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IMPROVING STATE FINANCIAL SUPPORT FOR THE IMPLEMENTATION OF WATER-SAVING TECHNOLOGIES IN THE REPUBLIC OF KARAKALPAKSTAN

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Abstract. This article examines issues related to improving state financial support mechanisms for the implementation of water-saving technologies in the Republic of Karakalpakstan under conditions of efficient water resource use, based on a comprehensive scientific approach. The economic, environmental, and social significance of increasing water-use efficiency in the agricultural sector under conditions of climate change, water scarcity, and land degradation is analyzed in depth.

The study substantiates the potential to reduce water consumption, increase yields, and lower production costs through the implementation of water-saving technologies, particularly drip and sprinkler irrigation systems. At the same time, based on data from the Food and Agriculture Organization and the World Bank, a comparative analysis of the effectiveness of these technologies using international experience is conducted.

The article evaluates the current state of financial instruments used by the state—subsidies, concessional loans, grants, and state programs—and analyzes their economic efficiency and coverage levels. It is found that although existing support mechanisms yield positive results, their institutional effectiveness and practical coverage remain insufficient.

Furthermore, the study identifies priority areas for improving the financial support system, including optimization of the subsidy mechanism, expansion of long-term concessional lending, attraction of investments based on public-private partnerships, and introduction of digital monitoring systems.

The research results have significant scientific and practical importance for the rational use of water resources, increasing the efficiency of the agricultural sector, and ensuring food security in the Republic of Karakalpakstan. They may serve as a methodological basis for improving state agrarian and financial policy.

Keywords: water-saving technologies, state financial support, agricultural sector, Karakalpakstan, subsidies, concessional loans, water resources, economic efficiency, drip irrigation

Annotatsiya. Ushbu maqolada Qoraqalpog‘iston Respublikasida suv resurslaridan samarali foydalanish sharoitida suvni tejovchi texnologiyalarni joriy etishni davlat tomonidan moliyaviy qo‘llab-quvvatlash mexanizmlarini takomillashtirish masalalari kompleks ilmiy yondashuv asosida tadqiq etilgan. Iqlim o‘zgarishi, suv tanqisligi va yer degradatsiyasi sharoitida qishloq xo‘jaligida suvdan foydalanish samaradorligini oshirishning iqtisodiy, ekologik va ijtimoiy ahamiyati chuqur tahlil qilingan.

Tadqiqotda tomchilatib va yomg‘irlatib sug‘orish tizimlarini joriy etish orqali suv sarfini kamaytirish, hosildorlikni oshirish hamda ishlab chiqarish xarajatlarini qisqartirish imkoniyatlari asoslab berilgan. Shu bilan birga, Birlashgan Millatlar Tashkilotining Oziq-ovqat va qishloq xo‘jaligi tashkiloti va Jahon banki ma’lumotlari asosida ushbu texnologiyalarning samaradorligi xalqaro tajriba bilan qiyosiy tahlil qilingan.

Maqolada davlat tomonidan qo‘llanilayotgan moliyaviy vositalar—subsidiyalar, imtiyozli kreditlar, grantlar va davlat dasturlarining amaldagi holati baholangan hamda ularning iqtisodiy samaradorligi va qamrov darajasi tahlil qilingan. Natijada, mavjud qo‘llab-quvvatlash mexanizmlari ijobiy natijalar berayotgan bo‘lsa-da, ularning institutsional samaradorligi va amaliy qamrovi yetarli emasligi aniqlangan.

Shuningdek, tadqiqot doirasida moliyaviy qo‘llab-quvvatlash tizimini takomillashtirishning ustuvor yo‘nalishlari ishlab chiqilgan bo‘lib, ular qatoriga subsidiya mexanizmini optimallashtirish, uzoq muddatli imtiyozli kreditlashni kengaytirish, davlat-xususiy sheriklik asosida investitsiyalarni jalb etish hamda raqamli monitoring tizimlarini joriy etish kiradi.

Tadqiqot natijalari suv resurslaridan oqilona foydalanish, qishloq xo‘jaligi samaradorligini oshirish va oziq-ovqat xavfsizligini ta’minlashda muhim ilmiy-amaliy ahamiyatga ega bo‘lib, davlat agrar va moliyaviy siyosatini takomillashtirish uchun metodologik asos bo‘lib xizmat qilishi mumkin.

