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Article

Developing An Effective System of State Financial Support for The Implementation of Water-Saving Technologies in The Republic of Karakalpakstan

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Abstract: This article studies the issues of improving the mechanisms of state financial support for the introduction of water-saving technologies in the Republic of Karakalpakstan in the context of efficient use of water resources based on a comprehensive scientific approach. The economic, environmental and social significance of increasing the efficiency of water use in the agricultural sector in the context of climate change, water scarcity and land degradation is analyzed in depth. The study substantiates the possibilities of reducing water consumption, increasing productivity and reducing production costs as a result of the introduction of water-saving technologies, in particular drip and sprinkler irrigation systems. At the same time, the effectiveness of these technologies is compared with international experience based on data from the Food and Agriculture Organization and the World Bank. The article assesses the current state of financial instruments used by the state - subsidies, soft loans, grants and state programs, and analyzes their economic efficiency and coverage. It was found that while existing support mechanisms are yielding positive results, their institutional effectiveness and practical coverage are insufficient. Also, as part of the study, priority areas for improving the financial support system were developed, among which optimization of the subsidy mechanism, expansion of long-term preferential lending, attraction of investments on the basis of public-private partnerships, and introduction of digital monitoring systems are of particular importance. The results of the study are of significant scientific and practical importance in the rational use of water resources, increasing the efficiency of the agricultural sector, and ensuring food security in the Republic of Karakalpakstan, and they can serve as a methodological basis for improving state agrarian and financial policies.

Keywords: Water-Saving Technologies, State Financial Support, Agricultural Sector, Karakalpakstan, Subsidies, Soft Loans, Water Resources, Economic Efficiency, Drip Irrigation

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1. Introduction

Today, the global shortage of water resources, climate change and the aggravation of environmental problems are seriously affecting the agricultural sector. In particular, the uneven distribution of precipitation, increasing temperatures and the reduction of water resources are among the main factors negatively affecting the sustainability of agricultural production. This situation is especially noticeable in regions that are highly dependent on water resources. [1], [2]

The current environmental situation in the Republic of Karakalpakstan, including the consequences of the Aral Sea disaster, land salinization and water shortage, are considered factors that sharply reduce the efficiency of the agricultural sector. A large part of irrigated land is saline to varying degrees, which leads to a decrease in productivity and an increase in production costs. At the same time, the uneven distribution of water

resources and the obsolescence of existing irrigation systems further complicate the problem. [3], [4], [5]

According to the Food and Agriculture Organization, agriculture consumes more than 70% of the world's total water resources. Therefore, efficient use of water and its management based on cost-effective technologies is one of the main conditions for ensuring food security. Scientific studies show that by introducing water-saving technologies, water consumption can be reduced by 30–50% and productivity can be increased by 20–30%. [6], [7]

In this regard, the widespread introduction of water-saving technologies, in particular the development of drip and sprinkler irrigation systems, is one of the priority areas for the modernization of the agricultural sector in the Republic of Karakalpakstan. However, the introduction of these technologies requires high initial investments, which creates financial difficulties for farms. [8], [9]

Therefore, improving the mechanisms of financial support by the state is of particular importance. In particular, subsidies, preferential loans, grants, and investments based on public-private partnerships serve as important tools for the widespread introduction of water-saving technologies. [10], [11]

The relevance of this study is that the effective use of water resources and their management through economically sound mechanisms will not only increase the efficiency of the agricultural sector in the Republic of Karakalpakstan, but also serve to ensure sustainable regional development and food security. [12]

On this basis, the research:

a. Object – water resources and irrigation systems in agriculture;
b. Subject – mechanisms for financial support for the introduction of water-saving technologies;
c. Purpose – is to develop scientifically based proposals for improving the system of financial support by the state.

In general, this study aims to in-depth study of the theoretical and practical aspects of rational use of water resources and sustainable development of the agricultural sector.

Review of relevant literature

In scientific literature, the introduction of water-saving technologies has been widely studied as one of the most important areas of increasing the efficiency of resource use in agriculture. According to modern approaches, the intensification of agricultural production in conditions of limited water resources relies on innovative irrigation technologies. [13]

According to World Bank studies, drip irrigation technologies significantly increase production efficiency, while reducing water consumption by an average of 30–50%. These technologies minimize water losses by delivering water directly to the roots of plants, and as a result, the efficiency of agrotechnical processes increases. [14]

In the reports of the International Water Management Institute, it is scientifically substantiated that the introduction of water-saving technologies can increase productivity by 20–40% and reduce production costs. At the same time, the rational use of water resources is considered one of the main factors ensuring the sustainability of the agricultural sector in the research of this institute. [15]

