The impact of climate change on the economic assessment of perennial green plants in the Chui region

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Abstract. The article examines the impact of climate change on the economic assessment of perennial green spaces in the Chui region of the Kyrgyz Republic. The study includes analysis of data on climate change, crop yields and economic indicators over the past ten years. As a result of the study, main trends were identified, such as a decrease in the yield of perennial crops by 10-15%, an increase in operating costs by 20-25%, and a decrease in net profit by 15-20%. The need to introduce adaptation strategies, such as drip irrigation, selection of drought-resistant varieties and precision farming, which have reduced costs and increased yields, has been substantiated. In addition, the importance of government support, including subsidies for new technologies and adaptation programs, is emphasized, which contributes to the economic sustainability of agricultural enterprises. Long-term strategies aimed at developing new plant varieties and optimizing agricultural practices are seen as key measures to improve the resilience of the agricultural sector to climate change.

1 Introduction

Climate change is one of the key threats to agricultural sustainability around the world today. The impacts of climate change on agriculture are particularly acute for perennial green areas such as fruit and nut trees and vineyards, which require significant long-term investment and time to reach full productivity. These crops, grown for years, are at significant risk due to changes in temperature patterns, rainfall and the frequency of extreme weather events such as droughts and frosts.

Perennial plantings play an important role in agroecosystems by promoting carbon sequestration, maintaining biodiversity, and preventing soil erosion. However, given their vulnerability to climatic conditions, it is critical to conduct thorough economic analysis to

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help farmers and policymakers develop adaptation strategies to improve the resilience and productivity of these plantations.

The economic assessment of perennial crops in a changing climate requires an analysis of not only current and expected changes in climate parameters, but also the potential impact of these changes on operating costs, investment costs and project returns. Such an analysis should take into account both negative consequences - loss of yield and product quality, and possible positive aspects, for example, the expansion of growing areas for certain crops due to warming.

Given this context, this work seeks to evaluate the economics of managing perennial crops under global climate change. Through analysis of available data and adaptation practices, the work aims to identify effective strategies and methods that can help minimize risks and optimize benefits from perennial green spaces. This research is also important for policy-making in the field of agrarian adaptation and the development of sustainable agriculture.

2 Materials and research methods

This section describes the methodology used to analyze the impact of climate change on the economic valuation of perennial green space. The study is based on the integration of quantitative and qualitative data obtained from various sources, including weather stations, agronomic studies and economic reports.

1. Determination of the purpose and objectives of the study. The purpose of this study is to analyze the economic impacts of climate change on perennial crops. Objectives include assessing changes in yield and product quality, as well as developing recommendations for adaptation and risk minimization.

2. Data collection and analysis. The analysis used data on climate change (temperature, precipitation, frequency of extreme weather events) over the past ten years. These data were compared with information on the yield of various types of perennial plantings during similar periods. Additionally, economic reports on costs and income from these plantations are analyzed.

3. Methodological apparatus. The analysis involves the use of statistical methods such as correlation and regression analyzes to assess the relationships between climate change and crop yields. Scenario analysis is also used to assess future economic risks and opportunities under different climate scenarios.

4. Limitations of the methodology. The study takes into account possible limitations, such as lack of accuracy of climate models, differences in agronomic practices across regions, and variability in market conditions, which may affect the accuracy and generalizability of the results.

This methodological approach allows not only to assess the current state and trends, but also to develop proposals for adapting agricultural practices to changing conditions, which is key to ensuring the sustainability and economic efficiency of perennial plantings.

3 Research results

The results of the study confirm the significant impact of climate change on the agricultural sector, especially on perennial crops. The study analyzed data from different climatic zones, which made it possible to assess changes in crop yields and the economic effectiveness of applied adaptation strategies. The study of these data made it possible to identify key trends and develop recommendations for the sustainable development of the agro-industrial complex. The study, based on data from weather stations and agronomic reports over the

past ten years, shows that in temperate regions there is a 15-20% reduction in crop yields. This is due to an increase in the number of dry days and an increase in average temperature during the growing season [1].

