The impact of climate change on the investment attractiveness of agricultural enterprises

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Abstract. The trend of climate change has a direct impact on the economic development of any country. Ukraine is an agrarian country and climatic conditions have a direct impact on its economic stability. The purpose of this work is to highlight the tightness of climate change and their direct impact on the development of the agricultural sector of Ukraine's economy on the example of a particular agricultural enterprise and develop recommendations for adapting the enterprise to climate change. The conducted research clearly shows the negative consequences of climate change and the forms of their manifestation, which threaten not only the studied enterprise, but also the agricultural sector of Ukraine. It is established that the main ones are the following: instability of temperature indicators, soil degradation and the spread of diseases and pests of crops.

1. Introduction

The problem of investment attractiveness of agricultural enterprises of Ukraine retains its relevance in today's rather complex economic realities. This is largely due to the fact that active investment helps to overcome the negative effects of economic and environmental crises. Investment attractiveness is an integral characteristic of individual enterprises - objects of future investment from the standpoint of prospects for their development, expanding production and marketing parameters, strengthening the market position, efficiency of assets and their liquidity, solvency and financial stability, which in general can provide appropriate the level of competitiveness of the entity. Therefore, one of the most important tasks facing each of them in particular and the economy as a whole.

In order to make a decision on capital investment, a domestic or foreign investor first studies the external and internal characteristics and investment situation of the enterprise, the favorable investment climate in the industry, which indicate the investment attractiveness of the object. As you know, the status of investment attractiveness is influenced by certain factors that directly shape it. These factors are divided into internal, which depend on the activities of the enterprise or organization, and external, which do not depend on the economic activity of the object and form its environment. For agricultural enterprises, special attention should be paid to such an external factor as the environment, because in national practice, despite the relevance and severity of this issue, little attention is paid.

2. Research results and discussion

The trend of climate change has a direct impact not only on the economic development of any enterprise, but for the whole country and the world. It should also be noted that the environmental factor is one of the most influential for the agricultural sector.

According to S. Rosenzweig (American climatologist), although food production has been able to keep pace with global population growth, there is a shortage of nutrients, food in different regions and it affects about a billion people worldwide. In this respect, climate change is one of the factors that can affect food production and availability in many parts of the world, especially those most prone to drought and famine [1]. An Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to compile statistics, determine the status and monitor the pace of climate change. From their Fifth Assessment Report it became known that:

- From 1880 to 2012, the global average temperature increased by 0.85 ° C;
- The global average sea level has risen by 19 cm due to global warming and melting glaciers;
- Given the current concentration and constant emissions of greenhouse gases, the global average temperature may increase by 1-2 ° C by 2100, compared with 1990;
- Compared to the period 1968-2005, the sea level may rise by 40-63 cm by the end of this century [2].

Based on standard approaches [3-6], the assessment of the effects of global climate change should be based on the analysis of the balance of positive and negative trends. Probable negative consequences for Ukrainian agricultural enterprises, which should be expected from climate change, include reduced soil fertility, reduced overall crop productivity, increased prevalence of pests and diseases of crops, increased frequency of extreme events related to water resources.

In turn, the risks associated with reduced soil fertility include the negative impact of water erosion, soil compaction, desertification, mineral starvation, soil salinization and changes in soil biota structures. And among the risks associated with varying degrees of pest spread, a distinction should be made between the appearance of alien species, an increase in the number of generations and the transition to traditional organisms that previously did not cause economic damage. The probable positive consequences for agricultural enterprises of Ukraine, which should be expected from climate change, include the increase in the length of the growing season, the spread to the north of the zone of cultivation of thermophilic crops,

It should be noted that 23% of CO_2, CH4 and N_2O emissions are accounted for by the agro-industrial complex, as is known from the Summary for Policymakers of the SRCCL. These gases are the main types of greenhouse gases in the world [7]. Given this situation, to study the impact of climatic conditions, it is advisable to consider an international company in the field of agricultural production. Therefore, we further propose to consider the impact of natural and climatic threats on the investment attractiveness of the company on the example of a specific enterprise.