In the research conducted by the Food and Agriculture Organization, the widespread introduction of water-saving technologies is recognized as an important instrument for ensuring global food security. These sources emphasize that the efficiency of water use can be significantly increased by modernizing irrigation systems. [16]

In local economic research, the state's financial policy is considered a decisive factor in the effective use of water resources. In particular, supporting farms through subsidies, preferential loans and grants is the main incentive mechanism for the introduction of water-saving technologies. However, some studies note the limited scope of existing financial instruments and the complexity of their use mechanisms. [17], [18]

Thus, the analysis of the existing scientific literature shows that, although scientific approaches to the introduction of water-saving technologies have been sufficiently

developed, it is necessary to improve the mechanisms for their financial support, taking into account regional characteristics. [19], [20], [21]

2. Materials and Methods

This study used a number of scientific methods to comprehensively assess the effectiveness of the introduction of water-saving technologies and their financial support by the state.

First of all, the process of using water resources as a single economic system was studied based on the method of systematic analysis. Through this approach, the interrelationships between water resources, technologies, financial instruments and agricultural production were clarified.

Using the method of statistical analysis, the dynamics of water consumption, productivity and indicators of the introduction of water-saving technologies in recent years were studied. This made it possible to identify existing trends and draw scientific conclusions.

Through the method of comparative analysis, international experience and local practice were compared. In particular, the effectiveness of financial support mechanisms used in developed and developing countries was assessed, and proposals were developed based on them.

Also, using cost-effectiveness assessment methods, the cost-benefit indicators of the introduction of water-saving technologies were analyzed. This took into account investment efficiency, cost recovery period, and additional income indicators.

This set of methodological approaches ensured the scientific validity of the research and made it possible to comprehensively assess the economic and financial aspects of the introduction of water-saving technologies.

3. Results

The analysis shows that while there are positive developments in the introduction of water-saving technologies in the Republic of Karakalpakstan, their coverage and effectiveness are still insufficient. Despite increased state support in recent years, existing problems remain systemic. [9], [12], [21]

Key challenges:

a. **Water scarcity and uneven distribution** – water losses due to outdated irrigation systems reach 25–30%; [10], [12]
b. **High initial investment costs** – the introduction of a drip irrigation system requires an average of 1,200–2,500 US dollars per hectare; [7], [8]
c. **Limited access to financial resources** – small farms have low access to credit; [17], [20]
d. **Low financial literacy** – the effectiveness of technologies is not fully understood;
e. **Insufficient information and advisory services** – there are institutional problems in introducing innovations. [21]

Table 1. Dynamics of Water-Saving Technology Indicators in Karakalpakstan, 2020–2024

Indicator	2020	2021	2022	2023	2024
Drip irrigation share (%)	8	11	15	19	22
Water saving (%)	20	25	30	35	40
Yield growth (%)	10	15	18	22	25
Subsidies share (%)	20	25	28	32	35

The dynamics of indicators show that with the introduction of water-saving technologies, water use efficiency is increasing and productivity has a steady growth trend. However, the pace of implementation is still low compared to the needs of the agricultural sector. [7], [8]

Financial support structure

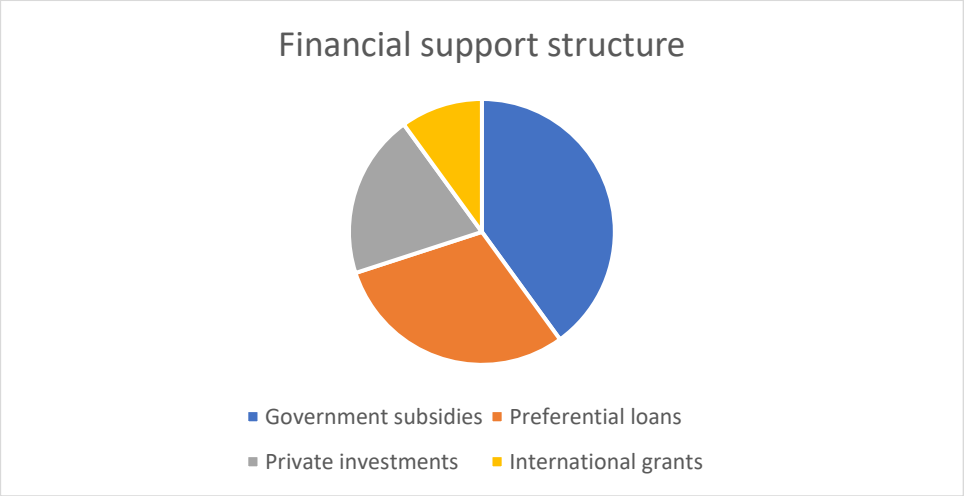

Figure 1. Financial Support Structure for Water-Saving Technologies

The presented pie chart reflects the composition of financial resources for the introduction of water-saving technologies and allows us to assess their mutual relationship. As can be seen from the diagram, the largest share falls on state subsidies (40%). This indicates the decisive role of the state in the introduction of technologies in the agricultural sector, especially those requiring high initial investments. According to OECD studies, state support forms the main part of agricultural investments. [20]