Kalit so‘zlar: suvni tejovchi texnologiyalar, davlat moliyaviy qo‘llab-quvvatlashi, qishloq xo‘jaligi, Qoraqalpog‘iston, subsidiyalar, imtiyozli kreditlar, suv resurslari, iqtisodiy samaradorlik, tomchilatib sug‘orish

Аннотация. В данной статье на основе комплексного научного подхода рассматриваются вопросы совершенствования механизмов государственной финансовой поддержки внедрения водосберегающих технологий в Республика Каракалпакстан в условиях эффективного использования водных ресурсов. Проведен углубленный анализ экономической, экологической и социальной значимости повышения эффективности водопользования в сельском хозяйстве в условиях изменения климата, дефицита воды и деградации земель.

В исследовании обоснованы возможности сокращения водопотребления, повышения урожайности и снижения производственных затрат за счет внедрения водосберегающих технологий, в частности систем капельного и дождевального орошения. На основе данных Продовольственная и сельскохозяйственная организация ООН и Всемирный банк проведен сравнительный анализ эффективности данных технологий с учетом международного опыта.

В статье дана оценка современного состояния финансовых инструментов, используемых государством—субсидий, льготных кредитов, грантов и государственных программ, а также проанализированы их экономическая эффективность и уровень охвата. Установлено, что, несмотря на положительные результаты, институциональная эффективность и практический охват данных механизмов остаются недостаточными.

Кроме того, в рамках исследования определены приоритетные направления совершенствования системы финансовой поддержки, включая оптимизацию механизма субсидирования, расширение долгосрочного льготного кредитования, привлечение инвестиций на основе государственно-частного партнерства и внедрение цифровых систем мониторинга.

Результаты исследования имеют важное научное и практическое значение для рационального использования водных ресурсов, повышения эффективности сельского хозяйства и обеспечения продовольственной безопасности в Республике Каракалпакстан и могут служить методологической основой для совершенствования государственной аграрной и финансовой политики.

Ключевые слова: водосберегающие технологии, государственная финансовая поддержка, сельское хозяйство, Каракалпакстан, субсидии, льготные кредиты, водные ресурсы, экономическая эффективность, капельное орошение

INTRODUCTION

Today, the global scarcity of water resources, climate change, and the intensification of environmental problems are exerting a significant impact on the agricultural sector. In particular, the uneven distribution of precipitation, rising temperatures, and the depletion of water resources are among the key factors negatively affecting the stability of agricultural production. This situation is especially evident in regions that are highly dependent on water resources.

The current environmental situation in the Republic of Karakalpakstan, including the consequences of the Aral Sea tragedy, land salinization, and water scarcity, is considered a factor that significantly reduces the efficiency of the agricultural sector. Most irrigated lands are saline to varying degrees, leading to decreased productivity and increased production costs. At the same time, the problem is further aggravated by the uneven distribution of water resources and the obsolescence of existing irrigation systems.

According to the Food and Agriculture Organization, more than 70% of global water resources are consumed in agriculture. Therefore, the efficient use and management of water based on resource-saving technologies is one of the key conditions for ensuring food security. Scientific studies indicate that the implementation of water-saving technologies can reduce water consumption by 30–50% while increasing productivity by 20–30%.

In this context, the widespread adoption of water-saving technologies, particularly the development of drip and sprinkler irrigation systems, represents one of the priority directions for modernizing the agricultural sector in the Republic of Karakalpakstan. However, the implementation of these technologies poses significant financial challenges for farms, as they require substantial initial investment.

Therefore, improving the mechanisms of state financial support is of particular importance. In particular, subsidies, preferential loans, grants, and investments based on public–private partnerships serve as essential instruments for promoting the large-scale adoption of water-saving technologies.

The relevance of this study lies in the fact that the effective use of water resources and their management through economically justified mechanisms not only enhances the efficiency of the agricultural sector in the Republic of Karakalpakstan but also contributes to ensuring regional sustainable development and food security.

On this basis, the research is structured as follows:

Object — water resources and irrigation systems in agriculture;

Subject — financial support mechanisms for the implementation of water-saving technologies;

Objective — to develop scientifically grounded proposals for improving the system of state financial support.

Overall, this study aims to provide an in-depth analysis of the theoretical and practical aspects of the rational use of water resources and the sustainable development of the agricultural sector.

