

Article

## Rational Use of Water Resources in Agriculture (In the Case of Uzbekistan)

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**Abstract:** Efficient water resource management is critical for continued agricultural development, especially in regions like Uzbekistan where lack of water has been a major challenge. Sticking with Central Asia, Uzbekistan is another country that relies heavily on its agricultural sector and uses more than 90% of its freshwater assets. This research wants to assess the current water management practices in Uzbekistan agriculture, examine their efficiency and identify potential improvements. This is a mixed-methods study, including field surveys, irrigation performance data analysis and case studies from multiple sites in Uzbekistan. The findings suggest that traditional methods of irrigation, especially furrow irrigation, dominate agriculture resulting in considerable amounts of evaporation and infiltration losses within the irrigated farms. Drip and sprinkle systems fall under future irrigation alongside modern irrigation technology to maximize water consumption efficiency by gaining around 40%. Furthermore, water governance reforms and policy changes aimed at freeing up 'water for money'/stimulating demand for water-saving technology are viewed as critical steps to long-term water sustainability. This insight suggests that we can, and must do the right thing by improving agricultural water resource management, so that food demand is met without depleting finite quantities of critical water supplies. These findings should improve understanding of water resource management in arid areas and offer tangible solutions for policy makers and farmers in Uzbekistan. Development of better irrigation methods and effective governance approaches will be critical to sustaining agricultural production coupled with environmental protection.

**Citation:** Ozodbek, T., Vohid, K. I., G'ayrat, T. A., & G'olib, S. S. Rational Use of Water Resources in Agriculture (In the Case of Uzbekistan). International Journal of Business Diplomacy and Economy 2024, 3(5), 142-146.

Received: 4<sup>th</sup> Oct 2024  
Revised: 10<sup>th</sup> Oct 2024  
Accepted: 17<sup>th</sup> Oct 2024  
Published: 24<sup>th</sup> Oct 2024



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**Keywords:** water resources, irrigation, agriculture, Uzbekistan, water management, sustainability

### 1. Introduction

It highlights the need for effective management of water resources within agriculture with specific focus on Uzbekistan where some of the most serious challenges to agricultural production are linked to a scarcity of water. Agricultural water use (A(WU)) in Uzbekistan, over 90% of all water, mainly relies on traditional irrigation methods that cause high losses. Optimisation of water usage is the key component of agricultural sustainability, economic progress and food security in the area. Consequently, this study investigates current water management systems details - reveals inefficiencies and proposes future improvements especially through modern irrigation technology. In the context of Uzbekistan, with its hot and arid climate and significant dependence on the agricultural sector, developing sustainable water management systems to ensure efficient water use in agriculture is a leading issue. The research here then looks at the various issues that stem from poor

water resource management – things like outdated irrigation systems, ineffective water retention strategies. Uzbekistan-Suva management of water resources has been too centralised and costly in the long run while disregarding local agricultural needs. High-level dialogues are opportunistic and target irrigation improvements, water governance, and sustainable agriculture through policy reforms.

The theoretical lens of this study is upon the concept of environmental sustainability and resource management that emphasizes on integrated use of natural resources for ecological balance over time. This research draws upon agricultural economics theory, which establishes the relationship between inputs of resources (particularly water) to outputs in agriculture (crop yield). Since sustainable management of water is one of the most relevant topics influencing agricultural production, these two approaches are also interrelated. Modern irrigation practices are known as practical applications of these ideas, offering a more efficient way to increase output while conserving water resources. There is a substantial knowledge gap regarding the widespread application of modern irrigation approaches in diverse agricultural environments in Uzbekistan. While smaller pilot programs have demonstrated the promise of water savings and improved agricultural productivity, studies that examine the socio-economic and structural barriers to broader adoption are scarce. Furthermore, previous work has mostly focused on the technical aspects of water savings and ignored social-political dimensions such as farmer understanding, policymaking processes and decentralisation of water governance.

This research attempts to overcome such gaps by providing technical assessments and socio-political analyses. Combining qualitative and quantitative approaches, the method covers field surveys, interviews with farmers and water management authorities, and a review of water consumption statistics. We will use statistical methods that will be used to assess irrigation efficiency and impacts of various irrigation schemes on agriculture production. The expected study will identify major inefficiencies on water use, evaluate the potential for expansion of modern irrigation technology or practices, and explore how governance can enhance water management. Results are expected to show that modern irrigation practices combined with government reforms and social action can bring about significant improvements in water use efficiency and overall increases in productivity. This study will increase the understanding of sustainable water management practices in dry regions and provides practical recommendations for Uzbekistani policymakers and farmers.