Kernel Agricultural Holding is the world's leading producer and exporter of sunflower oil and a key supplier of agricultural products from the Southern region of Ukraine to world markets. The company operates in the globally competitive growing Ukrainian agricultural sector:

- an integrated, sustainable and simple business model built around scale and global reach;
- a leader in all market segments supported by an unprecedented base of world-class assets with high barriers;
- meets the highest standard of corporate governance.
- The activity of Agroholding "Kernel" in agriculture is characterized by the following indicators:
- producer of grain crops №1 in Ukraine – 550 thousand hectares of leased agricultural land;
- modern large-scale operations, sustainable agronomic practice, cluster management system and export-oriented activities;
- about 100% of sales go through infrastructure and sunflower oil segments, earning additional profits.

Studies show that in 2019 the land fund of this enterprise amounted to 529,1 thousand hectares, but the targets for 2020 are slightly lower (Table 1).

A clear understanding of the consequences, risks and vulnerabilities in the short, medium and long term is a very important task for the effective adaptation of this agro-industrial enterprise to global climate change. This will allow the company's managers to develop a sequence of actions, relevant programs and activities. To do this, you need to develop a special research program.

Table 1. Acreage of Kernel Holding SA in 2019 financial year and 2020 planning year.

Cultures	Acreage, thousand hectares		
	2019	2020	Deviation in percent
Corn	224.2	231.4	+ 3%
Sunflower	134.5	136.5	+ 2%
Wheat	100.0	97.1	-3%
Soybean	36.3	24.3	-33%
Other cultures[1]	34.1	23.3	-32%
Total	529.1	512.7	-3%

Note[1]. Includes rapeseed, barley, rye, oats, forage crops and other minor crops, as well as fallow land. Differences are possible due to rounding.

Regarding the potential complications for the production of Kernel Holding SA, the study provided an opportunity to form the following natural and climatic threats: a larger amplitude of fluctuations in maximum and minimum temperatures in both summer and winter will require the selection of new and genetic modification and adaptation of existing crops. Such research activities will require significant financial investment, taking into account the loss of current profitability due to additional time costs.

From the 1980s, the average maximum, average and average minimum temperatures began to rise. But over the past 50 years, these figures have grown by 20%, 25% and 29%, respectively. We forecast the average annual temperature until 2040. using a polynomial model. Studies show a gradual increase in both the average annual temperature and increase its minimum and maximum level, the reliability of this forecast is confirmed by the approximation coefficient, the value of which ranges from 0.91-0.98 (Fig. 1).

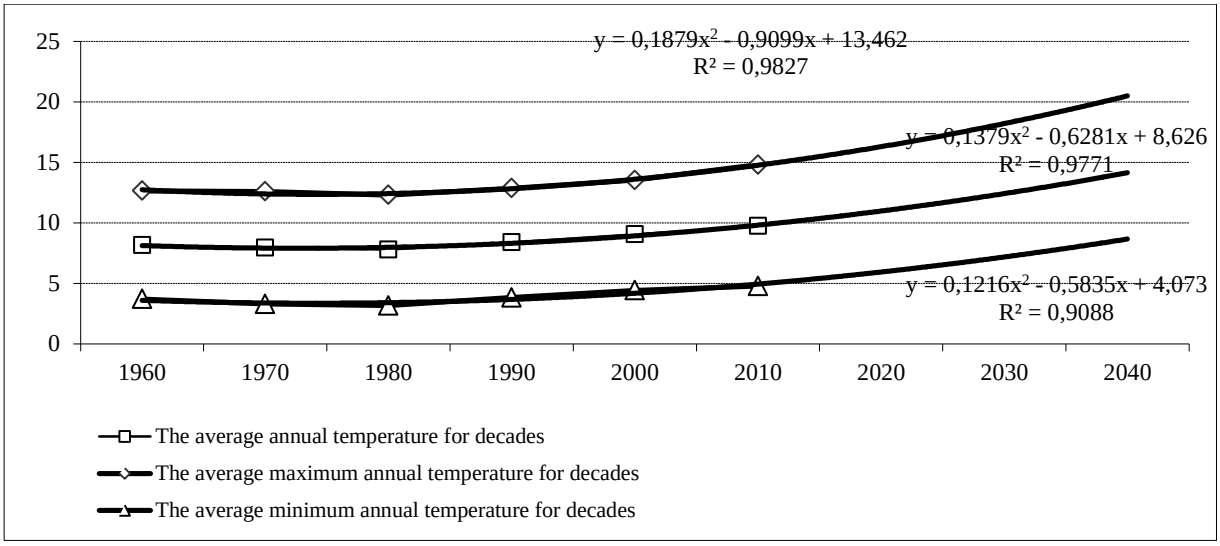

Figure 1. Dynamics of changes in the average annual temperature, the average annual maximum and minimum temperatures of the decade from the 1960s to 2010.

