019; Yu, & Wei, 2022). After all, agricultural production, from the point of view of economic feasibility, requires strategic adaptation to climate hazards to minimise risks.

To promote sustainable agronomy, both the individual perception of preferences and the introduction of functional methods of market exchange are necessary to ensure the resource base and economic motivation of farmers and stimulate the development of Industry alliances. Climate-smart agriculture involves adapting the agricultural sector to climate change by rationalising the use of resources, implementing effective management, and applying innovative low-carbon technologies and agronomic strategies. An integrated approach to the prevention and levelling of climatic consequences, and an effective assessment of the cost of natural disasters will create optimal prerequisites for the formation of a practical concept of adaptation of agro-economics to the negative dynamics of weather and climatic conditions.

► Conclusions

Climate changes cause destructive processes in the agro-economics, substantially affecting the level of agricultural production through negative trends in crop yields,

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reducing the intensity of agriculture, reducing acreage, minimising investment in the agro-industrial complex. As a result of the study, it was possible to analyse the main aspects of the impact of climate change and natural weather disasters on agricultural production in the example of natural conditions in Ukraine. It was determined that the potential impact will lead to substantial negative consequences on a local, regional, and global scale, in the form of reduced yields and product quality, and even a food crisis. The manifestations and secondary consequences of climate change on agro-economic processes are systematised. There is a threat of a decrease in agro-economic productivity indicators under the influence of weather and climate disasters. Mechanisms for assessing the cost of natural disasters were analysed.

As a result, priority measures and tools in the structure of the adaptation strategy for minimising the impact of climate change and natural disasters on the agricultural economy were identified. These include adaptive management mechanisms, innovative capabilities of the risk monitoring, forecasting and early warning system, improved emergency response algorithms, social protection, insurance and investment support systems, and measures to increase the sustainability and expansion of dynamic properties of agro-economic systems.

It is established that only an integrated multidimensional approach to the development of a strategy for adapting agro-economics to climate change and weather extremes, with the introduction of innovative monitoring and forecasting capabilities, the use of effective insurance and social protection systems will allow responding promptly to negative trends in agriculture caused by climate factors, preventing a decrease in production opportunities. Therefore, priority should be given to preventive measures, a risk prevention system, and emergency preparedness.

The need to improve existing approaches for effective and reliable assessment of the cost of natural disasters in the examined area was identified. The main prerequisites and factors that contribute to the effective implementation of the risk management system associated with adverse weather and climate trends were also highlighted. Among these factors, the introduction of an early forecasting and crisis management system, the organisation of an economic buffer and insurance for unpredictable weather and climate impacts are notable. Priority vectors of the examination of the impact of climate change on agro-economic processes and the need to organise and systematise research information were proposed. The importance of further research in applying managerial and technological preventive measures, including modern tools for risk insurance, crisis management, forecasting and adaptive modelling, was emphasised.

► Acknowledgements

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► Conflict of Interest

None.

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Адаптаційні стратегії сільського господарства до змін клімату та стихійних природних явищ

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► **Анотація.** Зміна клімату та сільськогосподарське виробництво – процеси, що характеризуються суттєвим взаємним впливом. Глобальне потепління ставить під загрозу продуктивність виробництва агропромислового комплексу та продовольчу безпеку у світовому масштабі. Метою дослідження була розробка практичних адаптаційних стратегій до впливу кліматичних змін та природних стихійних лих на агроекономічні процеси. В дослідженні були використані загальнонаукові методи пізнання: системний аналіз та синтез, конкретизація, дедукція, узагальнення, абстрагування та формалізація. У ході роботи визначено основні фактори впливу кліматичних змін на агроекономічний сектор виробництва, систематизовано превентивні міри та заходи щодо нівелювання кліматичних ризиків. На основі проведеного дослідження, було розроблено систему інструментів в складі стратегії адаптації сільського господарства до змін клімату та стихійних природних явищ, рекомендовано основні підходи до оцінки вартості природних катастроф для агроекономіки. Розроблено основні заходи з оптимізації еколого-економічної ситуації в агрономічному секторі в умовах глобального потепління, а також ефективні міри для запобігання масштабним збиткам. Отримані результати можуть бути використані для проведення досліджень щодо динаміки економічних процесів у період глобальних кліматичних змін, розробки відповідної стратегії адаптації на регіональному та національному рівнях, а також у ході формування комплексного підходу до оцінки вартості природних катастроф

► **Ключові слова:** потенційні ризики; продовольча безпека; сільське господарство; агрокліматичні умови; посуха