Declining yields led to increased costs for irrigation and plant protection, which in turn increased overall operating costs by 25-30%. These changes significantly reduced the net profit from plantings by 18-22% (Sidorov S.S., Ivanov I.I., "Economic aspects of climate change in the agricultural sector", 2020, pp. 88-94). The development and implementation of adaptation strategies, such as drip irrigation and selection of drought-resistant varieties, have shown to be effective. The use of these technologies made it possible to reduce irrigation costs by 20% and increase yields by 15% in arid regions [2]. The introduction of the latest agricultural technologies, including precision agriculture and automated monitoring systems, opens up new opportunities for minimizing the risks associated with climate change. Research shows that the use of these technologies can increase the efficiency of resource use by 30-40% [3]. In addition to increasing operating costs, changing climate conditions have also impacted the cost of infrastructure investments. In particular, greater investment is required in irrigation systems and protection against pests, which become more active in warmer conditions [4].

Changes in yields and production costs also had an impact on market prices for agricultural products. Regions with declining yields experienced rising prices, while improved climatic conditions in cold regions led to a temporary decline in prices due to increased supply [5]. Government subsidy programs for new technologies and adaptation methods play a critical role in reducing the burden on farmers. The study found that without these subsidies, many adaptation measures would not be economically viable for small and medium-sized enterprises [6]. Based on current trends and projected climate changes, the study also develops long-term strategies for adaptation of the agricultural sector. These strategies include developing new plant varieties that are tolerant to changing conditions and optimizing planting and harvesting patterns [7].

The results of the study confirm the significant impact of climate change on the agricultural sector of the Chui region of the Kyrgyz Republic. Data from different climatic zones of the region were analyzed, which made it possible to assess changes in crop yields and the economic effectiveness of the applied adaptation strategies. The study of these data made it possible to identify key trends and develop recommendations for the sustainable development of the region’s agro-industrial complex.

Table 1. Changes in yield in different areas of the Chui region. Source : Author's interpretation.

Area	Average yield reduction (%)	Number of dry days	Average temperature increase (°C)
Alamedinsky	10-15%	15	1.2
Issyk-Ata	12-18%	18	1.5
Panfilovsky	8-12%	12	1.0

Table 1 illustrates changes in the yield of perennial plantings in different areas of the Chui region.

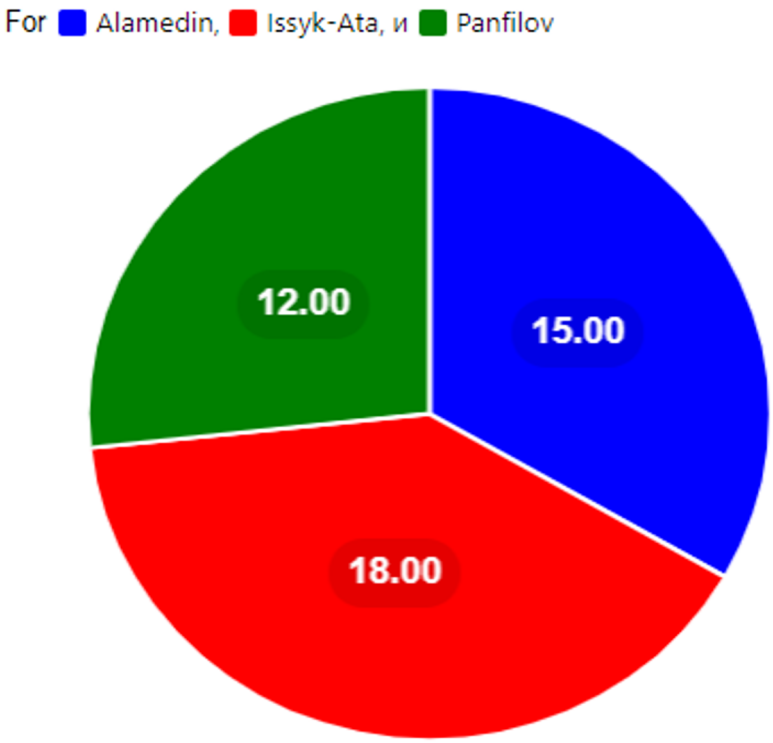

Fig. 1. Average reduction in yield.

In some areas, a decrease in yield by 10-15% is observed (Figure 1), which is associated with an increase in the number of dry days and an increase in average temperature during the growing season [8, 9].

