

American Journal of Economics and Business Management

Vol. 9 Issue 10| pp. 144-151| **ISSN:** 2576-5973
Available online @ https://www.globalresearchnetwork.us/index.php/ajebm

Article

Assessment of the Technical and Economic Efficiency of Drip Irrigation Technology in Cotton Growing in Uzbekistan

Mirzayev Akmal Arziyevich

1. Independent Researcher, Scientific Research Institute of Irrigation and Water Problems, Uzbekistan

Correspondence: a.mirzayev@antimon.gov.uz

Abstract: This article evaluates the technical and economic efficiency of using drip irrigation technology in cotton production in Uzbekistan. Based on field observations, timekeeping, and economic calculations, the study analyzed the technical and operational indicators of drip irrigation technology, including water, mineral fertilizer, and electricity consumption, as well as its economic outcomes. The research results demonstrated that drip irrigation technology enables the efficient use of resources and improves the economic outcomes of cotton cultivation. At the same time, it was found that the effectiveness of the technology varies depending on regional and farm conditions. The study substantiated that when evaluating the effectiveness of drip irrigation technology, it is necessary to comprehensively consider technical and operational indicators, investment and operational costs, and economic outcomes, alongside resource savings.

Keywords: cotton growing, drip irrigation, water conservation, resource efficiency, technical and economic efficiency, operational efficiency, economic effect.

Citation: Arziyevich, M. A. Assessment of the Technical and Economic Efficiency of Drip Irrigation Technology in Cotton Growing in Uzbekistan. American Journal of Economics and Business Management 2026, 9(10), 144-151.

Received: 25th Jul 2026
Revised: 20th Aug 2026
Accepted: 15th Sep 2026
Published: 6th Oct 2026

Copyright: © 2026 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

1. Introduction

In Uzbekistan, the share of irrigated land is high, and cotton growing is one of the important branches of agriculture. Under conditions of growing water scarcity in the Aral Sea basin, the efficient use of water resources, increasing yields on existing areas, and reducing production costs are directly linked to the implementation of modern agricultural technologies [1]. Drip irrigation technology is an important technological tool, as it allows for the standardized supply of water to the plant's root system, the application of mineral fertilizers through fertigation, and the management of the irrigation process [2]. Its resource-saving effect is greatest when irrigation rates are matched to the actual water requirements of the crop [3].

The theoretical and practical foundations of drip irrigation in Uzbekistan were laid in the 1990s. Dukhovny analyzed the prospects of drip irrigation and the factors hindering its widespread implementation Bezborodov and Kamilov studied the water and nutrient regime of cotton fields under drip irrigation Horst and Ikramov substantiated the basic principles of zoning the irrigated lands of Uzbekistan according to their suitability for drip irrigation and Lyubar and Malaev developed model schemes for the placement of drip irrigation systems on inter-row crops. Subsequent field experiments confirmed the resource-saving potential of the technology: trials under the

conditions of Mirzachul examined irrigation techniques and regimes for cotton based on resource-saving technologies and a comparison of drip and furrow irrigation of cotton in Uzbekistan showed a marked increase in water use efficiency under drip irrigation [4]. The problems of improving irrigation technology under water scarcity the application of drip irrigation in cotton irrigation and the economic efficiency of various cotton irrigation methods have also been examined.

The organizational and economic aspects of the problem have been addressed in national studies on ways to increase the efficiency of innovative water-saving technologies in agriculture the efficiency of land reclamation measures the development of innovative activities in the water management system the economic efficiency of water use in agriculture the efficiency of applying drip irrigation technology and organizational and economic mechanisms for stimulating the introduction of innovative technologies [5]. However, these studies have not sufficiently addressed the joint assessment of the technical and operational indicators, resource savings, and economic results of drip irrigation technology in cotton growing, and insufficient attention has been paid to the actual operational state of the technology and its relationship with resource utilization and economic results.

At the same time, it is insufficient to evaluate the effectiveness of implementing drip irrigation solely by water savings or increased yields. To implement the technology, initial investment, operating costs, maintenance, downtime, and the consumption of energy and labor resources must also be taken into account. Therefore, when evaluating the actual efficiency of a technology, it is necessary to consider technical and operational indicators, resource savings, and economic results in their interconnection [6].

The main goal of the study is to evaluate the efficiency of using drip irrigation technology in cotton growing in Uzbekistan based on technical and economic indicators and to determine its impact on resource savings and economic results [7].

The study utilized data on water-saving technologies implemented in the Fergana, Namangan, and Andijan regions of Uzbekistan, including field studies, time-and-motion studies, and economic calculations from 2019–2020.

The relevance of the research lies in the fact that when evaluating the effectiveness of implementing drip irrigation technology, it is necessary to take into account not only resource savings but also the actual operational state of the technology and the economic result obtained [8].

