



THE IMPACT OF WATER SCARCITY ON AGRICULTURE AND THE ECOLOGICAL ENVIRONMENT

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Abstract: *Water scarcity is becoming one of the most important environmental, economic, and social challenges facing many regions of the world. This problem is particularly significant for Uzbekistan because agriculture depends heavily on irrigation, while water resources are limited and unevenly distributed. Water scarcity affects agricultural productivity, soil quality, crop development, farmers' incomes, and food security. At the same time, insufficient water availability contributes to the degradation of natural ecosystems, reduction of water bodies, soil salinization, desertification, and deterioration of biodiversity. Climate change, increasing temperatures, population growth, inefficient irrigation systems, and excessive water consumption further intensify the problem. In recent years, Uzbekistan has implemented measures aimed at improving water-use efficiency, introducing water-saving irrigation technologies, reducing losses in irrigation networks, and strengthening integrated water-resource management. In 2023, measures were adopted to improve water-use efficiency, including stricter allocation of available water resources, reduction of irrigation losses, and wider introduction of water-saving technologies. The purpose of this article is to examine the main effects of water scarcity on agriculture and the ecological environment and to discuss approaches for sustainable water-resource management in Uzbekistan.*

Keywords: *water scarcity, agriculture, irrigation, water resources, ecological environment, soil salinity, climate change, water-saving technologies, sustainable development, Uzbekistan.*



Water is one of the most important natural resources for economic development, human well-being, and the functioning of ecosystems. Agriculture is one of the sectors most dependent on water resources because sufficient water is necessary for crop growth, livestock production, soil fertility, and agricultural productivity. In countries with arid and semi-arid climates, irrigation plays a particularly important role in maintaining agricultural production. Uzbekistan is characterized by a dry climate and significant dependence on irrigated agriculture. Therefore, changes in the availability of water resources can directly affect agricultural production and rural livelihoods. The problem is becoming more complex because of climate change, increasing air temperatures, changes in precipitation patterns, population growth, and increasing demand for water. The Uzbek government has identified efficient and rational water use as an important priority. In particular, the 2023 presidential decision on improving the efficiency of water-resource use established measures for reducing water losses, introducing modern technologies, and improving the management of water resources [1].

Water scarcity has a direct influence on agricultural productivity. When sufficient irrigation water is unavailable, crops experience water stress, which can slow their growth and reduce yields. The most sensitive periods are seed germination, flowering, and fruit formation. Insufficient irrigation during these stages can significantly reduce the quantity and quality of agricultural products. Water scarcity also affects the economic condition of farmers. Lower crop yields can reduce agricultural income and increase production costs because farmers may need to invest in additional irrigation infrastructure, water pumps, or alternative technologies. Small farms can be particularly vulnerable because their financial resources for adapting to water shortages are often limited [2].

Another important consequence is the deterioration of soil conditions. Insufficient and poorly managed irrigation can contribute to the accumulation of salts in the soil, especially in areas with high evaporation and inadequate drainage. Soil salinity reduces agricultural productivity and can gradually make agricultural land



less suitable for cultivation. According to information presented by the Government of Uzbekistan in 2024, around 2 million hectares of agricultural land were affected by salinization to varying degrees, while approximately 3 million hectares of pastures and agricultural land had experienced degradation. These conditions demonstrate the close relationship between water management, agricultural productivity, and land conservation. Water scarcity can also influence crop selection and agricultural specialization. Farmers may be forced to select crops that require less water or reduce the area under cultivation. Therefore, long-term water shortages may lead to changes in agricultural production patterns and affect regional food security [3].

The effects of water scarcity extend beyond agriculture. Natural ecosystems require sufficient water to maintain ecological balance. Rivers, lakes, wetlands, and groundwater systems provide habitats for plants and animals and support important ecological processes. When water availability decreases, the ecological condition of rivers and lakes can deteriorate. Lower water levels may reduce habitats for aquatic organisms and negatively influence biodiversity. Reduced river flows can also affect vegetation along riverbanks and contribute to the degradation of surrounding landscapes. One of the most important environmental consequences in Central Asia is land degradation and desertification. The reduction of water availability, combined with high temperatures and unsustainable land use, can accelerate the degradation of agricultural and pasture lands. In areas affected by salinization and desertification, vegetation cover may decrease and the ecological productivity of the land may decline [4].

The Aral Sea region represents a particularly important example of the environmental consequences associated with water-resource management. Environmental degradation in this region has affected ecosystems, agricultural lands, biodiversity, and the living conditions of local communities. Current adaptation programs in Uzbekistan include measures aimed at improving agroecological landscapes and degraded pastures in the Aral Sea region.



Sustainable water management requires cooperation between agriculture, environmental institutions, local authorities, farmers, and other water users. Water resources should be distributed according to scientifically justified limits and monitored through modern information technologies. The 2023 presidential decision on improving water-resource efficiency identified several important directions, including strict distribution of available water among users, government support for water-saving technologies, reduction of losses in irrigation systems, and introduction of modern information and communication technologies into water management.

Integrated water-resource management is also being developed at the basin level. In 2024, a project for climate-resilient integrated water-resource management was launched in the Zarafshan River basin. The project included a pilot area of 3,000 hectares and cooperation with 100 farmers to improve irrigation, agricultural practices, and water measurement. The experience of recent years demonstrates that water-saving measures can produce substantial results. The reported saving of approximately 2 billion cubic meters of water in 2023 indicates the potential benefits of combining technological modernization with improved water management. Nevertheless, technological development should be accompanied by environmental monitoring so that water-saving measures do not create new ecological problems.

Conclusion

Water scarcity has a complex and long-term impact on agriculture and the ecological environment. In agriculture, insufficient water can reduce crop yields, increase production costs, worsen soil conditions, and threaten food security. In the ecological environment, water scarcity can contribute to the degradation of rivers and lakes, reduction of biodiversity, soil salinization, desertification, and deterioration of natural landscapes. For Uzbekistan, addressing water scarcity requires an integrated approach. Efficient irrigation technologies, improved irrigation infrastructure, digital water monitoring, rational crop planning, soil protection, and climate adaptation should be developed simultaneously. The protection of natural ecosystems must also remain an important component of water-resource policy. Sustainable water



management can help maintain agricultural productivity while reducing pressure on ecosystems. Therefore, the rational use of water resources, introduction of modern technologies, strengthening of scientific research, and cooperation between farmers, government institutions, and environmental organizations are essential for ensuring sustainable agricultural and ecological development in Uzbekistan.

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