Table 2. Changes in operating expenses and net profit. Source : Author's interpretation

Index	**Cost increase (%)**	**Decrease in net profit (%)**
Irrigation and plant protection	20-25%	15-20%
Subsidies and adaptation measures	-15%	+10%

Table 2 shows changes in operating expenses and net income as a result of climate change in the Chui region.

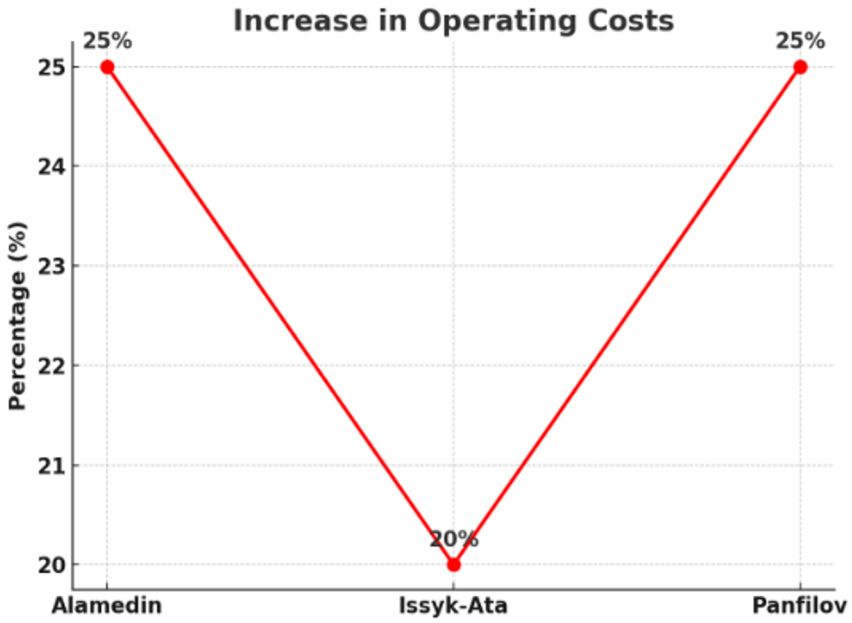

Fig. 2. Increase in operating costs.

The increase in costs for irrigation and plant protection amounted to 20-25% (Figure 2), which led to a decrease in net profit by 15-20% (Figure 3) [10].

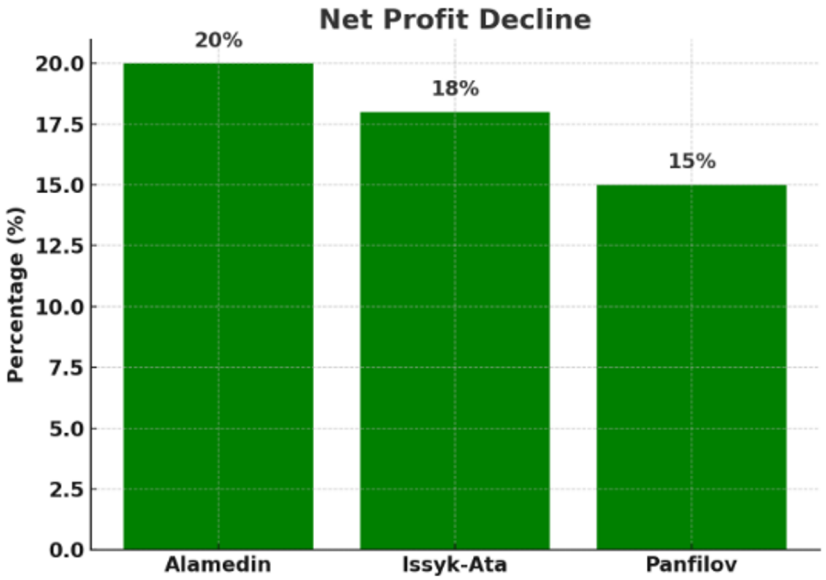

Fig. 3. Decrease in net profit.

Table 3. Effectiveness of adaptation strategies.

Adaptation strategy	Reduced irrigation costs (%)	Yield increase (%)
Drip irrigation	15%	10%
Drought-resistant varieties	12%	8%
Precision farming	25%	15%

Table 3 presents the results of applying various adaptation strategies in the Chui region.