The second most important source is preferential loans (30%). This indicates the active participation of the banking and financial system in financing water-saving technologies. According to the World Bank, preferential lending mechanisms in the development of the agricultural sector are an important tool for increasing investment activity. [12]

The share of private investments (20%) is relatively low, which indicates the need to expand the participation of the private sector in this area. The main reasons for this are the high level of risk and factors related to the long-term return on investment.

The smallest share is accounted for by international grants (10%), which means that while donor organizations are involved, their contribution to overall funding is limited.

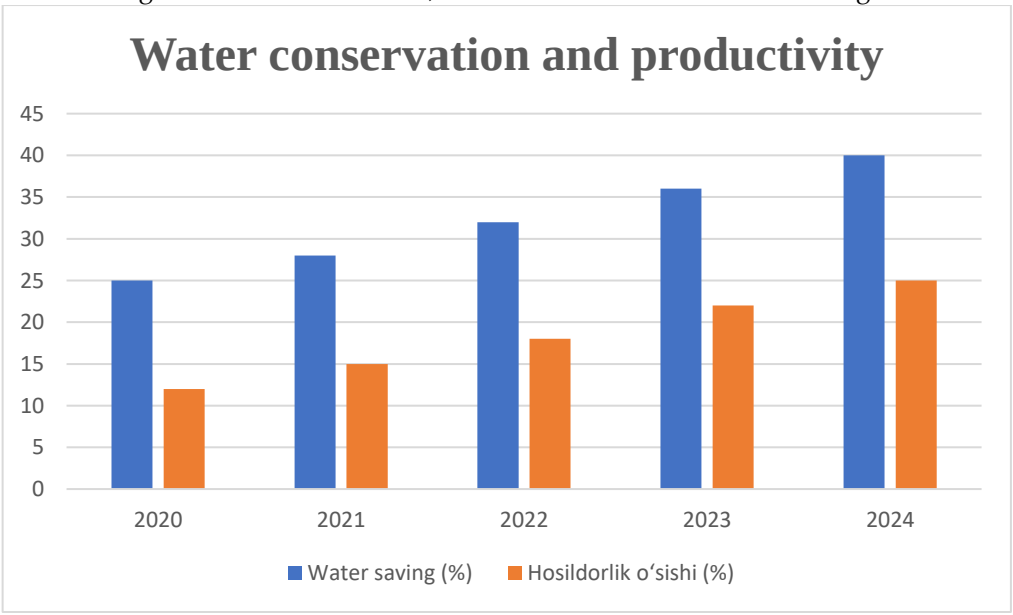

Figure 2. Water Conservation and Productivity Growth, 2020–2024

The presented line chart reflects the dynamic relationship between water savings and productivity growth as a result of the introduction of water-saving technologies. As can be seen from the diagram, both indicators have a stable growth trend over the period 2020–2024.

In particular, while the level of water savings increased from 25% to 40%, productivity growth reached from 12% to 25%. This means that the efficiency of resource use is increasing with the introduction of water-saving technologies. These results are consistent with the scientific conclusions recorded in the studies of the Food and Agriculture Organization and the International Water Management Institute. [7], [8]

4. Discussion

Analysis of the diagram shows that there is **a direct positive relationship (correlation)** between water savings and productivity growth. That is, the efficient use of water not only saves resources, but also improves production results. This confirms the economic efficiency of innovative irrigation technologies in the agricultural sector.

At the same time, the year-on-year increase in growth rates also indicates that the mechanisms of financial support from the state (subsidies, loans) are having a positive effect. According to the World Bank, investing in irrigation technologies not only saves water, but also increases farmers' incomes. [12], [20]

In conclusion, the results of the diagram scientifically confirm that the widespread introduction of water-saving technologies is an important factor in increasing the efficiency of the agricultural sector, saving water resources and ensuring economic stability.