Source: built by the authors on the basis of data [8].

The decrease in temperature indicators of the cold period and the change of temperature regimes in the spring lead to a shift in the beginning of the sowing campaign in recent years. There is a slight decrease in precipitation throughout Ukraine, which has a negative impact on the formation of sufficient soil moisture and contributes to the spread of drought throughout Ukraine. In recent decades, there has been an actual shift of natural and climatic zones by 100-150 km to the north.

Reducing summer rainfall leads to an increase in the frequency and severity of droughts, forcing agricultural enterprises to create new and improve old irrigation technologies in order to maintain an acceptable level of investment attractiveness.

In particular, at Kernel Holding SA today modern technologies for growing cultivated plants degrade the quality of soil fertility, so the compaction of soils by running systems has become a problem of agriculture. The problem will remain relevant as long as there are traditional tillage technologies together with traditional methods of their research. The use of elements of precision farming is given in Table 2.

Table 2. The results of the use of precision farming in Kernel Holding S.A.

№	Stage	Result
1	Introduction of control systems for fertilizers and plant protection products	Avoidance of double application on floors, especially in fields with complex configuration, which allowed to increase the efficiency of the company's resources. Also avoid the possibility of reducing yields in some areas up to 25%, due to excessive application of active substances of plant protection products, or vice versa due to omissions when fertilizing. Savings and payback of systems depend on the number of technological operations involving converted equipment, the volume and quality of work, culture and volume of sown area
2	As a result of introduction of an element of exact agriculture-tape application of fertilizers	Avoidance of losses from irrational use of fertilizers, both liquid and bulk. With the reduction of the number of technological operations, reducing the rate of fertilizer application to 30% - the yield in the company remained at the same level, compared to traditional methods and rates of application. At the same time, the company managed to save additional fuel and lubricants, motor resources of equipment, payroll, and most importantly - this is the time due to which savings have increased the productivity of the equipment
3	Installation and use of automatic control system	Reducing the load on the operator. This is monitored both when working in the fold, and when turning the equipment at the end of the run. Also, the operator is less tired, due to the reduction of concentration during field work, which allows you to effectively perform technological operations, even at night. The use of automatic control system with RTK signal (accuracy 2-3 cm), allowed not only to reduce resource costs and increase productivity, but also to improve the culture of production in the fields and due to the precise passage of machinery on the tracks managed to reduce the percentage of trampling plants

Source: formed by the author on the basis [9, 10].

At the same time, global climate change can help increase the capacity of the agricultural enterprise through weather and climate conditions. However, this is possible only with the effective adaptation of the agricultural company to the new conditions, synchronized with the pace of their change. Otherwise, warming threatens to increase the instability of agricultural production. To adapt agriculture to changing climate conditions, it is necessary to assess the existing conditions and model agro-climatic resources for the future.

Climate change poses a real danger to Ukraine, as insufficient moisture reserves in the soil make it very difficult to harvest crops. In addition, strong winds lead to wind erosion of soils. Also with warming, the probability of increasing the number of pests by 1.5-2 times increases.

Therefore, the next stage of our study is to predict changes in average annual temperature and precipitation in the southern regions of Ukraine by 2030. For the preliminary selection of models, the method of characteristics of average increments is used, which is the most universal and provides a choice of models from a wide class of functions. According to this method, the sequence of values of the indicator is smoothed by the method of a simple moving average [11].

It should be noted that the term "moving average" is used because the new average is calculated and used as a forecast each time a new observation is available. This method is used to characterize the development trend of the studied statistical population and is based on the calculation of the average levels of the series for a certain period.

Forecasting temperatures and precipitation by the formula:

$$K = K_o \times SMA \tag{1}$$

where K_0 is the indicator of the base year (2010); SMA – the average three-year moving rate of change of the indicator for the three years preceding the corresponding year of the medium-term forecasting period.

Moving averages are tools of financial analysis that smooth out the fluctuations of the studied value by averaging over a certain historical period. Moving averages are studied by the method of averaging: simple moving average (SMA); weighted moving (WMA); Exponential Moving Average (EMA); modified exponential moving average [12]. Moving average formula:

$$SMA = \sum_{i=1}^{n} T_i \tag{2}$$

Ti - growth rate of the i-th period (up to the previous year);

n - the period of SMA.