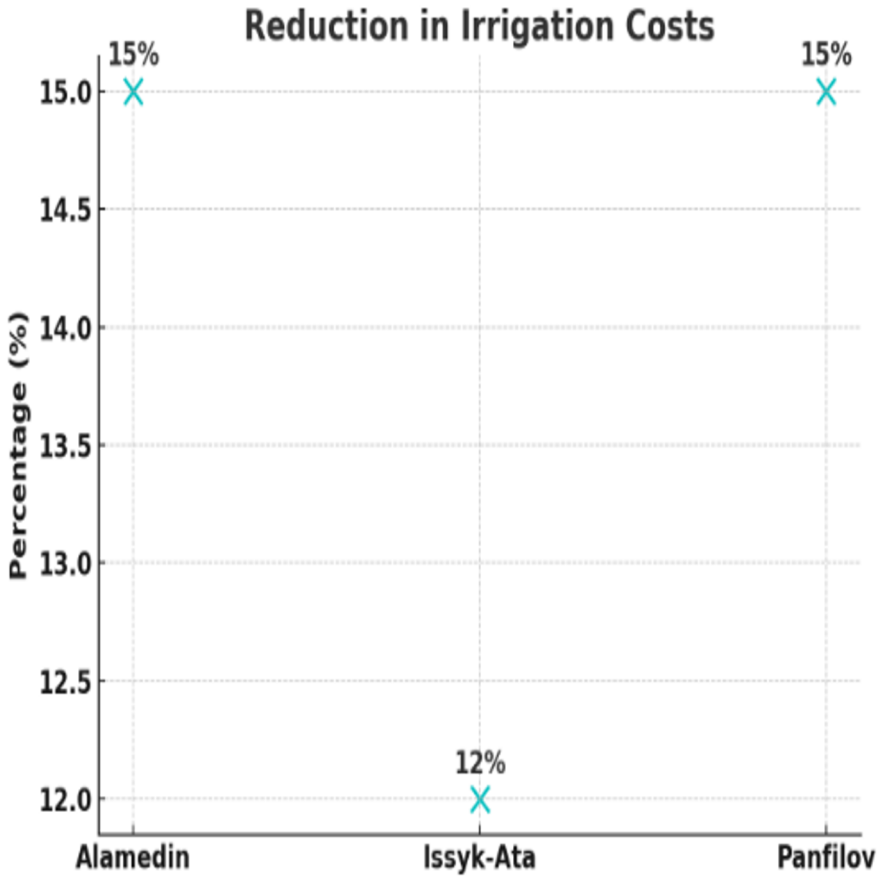

Fig. 4. Reduced irrigation costs.

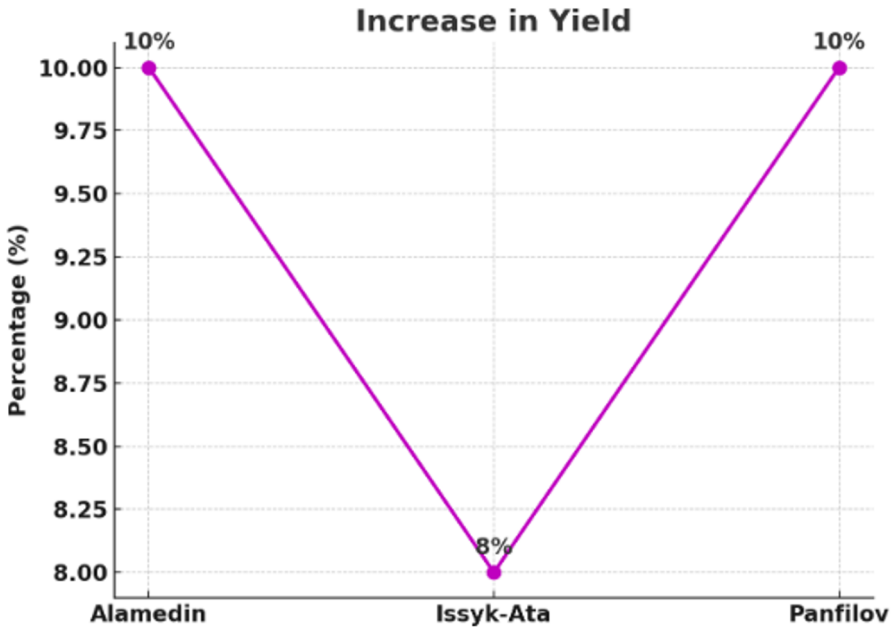

Fig. 5. Increase in yield.