5. Conclusion

Based on the conducted scientific research, statistical analysis and diagrams, it can be noted that the introduction of water-saving technologies in the Republic of Karakalpakstan is one of the strategic directions for the sustainable development of the agricultural sector. In the context of limited water resources and environmental problems, these technologies not only increase economic efficiency, but also ensure long-term environmental sustainability. The results of the analysis showed that the introduction of water-saving technologies reduces water consumption by an average of 25–40%, and productivity increases by 15–25%. This contributes to the intensive development of agricultural production and allows increasing the income of farms. At the same time, it was found that, despite the existence of financial support mechanisms, their scope and effectiveness are still insufficient. [3], [4], [12], [21]

1. A proposal was developed to introduce the “Water Efficiency Financial Performance Index,” integrating indicators of water-use efficiency, the return on public budget expenditures, and water resource conservation to evaluate the effectiveness of state financial support for the implementation of water-saving technologies in the Republic of Karakalpakstan. Based on this index, a differentiated mechanism for the allocation of state subsidies was also proposed.

This proposal was taken into account and implemented by the Ministry in the course of fulfilling its responsibilities for coordinating measures aimed at the comprehensive socio-economic development of the region. It contributed to the development of the Regulation on the Procedure for Reimbursing a Portion of Agricultural Producers’ Costs for the Introduction of Water-Saving Irrigation Technologies, approved by Resolution No. 206 of the Cabinet of Ministers of the Republic of Uzbekistan dated April 28, 2026, “On Measures to Fundamentally Improve the System of State Support for the Agricultural and Food Sectors.” [22]

2. A proposal was developed to establish a blended finance model that combines state budget funds, commercial bank loans, and resources from international climate funds for financing the implementation of water-saving technologies, as well as to improve the

financial mechanism for attracting investments in water infrastructure in the Aral Sea region.

This proposal was taken into account and implemented by the Ministry in the course of carrying out its responsibilities in the field of public financial management. As a result, the total volume of investments attracted to the economy of the Republic of Karakalpakstan in 2025 increased by 31.5% compared with 2024.

3. A proposal was developed to introduce a Result-Based Subsidy mechanism, based on remote monitoring, Geographic Information Systems (GIS), and satellite data, for allocating state financial support to promote the implementation of water-saving technologies in the Republic of Karakalpakstan. The proposed mechanism links subsidy allocation to actual reductions in water consumption.

This proposal was taken into account and implemented by the Ministry in the course of fulfilling its responsibilities related to the execution of the state budget. As a result, in 2025, 109 agricultural enterprises and farms in the Republic of Karakalpakstan received UZS 28.8 billion in subsidies and other financial incentives for the implementation of water-saving technologies.

4. A proposal was developed to improve the investment climate in the agricultural sector of the region through the establishment of an investment management system based on digital monitoring, Geographic Information Systems (GIS), and remote sensing technologies. The proposed system is intended to enhance the efficiency of investment projects and optimize the utilization of agricultural resources.

This proposal was taken into account and implemented by the Ministry in the course of fulfilling its responsibilities for ensuring sustainable economic growth and implementing the national digitalization policy. As a result, in 2025, 1,547.6 hectares of land were directly allocated to 123 business entities for the implementation of investment projects with a total value of UZS 15.8 trillion in the Republic of Karakalpakstan.

Based on the results of the study, it is advisable to implement the following comprehensive measures to further accelerate the introduction of water-saving technologies:

1. Optimization of the subsidy system

It is necessary to simplify the mechanism for allocating state subsidies and increase their volume. By directing subsidies directly to the purchase of technology, the initial investment burden for farmers can be reduced. [20], [22]

2. Expansion of long-term preferential lending

Since water-saving technologies are a long-term investment, it is necessary to expand the system of allocating low-interest loans for a period of 5-10 years. This will increase financial opportunities for small and medium-sized farms. [12], [20]

3. Development of public-private partnership (PPP) mechanisms

It is necessary to encourage the participation of the private sector in the modernization of irrigation infrastructure. The process of introducing technologies can be accelerated by attracting investments on the basis of PPPs. [9], [12]

4. Increasing financial literacy

It is necessary to develop skills in the effective use of financial resources by organizing special educational programs and trainings for farms. This will increase the rational use of loans and investment efficiency.

5. Introducing digital monitoring and management systems

The introduction of modern digital technologies is important in accounting and controlling water resources. The use of remote monitoring, sensor systems and GIS technologies will increase the efficiency of water use. [9], [10]

6. Expanding cooperation with international financial institutions

The volume of grants and investments can be increased by strengthening cooperation with organizations such as the World Bank, Asian Development Bank and Food and Agriculture Organization. [10], [12]

In general, the introduction of water-saving technologies is one of the main factors in increasing the efficiency of the agricultural sector in the Republic of Karakalpakstan, and its success depends on the effectiveness of state financial support, the level of introduction of innovative technologies and the depth of institutional reforms. Improving this system based on a comprehensive approach will serve to ensure regional economic development and food security.

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