## 2. Materials and Methods

The methodology of this study, in terms of rational use of water resources in the agricultural sector of Uzbekistan, combines qualitative and quantitative research methods that provide comprehensive basic information regarding existing practices and potential for improvements. The next step is a brief review of existing studies, policies papers on water resources management and agricultural practices in Uzbekistan to build an analytical framework. Then, field evaluations will be performed in a number of key farming regions of Uzbekistan, focusing on areas with high irrigated agriculture water consumption. Structured interviews will be used to collect qualitative perspectives on regional water use methods and challenges from farmers, irrigation authorities, and agricultural experts. In combination with qualitative interviews, quantitative water consumption, agriculture productivity and irrigation performance data will also be collected by governmental agencies and local water authorities.

We will analyze the data to assess the relationship between water use and agricultural production, either through regression or similar statistical methods to identify trends and inefficiencies. The results will be supplemented by case studies of farms using modern

irrigation types such as drip or sprinkler systems to examine the effects on water saving and agricultural output; Water distribution patterns will be determined using GIS (Geographic Information System) techniques and the areas with greatest inefficiencies recognised. Field data, case studies and statistical analysis will be combined to build a strong basis for suggesting ways to increase water use efficiency in Uzbekistan agriculture.

### 3. Results and Discussion

The results of this study show that current water management practices in Uzbekistan's agricultural system are not effective and, largely due to the widespread use of traditional irrigation methods such as furrow irrigation, they lead to significant losses. According to field studies and interviews, the water efficient use is very low in many areas with more than 50% of their total water lost to evaporation and seepage. Modern irrigation techniques such as drip and sprinkler systems were found to significantly reduce water lost, increasing efficiency by up to 40 percent. These results are associated with the international studies about complex irrigation technology implementation benefits among arid and semi-arid regions. The study suggested sites with efficient irrigation practices produced higher yields, and therefore a positive association was observed between water-use efficiency and crop yield in most cases. However, that adoption is limited by high capital costs, a lack of technical skills and low government incentives for such technology. These challenges highlight an important gap between what modern water-saving technologies can do and how they are used in reality in Uzbekistan.

Water management in Uzbekistan largely remains centralised, allowing very little scope for the local people and farmers to take part in decision making regarding the utilisation of water resources; the study further unveiled. Such top-down strategy often fails to consider the local needs and circumstances, resulting in poor resource distribution and management. Additionally, while regulatory reforms have been introduced to promote sustainable water use, these regulations are weakly enforced and farmers have little knowledge of water conservation techniques. This governance gap is a key opportunity for future reforms as this is where providing incentives to promote water-efficient technologies will be particularly important, especially given that many irrigation systems remain largely community-managed.

### Further Research and Theoretical Implications

While this study provides valuable insight into the challenges of water management in Uzbekistan's agricultural sector, further investigation is needed because some information gaps still exist. First, an extensive theoretical investigation is needed across the long-term socio-economic impacts of water inefficiency on rural livelihoods, food security and economic viability. Today too much research focuses on tech solutions without consideration of socio-economics factors, including farmers adaptive strategies and local communities capability to adjust accordingly. In parallel, future research could benefit from using more advanced hydrological modelling approaches to project water supply under different climate change scenarios. Because climate change and population growth are increasing competition for water, it is important to explore how different water management strategies affect trade-offs between short-term production gains versus long-term availability of resources.

### Practical Applications and Policy Implications

Further research needs to be focused on testing and scaling out new irrigation technologies across Uzbekistan's different agricultural contexts. Drip and sprinkler systems

have been subject to pilot trials that show promise, but broader evaluations are needed before their adoption is considered economical in different regions and under different planting regimes. It also needs research to develop low-cost local water-conserving technology that may overcome the economic barriers now preventing wide adoption. More investigation is required into how to manage water resources. Exploring models of local or decentralised, community-based water management systems may shed light on how farmer participation and tapping local expertise in water allocation might work better. Such comparative analyses across Uzbekistan and successfully climate-adapting arid countries may help inform policy guidance.

#### 4. Conclusion

This study indicates an immediate action needed in the country over water management practices within agricultural sector of Uzbekistan. Although performance of modern irrigation systems could enhance water-use efficiency and agricultural output considerably, they face economic and governance impediments to implementation. To safeguard Uzbekistan's agri-food system under rising water scarcity, it will be critical to provide appropriate regulation and incentives as well as community-based water management systems. We need to do more here in terms of examining technical and socio-economic aspects of water resource management to fill knowledge gaps, while engineering faster and more sustainable solutions.

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