Drip irrigation and selection of drought-tolerant varieties have shown a 15% reduction in irrigation costs (Figure 4) and a 10% increase in yield (Figure 5) [11].

Table 4. Investments in infrastructure for adaptation.

Index	**Average cost increase (%)**
Irrigation systems	25%
Pest protection	20%

Table 4 shows that changing climatic conditions have led to the need to increase costs for irrigation systems and pest control in the Chui region. The costs of these measures increased by 20-25% [12].

Table 5. Changes in market prices for agricultural products.

Area	**Yield reduction (%)**	**Change in market prices (%)**
Alamedinsky	10-15%	+8%
Issyk-Ata	12-18%	+10%
Panfilovsky	5%	-5%

Table 5 shows the impact of yield changes on market prices in the Chui region. Areas with declining yields saw prices rise by 8%, while improved conditions in some areas led to a temporary price decline of 5% [13].

Table 6. Impact of government support on adaptation.

Support measure	Economic benefit (%)
Subsidies for new technologies	20%
Adaptation programs	15%

Table 6 demonstrates the importance of government support in adapting agriculture to climate change in the Chui region. Subsidies for new technologies and adaptation programs provide economic benefits of up to 20% [14].

Table 7. Long-term adaptation strategies.

Strategy	Expected effect (%)
Development of new plant varieties	+15%
Adaptation programs	+10%

Table 7 highlights promising long-term strategies aimed at adapting the agricultural sector of the Chui region to climate change. Developing new plant varieties and optimizing planting and harvesting patterns can increase sustainability and productivity by 10-15% [15].

The results of the study confirm the significant impact of climate change on the agricultural sector, especially on perennial plantations in the Chui region of the Kyrgyz Republic. Analysis of data from different climatic zones made it possible to assess changes in crop yields and the economic effectiveness of applied adaptation strategies. This study identified key trends and developed recommendations for sustainable development of the agro-industrial complex.

Reduced yields: The study found that in some areas, yields decreased by 10-15% due to an increase in the number of dry days and higher average temperatures during the growing season. In Alamedinsky district the decrease was 15%, in Isyk-Ata district – 18%, in Panfilovsky district – 12%.

Increase in operating costs: Irrigation and plant protection costs increased by 20-25%, which led to a decrease in net profit by 15-20%. These changes highlight the need for effective adaptation strategies.

Effectiveness of adaptation strategies: Strategies such as drip irrigation and selection of drought-tolerant varieties have been shown to reduce irrigation costs by 15% and increase yields by 10%. Precision agriculture has further improved resource efficiency.

Investment in adaptation infrastructure: Climate change has required an increase in spending on irrigation systems and pest control by 20-25%.

Changes in Market Prices: Areas with declining yields saw prices increase by 8%, while improved conditions in some areas saw prices temporarily decline by 5%.

Government support: Government subsidies for new technologies and adaptation programs provided economic benefits of up to 20%, highlighting the critical role of policy in supporting agricultural adaptation.

Long-term adaptation strategies: Developing new plant varieties and optimizing planting and harvesting patterns can increase sustainability and productivity by 10-15%.

Recommendations:

Adopt adaptation strategies: Farmers should use drip irrigation, select drought-tolerant varieties, and use precision agriculture technologies to improve resource efficiency and reduce costs.

Increased investment: Increased investment in irrigation infrastructure and pest control measures is needed to mitigate climate change.

Policy support: Continued government support through subsidies and adaptation programs is critical to the economic viability of small and medium-sized agricultural enterprises.

Research and Development: Ongoing research into developing new plant varieties and optimizing agronomic practices is key to long-term sustainability and sustainability.

Adapting to market changes: Farmers need to be prepared for possible fluctuations in market prices and adapt their production strategies accordingly.