Thus, from a practical point of view, the moving average method is used for series that have a linear trend, and the method of exponential smoothing is used in cases where forecasting is based on time series in which the trend is volatile or in which there is no trend [13]. At this stage of research, we will forecast the change in average annual temperature using the moving average method from 2019-2020. and the main results are presented in the form of Fig. 2.

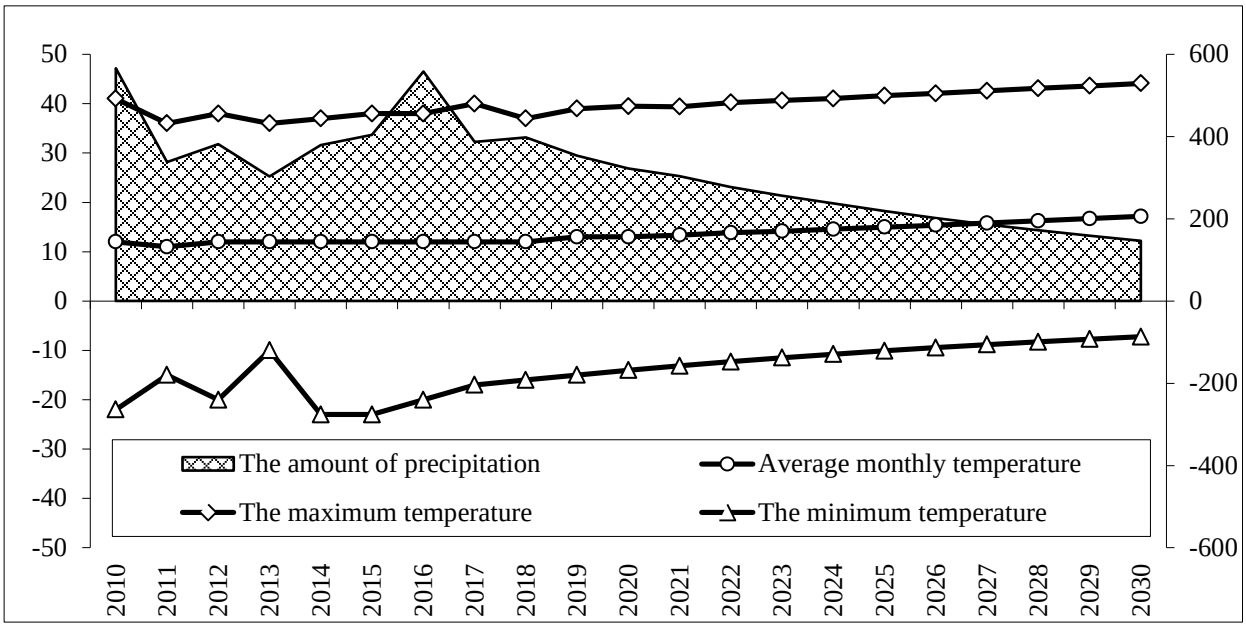

Figure 2. Forecast of temperature change and precipitation in the Southern region of Ukraine until 2030.

Source: built by the authors on the basis of data [14].

Based on forecasting and analyzing the data, according to the above research results, it is established that the average annual temperature over 10 years will increase by 4,2 degrees and in 2030 will be 17.2 degrees. The maximum temperature will rise from 40 degrees in 2020 to 44.1 degrees in 2030. As for the minimum temperature, its limit value in 2030 will be -7.2 degrees, ie it will increase by 6,8 degrees. Regarding the amount of precipitation, the negative dynamics is similarly observed. Thus, by 2030, their number will decrease by 175.5 mm and will be only 146.5, while in 2020 this figure was 322.

Based on the research, it is established that the moving average method is used in the practice of forecasting quite often and is practically the most common method of trend detection. Externally, it is only a purely empirical method of preliminary analysis, which is dominated by arithmetic operations with levels of time series, but understanding the nature of the phenomenon occurs when determining the period of sliding, because the average obtained by sliding reflects not purely arithmetic operation, and the transition to larger intervals time.

During the study we found that the result of the influence of climatic conditions on the cultivation of crops are significant fluctuations in yield.

The change in yield depends on many factors, which can be combined into two large groups - deterministic and random. Deterministic factors include soil degradation, improvement of production technology, and accidental climate change.