LITERATURE REVIEW

The introduction of water-saving technologies has been widely examined in scientific literature as one of the most important directions for improving resource-use efficiency in agriculture. According to contemporary approaches, the intensification of agricultural production under conditions of limited water resources is closely associated with the adoption of innovative irrigation technologies.

According to research conducted by the World Bank, drip irrigation technologies significantly enhance production efficiency while reducing water consumption by an average of 30–50%. These technologies minimize water losses by delivering water directly to plant roots, thereby improving the efficiency of agrotechnical processes.

Reports by the International Water Management Institute provide scientific evidence that the implementation of water-saving technologies can increase crop yields by 20–40% while reducing production costs. At the same time, these studies identify the rational use of water resources as one of the key factors ensuring the sustainability of the agricultural sector.

Studies conducted by the Food and Agriculture Organization recognize the widespread adoption of water-saving technologies as a critical instrument for ensuring global food security. These sources emphasize that water-use efficiency can be substantially improved through the modernization of irrigation systems.

In domestic economic research, state financial policy is considered a decisive factor in ensuring the efficient use of water resources. In particular, support for farms through subsidies, preferential loans, and grants serves as a primary incentive mechanism for the implementation of water-saving technologies. However, some studies highlight the limited scope of existing financial instruments and the complexity of their implementation mechanisms.

Thus, an analysis of the existing scientific literature indicates that, although theoretical and practical approaches to the implementation of water-saving technologies are well developed, there remains a need to improve financial support mechanisms, taking into account regional characteristics.

RESEARCH METHODOLOGY

In this study, a set of scientific methods was employed to comprehensively evaluate the effectiveness of implementing water-saving technologies and the mechanisms of their state financial support.

First, the process of water resource utilization was examined as an integrated economic system using the method of system analysis. This approach made it possible to identify and clarify the interrelationships between water resources, technological solutions, financial instruments, and agricultural production.

Using statistical analysis methods, the dynamics of water consumption, crop yields, and the adoption of water-saving technologies in recent years were investigated. This enabled the identification of key trends and the formulation of evidence-based conclusions.

Furthermore, international experience and local practices were compared using the comparative analysis method. In particular, the effectiveness of financial support mechanisms applied in both developed and developing countries was assessed, and relevant proposals were formulated on this basis.

In addition, cost–benefit analysis and economic efficiency assessment methods were applied to evaluate the implementation of water-saving technologies. Key indicators such as investment efficiency, payback period, and additional income were taken into consideration.

The application of this комплекс methodological framework ensures the scientific validity of the research and enables a comprehensive evaluation of the economic and financial aspects of implementing water-saving technologies.

ANALYSIS AND RESULTS

The conducted analysis indicates that, although positive shifts in the implementation of water-saving technologies are observed in the Republic of Karakalpakstan, their scope and overall effectiveness remain insufficient. Despite the expansion of state support in recent years, existing challenges continue to exhibit a systemic nature.

Key Issues

Water scarcity and uneven distribution — water losses reach approximately 25–30% due to the obsolescence of irrigation systems;

High initial investment costs — the implementation of drip irrigation systems requires, on average, 1,200–2,500 US dollars per hectare;

Limited access to financial resources — small farms face constrained opportunities to obtain credit;

Low financial literacy — the economic benefits and efficiency of technologies are not fully understood by users;

Insufficient information and consulting services — institutional barriers hinder the effective implementation of innovations.

Statistical Analysis

Table 1

Dynamics of the Implementation of Water-Saving Technologies and Key Efficiency Indicators in the Republic of Karakalpakstan (2020–2024)

Indicator	2020	2021	2022	2023	2024
Share of drip irrigation (%)	8	11	15	19	22
Water savings (%)	20	25	30	35	40
Yield growth (%)	10	15	18	22	25
Share of subsidies (%)	20	25	28	32	35

The dynamics of these indicators demonstrate that the adoption of water-saving technologies significantly enhances water-use efficiency and supports a stable upward trend in agricultural productivity. This reflects the growing effectiveness of resource utilization in the agricultural sector. Furthermore, accelerating the pace of implementation would further expand these positive outcomes and better align them with the evolving needs of the sector (Figure 1).