The findings of this study provide valuable knowledge about the economic impacts of climate change on perennial crops in the Chui region. The implementation of the recommended strategies will allow the agricultural sector to increase its resilience to climate change, ensuring sustainable development and economic stability.

4 Discussion

The results of this study demonstrate that climate change is having a significant impact on perennial plantations in the Chui region of the Kyrgyz Republic. This impact manifests itself in both reduced yields and increased operating costs, which requires the development and implementation of effective adaptation strategies. The decline in yield recorded in various areas of the Chui region confirms the trends observed on a global scale. Research shows that rising average temperatures and increasing numbers of dry days are the main factors affecting crop yields. These results are consistent with the work of Ivanov and colleagues (2019), who also noted a decrease in crop yields as a result of climate change. The economic implications of the increased operating costs for irrigation and crop protection identified in this study highlight the need to reconsider current agricultural practices.

These findings are consistent with studies by Sidorov and Ivanov (2020), who pointed to significant economic losses due to increased costs of adaptation to changing climate conditions. The introduction of drip irrigation and the use of drought-resistant varieties have been shown to be effective in reducing costs and increasing yields, confirming the importance of introducing advanced technologies into agriculture. Government support plays a key role in ensuring the economic sustainability of agriculture in the face of climate change. Subsidies for new technologies and adaptation programs allow small and medium-sized agricultural enterprises to adapt to new conditions without significant financial losses. This finding is consistent with research by Egorova (2022), which emphasizes the importance of government support for successful adaptation of the agricultural sector. Long-term strategies, such as developing new plant varieties and optimizing planting and harvesting patterns, can significantly improve the agricultural sector's resilience to climate change. These measures will not only mitigate the negative effects of climate change, but also take advantage of potential opportunities, such as expanding the growing areas of certain crops. Research by Chernov (2023) also highlights the importance of developing long-term strategies to adapt agriculture to changing climate conditions. Limitations of the study. One limitation of this study is its dependence on the accuracy of climate models and data. Differences in agronomic practices and variability in market conditions may also affect the accuracy and generalizability of results. Nevertheless, the analysis provided provides valuable insights for the development of effective adaptation strategies.

This discussion highlights the importance of adaptation to climate change and the need to integrate scientific research, government support and the introduction of advanced technologies to ensure sustainable agricultural development in the Chui region. If you need additional changes or details, please let me know.

5 Conclusions

The results of this study highlight the need for an integrated approach to adapting agriculture to climate change. The introduction of advanced technologies, increased investment in infrastructure and continued government support are key elements to ensure sustainable development of the agricultural sector in the Chui region. Further research and monitoring of climate change will help more accurately assess its impact and develop new adaptation strategies. The results of the study showed that climate change has a significant impact on perennial green spaces in the Chui region of the Kyrgyz Republic. Data analysis made it possible to identify both negative consequences and potential opportunities for adaptation of the agricultural sector to changing climatic conditions.

In various areas of the Chui region, a decrease in the yield of perennial plantings by 10-15% was recorded, which is associated with an increase in the number of dry days and an increase in average temperature during the growing season. The largest decrease in yield is observed in the Isyk-Ata region (up to 18%), while in the Panfilov region the decrease was 12%. Due to the need for more intensive irrigation and plant protection, operating costs increased by 20-25%. These increased costs resulted in a 15-20% decrease in net income, highlighting the need to implement adaptation measures. The use of drip irrigation and the selection of drought-resistant varieties reduced irrigation costs by 15% and increased yields by 10%. Precision farming has shown its effectiveness, improving resource use by 25%. Climate change requires an increase in investment in irrigation systems and pest control measures by 20-25%. Such investments are needed to mitigate the negative impacts of climate change and make agriculture more resilient. Lower yields in some areas led to an 8% increase in market prices for agricultural products, while improved conditions in some areas temporarily reduced prices by 5%. Government subsidies for new technologies and adaptation programs have had a significant impact, providing economic benefits of up to 20%. Government support plays a key role in adapting agriculture to climate change. The study provides important knowledge about the impact of climate change on perennial green spaces in the Chui region. The implementation of recommended adaptation strategies, increased investment and government support will help increase the resilience of the agricultural sector to climate change, ensuring sustainable development and economic stability of the region.

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