2. Materials and Methods

The study was conducted using the example of drip irrigation technologies implemented in the cultivation of cotton on irrigated lands in the Fergana, Namangan, and Andijan regions. The study utilized theoretical-empirical research methods, field observations, time study, comparative analysis, and economic calculation methods.

Field data were processed to evaluate the operating process, resource consumption, and economic results of the technology. The study period mainly covered the areas where water-saving technologies were introduced in cotton growing in 2019–2020.

2.1 Comprehensive technical and operational assessment.

The effectiveness of drip irrigation technology was evaluated based on three interrelated areas:

- technical and operational block – performance, utilization of working time, and technological stability;
- resource-saving block – irrigation rates, water consumption, water losses, and mineral fertilizer consumption;
- economic block – productivity, investment and operating costs, and economic result.

When determining the technical and operational efficiency of the technology, the hourly productivity of the main operating hours, the time spent on installing and preparing the technology for operation, scheduled maintenance, troubleshooting, repair, and downtime were taken into account. Its main goal is to determine the actual operational efficiency of the technology, rather than its nominal efficiency.

In subsequent calculations, the share of non-working time for technology installation, maintenance, repair, and other tasks in total working time is taken into account. Thus, the difference between design productivity and actual operational efficiency is determined.

An important aspect of this approach is that a technology that has high nominal performance but requires a long time for maintenance or repair is not automatically evaluated as the most effective technology. Real efficiency is determined in conjunction with operational time utilization and technological stability.

2.2 Assessment of resource conservation and investment efficiency.

The resource efficiency of drip irrigation technology was evaluated based on changes in water, mineral fertilizer, and electricity consumption. At the same time, the resource consumption in the area where the technology was applied was compared with actual results, and relative and absolute savings were determined.

When assessing economic efficiency, initial investments in the acquisition and installation of technology, production costs, productivity, and the economic benefit resulting from the application of the technology were taken into account. The annual economic effect was calculated based on changes in the value of gross output and production costs associated with the application of the technology.

Furthermore, when evaluating investment decisions, limited water resources, water losses, and the impact of government subsidies were taken into account. This approach serves to assess the economically acceptable conditions for implementing the technology.

Thus, the methodological approach was formed based on the following logical chain:

technological parameters – technical and operational result – resource savings – economic result.

In this approach, comprehensive efficiency was not formed as a separate index; its content was revealed through a combined analysis of the technical, resource, and economic indicators of the technology.

3. Results

Field studies conducted in various regions of Uzbekistan have shown that drip irrigation technology can increase the efficiency of water and mineral fertilizer utilization. However, the results are not uniform across regions. This shows that the effectiveness of the technology depends on natural-climatic, reclamation, technical, and production conditions [9].

3.1 Fergana Region

In 2020, drip irrigation technology was introduced in cotton cultivation on an area of 1,487 hectares in the Fergana region. The average cotton yield in the areas where the technology was applied was 37 c/ha. The application of drip irrigation resulted in a 42.1% reduction in water consumption, a 46.0% reduction in mineral fertilizer consumption, and a 7.0% reduction in electricity consumption.

The results indicate that the use of drip irrigation technology in the Fergana region contributed to substantial savings in the main production resources. In particular, water savings reached 42.1%, while mineral fertilizer savings amounted to 46.0%. The absolute water saving was 4.8 million m^3. At the same time, the average cotton yield reached 37

c/ha, indicating that resource conservation was accompanied by maintaining cotton productivity.

At the farm level, observations conducted on an area of 21 hectares at the "Sultan Kodirov Ota" farm showed a 44.3% reduction in water consumption and a 47.0% reduction in mineral fertilizer consumption, while cotton yield reached 43 c/ha. These results further demonstrate the resource-saving effect of drip irrigation and its contribution to maintaining cotton productivity under farm-level production conditions.

3.2 Namangan Region

In 2020, drip irrigation technology was implemented on 550.8 hectares of cotton fields in the Namangan region. The average cotton yield in the areas where the technology was applied was 33.1 c/ha. The use of drip irrigation resulted in a 39.6% reduction in water consumption, a 43.0% reduction in mineral fertilizer consumption, and a 2.0% reduction in electricity consumption.

The results demonstrate that drip irrigation technology in the Namangan region contributed to significant savings in the main production resources. Absolute water savings amounted to 1.4 million m^3. At the same time, the average cotton yield reached 33.1 c/ha, indicating that the reduction in resource consumption was accompanied by maintaining cotton productivity.

The data presented in Table 1 show differences in the main resource-saving indicators across the studied regions. In the Namangan region, water savings amounted to 39.6%, mineral fertilizer savings to 43.0%, and electricity savings to 2.0%. Compared with the Fergana and Andijan regions, the level of resource savings differed, reflecting differences in the conditions of technology implementation and production.

Overall, the regional results indicate that the effectiveness of drip irrigation should be assessed not only by the amount of water saved, but also by mineral fertilizer and electricity savings, together with the achieved level of cotton productivity.