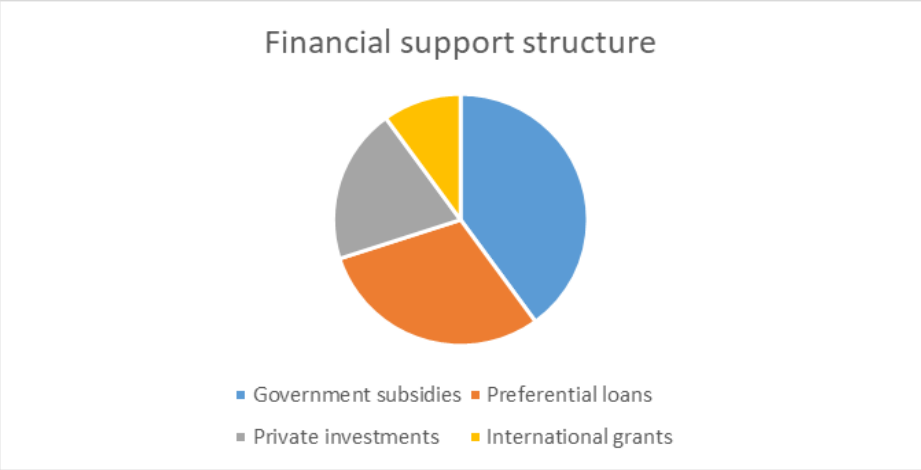

Figure 1. Structure of Financial Support for the Implementation of Water-Saving Technologies

The presented pie chart illustrates the composition of financial resources allocated for the implementation of water-saving technologies and enables an assessment of their relative proportions. As shown in the diagram, the largest share is attributed to state subsidies (40%). This indicates that the state plays a decisive role in the adoption of such technologies in the agricultural sector, particularly those requiring substantial initial investment. According to research by the Organisation for Economic Co-operation and Development, state support constitutes the major component of agricultural investment.

Preferential loans (30%) represent the second most significant source of financing. This reflects the active involvement of the banking and financial system in supporting water-saving technologies. According to data from the World Bank, preferential lending mechanisms are a key instrument for stimulating investment activity in the agricultural sector.

The share of private investment (20%) remains relatively low, indicating the need to expand private sector participation in this field. The primary reasons for this include high levels of risk and the long-term return on

investment associated with such projects.

The smallest share is accounted for by international grants (10%). This suggests that, although donor organizations are involved, their overall contribution to total financing remains limited (Figure 2).

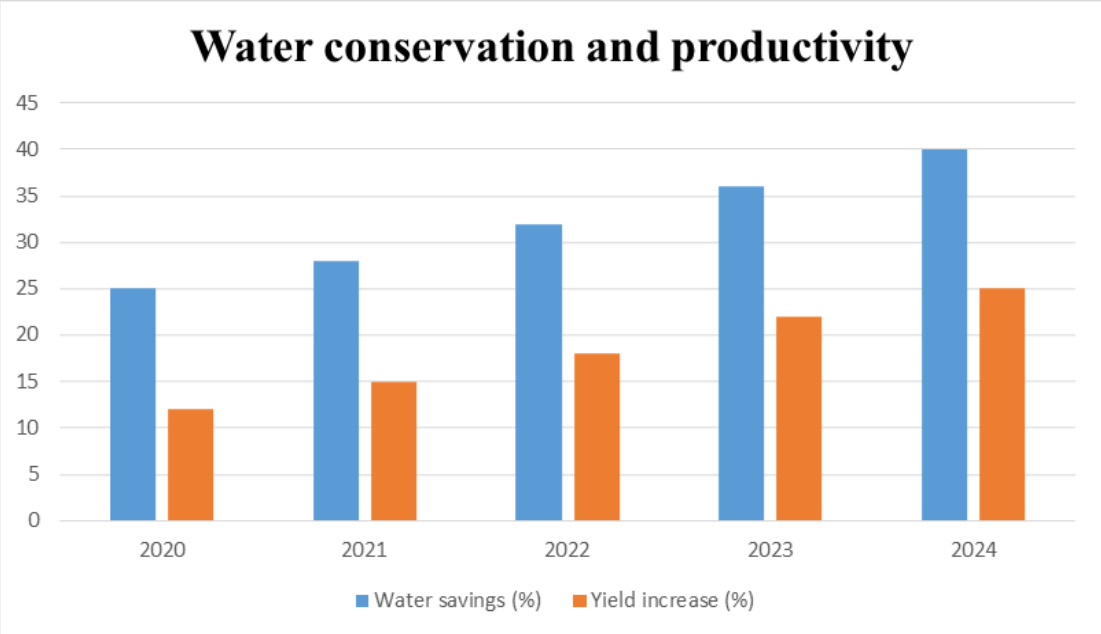

Figure 2. Dynamics of Water Conservation and Crop Productivity (2020–2024)