Studies show that the trend is interpreted as the influence of deterministic factors, the main of which is the technology of production (increased fertilizer application, use of high-yielding varieties, advanced plant protection products). The coefficient of variation characterizes the scatter of points relative to the trend line: the smaller its value, the smaller the scatter, ie the smaller the influence of random factors (climate change).

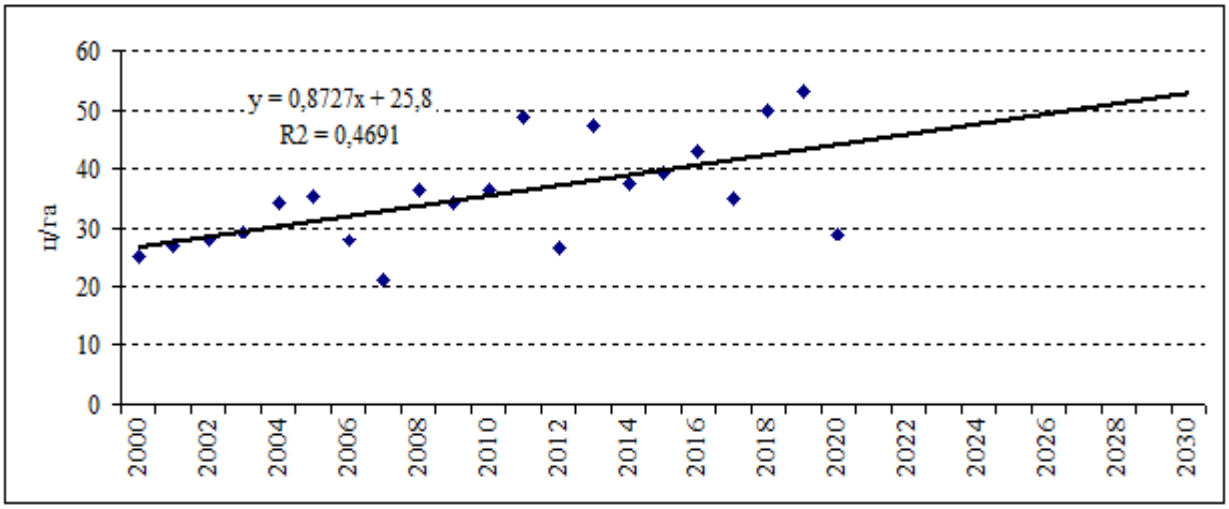

Figure 3. Dynamics of corn yield in the Southern region of Ukraine until 2030
Source: built by the authors on the basis of data [8].

Using multivariate regression analysis, we investigate the dependence of yield gains (fluctuations) in corn, wheat and sunflower on four indicators: X1 – average monthly temperature, X2 – maximum temperature, X3 – minimum temperature, X4 – the amount of precipitation.

With the help of regression dependence, we will determine the quantitative influence of reliable factors on the performance trait, and, using the regression equation, we will calculate the forecast values of corn yield by 2030.

The level of connection density between the studied factors is estimated by the value of the multiple correlation coefficient. As a result of correlation-regression analysis, it was found that the degree of closeness of the connection is significant R = 0.681.

The unit of measurement of the simultaneous effect due to the variation of all factors included in the study is the coefficient of multiple determination. In our case, R2 is 0.464. This means that the variation in yield by 46.42% depends on changes in the studied factors. The significance of the regression coefficients is checked using Student's t-test. The values of t-statistics of all factors exceed the tabular value of Student's t-test. This confirms the reliability of the influence of selected factors on the result (Table 3). Therefore, it is possible to proceed to the economic interpretation of the research results. The equation of dependence of corn yield on changes in climatic conditions has the form:

$$Y = 137{,}653 - 1{,}90074\ X1 - 3{,}09493X2 + 0{,}999112X3 + 0{,}054516X4$$

Substituting the forecast values of climatic factors into the equation, we obtain the forecast values of yield fluctuations in the Southern region. Thus, the projected yield of corn by 2030 will decrease to 29,96 q / ha, with actual values in 2020 of 40,44 q / ha (29,96 c / ha by 2030).

The equation of the dependence of wheat yield on changes in climatic conditions has the form:

$$Y = 13{,}74449 - 0{,}92813\ X1 - 0{,}15398X2 + 0{,}235218X3 + 0{,}001837X4$$

The results of correlation-regression analysis show a moderate dependence of fluctuations in wheat yield on climatic factors. Forecast wheat yields, taking into account changes in average annual temperature and precipitation, are declining, and in 2030 the yield will be – 29,43 kg / ha.