The presented line chart illustrates the dynamic relationship between water savings and crop yield growth resulting from the implementation of water-saving technologies. As shown in the diagram, both indicators exhibit a steady upward trend over the 2020–2024 period.

In particular, the level of water savings increased from 25% to 40%, while crop yield growth rose from 12% to 25%. This indicates that the adoption of water-saving technologies significantly enhances the efficiency of resource utilization. These findings are consistent with the scientific conclusions reported by the Food and Agriculture Organization and the International Water Management Institute.

The analysis of the diagram reveals a direct positive correlation between water savings and crop yield growth. In other words, efficient water use not only conserves resources but also improves agricultural productivity. This confirms the economic efficiency of innovative irrigation technologies in the agricultural sector.

At the same time, the consistent increase in growth rates over the years indicates that state financial support mechanisms—such as subsidies and preferential loans—have a positive impact. According to the World Bank, investment in irrigation technologies contributes not only to water conservation but also to increased farmer incomes.

In conclusion, the results presented in the diagram provide strong scientific evidence that the widespread adoption of water-saving technologies is a key factor in enhancing agricultural efficiency, conserving water resources, and ensuring economic stability.

CONCLUSIONS AND RECOMMENDATIONS

Based on the conducted scientific research, statistical analyses, and graphical evidence, it can be concluded that the introduction of water-saving technologies in the Republic of Karakalpakstan represents one of the key strategic directions for the sustainable development of the agricultural sector. Under conditions of limited water resources and increasing environmental challenges, these technologies not only enhance economic efficiency but also contribute to long-term environmental sustainability. The analysis demonstrates that the implementation of water-saving technologies can reduce water consumption by an average of 25–40% while increasing crop yields by 15–25%. This contributes to the intensification of agricultural production and creates opportunities for increasing farm incomes. At the same time, the study reveals that, despite the existence of financial support mechanisms, their coverage and overall effectiveness remain insufficient. Water-saving technologies significantly improve resource-use efficiency and reduce water losses, while productivity growth is directly associated with water conservation, indicating a positive correlation between these variables. State financial support, including subsidies and preferential loans, serves as the primary incentive for technology

adoption; however, existing financial mechanisms require further institutional and organizational improvement, and private sector participation remains limited, thereby constraining the overall volume of investment. Based on the research findings, it is recommended to implement a set of comprehensive measures aimed at accelerating the adoption of water-saving technologies. In particular, it is necessary to optimize the subsidy system by simplifying allocation mechanisms and increasing funding volumes, as well as directing subsidies specifically toward the acquisition of water-saving technologies in order to reduce the initial investment burden on farmers. Furthermore, the expansion of long-term concessional lending is essential, given that such technologies represent long-term investments; therefore, increasing the availability of low-interest loans with maturities of 5–10 years will enhance financial accessibility for small and medium-sized farms. In addition, the development of public–private partnership mechanisms is crucial for encouraging private sector participation in the modernization of irrigation infrastructure and for accelerating technology adoption through increased investment. It is also important to enhance financial literacy by organizing specialized training programs aimed at improving farmers' ability to use financial resources effectively, which will increase the efficiency of loan utilization and investment management. Moreover, the implementation of digital monitoring and management systems plays a critical role in ensuring effective accounting and control of water resources, as the use of remote sensing, sensor-based systems, and GIS technologies significantly improves water-use efficiency. Finally, expanding cooperation with international financial institutions, such as the World Bank, the Asian Development Bank, and the Food and Agriculture Organization, will contribute to increasing the volume of grants and investment resources. Overall, the introduction of water-saving technologies is a key factor in improving the efficiency of the agricultural sector in the Republic of Karakalpakstan, and the success of this process depends on the effectiveness of state financial support, the level of adoption of innovative technologies, and the depth of institutional reforms. Improving this system through a comprehensive approach will contribute to regional economic development and the strengthening of food security.

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