Table 3. Correlation model of dependence of yield increase on the studied factors.

Regression statistics						
Multiple R	0.681382					
R-square	0.464281					
Normalized R-square	0.107135					
Standard error	8,396601					
Observation	11					
Analysis of variance						
	df	SS	MS	F	Significance of F	
Regression	4	366.6081	91.65202	5,299975	0.367896	
Remainder	6	423.0174	70.50291			
Together	10	789.6255				
	Coefficients	Standard error	t-statistics	P-Value	Lower 95%	Upper 95%
Y-intersection	137,653	71.22248	1,932718	0.101461	-36.6223	311.9283
x1	-1,90074	6,548761	-2.29024	0.7814	-17,925	14.12352
x2	-3.09493	2,437264	-2.26984	0,251166	-9.0587	2,868847
X3	0.999112	0,822586	2,214598	0,270147	-1.01369	3,011909
X4	0.054516	0.045156	2,207275	0.272755	-0.05598	0.165008

Source: calculated by the author according to the data [6, 12].

The equation of the dependence of sunflower yield on changes in climatic conditions has the form:

$$Y = 20{,}23631 + 1{,}520151\ X1 - 1{,}09757X2 + 0{,}151513X3 + 0{,}013072X4$$

The forecast values of sunflower yield in the Southern region of Ukraine in 2030 will be 13.67 q / ha, while in 2020 it will be 17.42 q / ha. In order to study the impact of climatic conditions on the financial results of agricultural enterprises, we assess the impact of reduced yields on the level of profitability of individual crops, taking into account prices and the cost of 2020. Thus, in 2020 the company had a level of profitability of wheat production of 51,93%, taking into account the invariability of price and cost, and only a decrease in yield under the influence of climatic conditions, the level of profitability will decrease to 38,8%. With regard to sunflower and corn, the decrease in yield is more significant and as a result the profitability will decrease by 31.41% and 37.04%, respectively (Table 4).

Table 4. Forecast financial results of Kernel Agroholding activity.

	Factual data				Forecast data			Deviation	
Product	Average yield, c / ha	Decrease rate	Profitability,%	Total profit, UAH million	Average yield, c / ha	Profitability,%	Total profit, UAH million	Profitability,%	Total profit, UAH million
Corn	48,6	0,741	42,94	1689	36,0	5,9	231,4	-37,06	-1457,8
Wheat	38,7	0,913	51,93	706	35,3	38,8	526,9	-13,17	-179,0
Sunflower	20,9	0,785	46,31	948	16,4	14,9	304,5	-31,44	-643,8

Source: calculated by the author.

3. Conclusions

In the environment of functioning of agricultural producers there is a set of risks and threats, under the influence of which the main aspects of the activity of enterprises are formed and on which their investment attractiveness depends. By their nature and source of origin, they can be attributed to the category of those risks that pose a risk of losing investment attractiveness to the enterprise and the entire agricultural sector of Ukraine.

The conducted research clearly shows the negative consequences of climate change and the forms of their manifestation, which threaten not only the studied enterprise, but also the agricultural sector of Ukraine. It is established that the main ones are the following: instability of temperature indicators, soil degradation and the spread of diseases and pests of crops.

Therefore, given the increasing aridity of the climate, it is necessary to take systematic and scientifically sound measures to adapt agricultural production to new climatic conditions. Resistance to the constant shortage of moisture in agriculture is achieved through the accumulation and preservation of it through the constant use of modern energy-saving technologies for growing crops, minimizing tillage, reducing the time of spring field work, and generally adhering to regulations for all technological operations. These measures contribute to the sustainable development of the agricultural sector of Ukraine, as they are based on the principles of the golden rule of ecology, which must always be implemented at the farm level - global environmental problems are solved locally.

We have made proposals to adapt Kernel Agricultural Holding to the new conditions for conducting agricultural business, taking into account the conditions of climate change. The main ones are: ensuring monitoring and control of hydrometeorological conditions for the future; development and introduction of scientifically substantiated crop rotation; adaptation of reclamation systems and introduction of drip irrigation system. The proposed measures will preserve the investment attractiveness of the studied enterprise and the agricultural sector of the Ukrainian economy as a whole.

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