Table 1. Main results of drip irrigation in cotton growing in Uzbekistan

Indicator	Fergana Region	Namangan Region	Andijan Region
Implemented area, ha	1487	550,8	1383
Average yield, centner/ha	37	33,1	31
Water saving, %	42,1	39,6	46,8
Mineral fertilizer saving, %	46,0	43,0	46,9
Electric energy saving, %	7,0	2,0	1,5

Source: compiled by the author based on field research and calculations.

3.3 Andijan Region

In 2020, drip irrigation technology was implemented on 1,383 hectares of cotton fields in the Andijan region. The average cotton yield in the areas where the technology was applied was 31 c/ha. The use of drip irrigation resulted in a 46.8% reduction in water consumption, a 46.9% reduction in mineral fertilizer consumption, and a 1.5% reduction in electricity consumption.

The results demonstrate that drip irrigation technology in the Andijan region contributed to significant savings in the main production resources. Absolute water savings amounted to 4.2 million m^3. At the same time, the average cotton yield reached 31 c/ha, indicating that resource conservation was accompanied by maintaining cotton productivity.

At the farm level, observations conducted at the "Sobirjon Yuqori Hosili" farm on an area of 18.6 hectares showed a 46.9% reduction in water consumption and a 46.6% reduction in mineral fertilizer consumption, while cotton yield reached 45 c/ha. At the

"Ulug Qudrat Sohibi" farm, covering 25 hectares, water savings amounted to 46.8%, mineral fertilizer savings to 46.7%, and cotton yield reached 44 c/ha. These results further demonstrate the resource-saving effect of drip irrigation and its contribution to maintaining cotton productivity under farm-level production conditions.

In addition to consolidated data by region, the results for individual farms allow for a more accurate assessment of the technology's effectiveness.

Table 2. Results of Drip Irrigation in Selected Farms

Farmer	Farms Area, ha	Water saving, %	Mineral fertilizer saving, %	Yield, centner/ha
"Sulton Qodirov Ota"	21,0	44,3	47,0	43
"Mamadaliyev Oybek"	17,4	40,0	53,7	38
"Qambarali Ota's Grandson Bakhtiyor"	17,0	40,0	51,8	41
"Sobirjon's High Yield"	18,6	46,9	46,9	45
"Owner of Great Power"	25,0	46,8	46,7	44

Source: Compiled by the author based on field research.

The results presented in the table show that water savings in the selected farms ranged from 40.0 to 46.9 percent. Mineral fertilizer savings ranged from 46.6 to 53.7 percent, while cotton yields varied from 38 to 45 centners per hectare. These results demonstrate that the application of drip irrigation technology contributes to significant resource conservation while maintaining a relatively high level of cotton productivity at the farm level [10].

These findings indicate that the effectiveness of drip irrigation technology should not be assessed solely on the basis of water savings. A comprehensive assessment should consider water and mineral fertilizer savings together with cotton productivity and the operational conditions of the technology.

To evaluate the technical and operational efficiency of the technologies, a comparison of domestic and imported drip irrigation technologies was conducted [11]. In both technologies, water discharge through the irrigation belts was 1.8 l/h, and the irrigation rate was 350 m^3/ha.

The hourly productivity during daytime operation was 0.341 ha/h for the Turkish technology and 0.338 ha/h for the domestic technology. At night, the corresponding indicators were 0.220 and 0.217 ha/h, respectively. Overall operational productivity was 0.219 ha/h for the Turkish technology and 0.210 ha/h for the domestic technology.

The obtained results show that the hourly productivity of the two technologies was relatively close. Therefore, the assessment of drip irrigation technologies should consider not only hourly productivity but also operational efficiency and other relevant performance indicators [12].

Chronometry data also made it possible to determine the level of utilization of the technology's working time. For the Turkish technology, 681 hours out of 860 hours of total working time were net working time, resulting in a time utilization coefficient of 0.792. For the domestic technology developed at a specialized polymer plant, total working time was 865 hours, of which 680 hours constituted net working time, resulting in a coefficient of 0.786.

The time utilization coefficients were therefore 0.792 for the Turkish technology and 0.786 for the domestic technology [13]. These indicators should be considered

together with resource consumption, operational conditions, and economic results when assessing the overall efficiency of the technologies.

Thus, the technical and operational assessment demonstrates the importance of a comprehensive approach to technology evaluation. The assessment should consider resource consumption, operational performance, working-time utilization, and economic results rather than relying on a single indicator such as hourly productivity or the time utilization coefficient [14].

4. Discussion

The research results showed that the effectiveness of drip irrigation technology is determined by several interrelated factors. The main resource-saving effects of the technology were the reduction in water consumption and the efficient use of mineral fertilizers in the Fergana Valley. However, differences between regions show that the effectiveness of the technology also depends on natural-climatic, reclamation, technical, and organizational conditions.

At the farm level, the results showed that water savings ranged from 40.0 to 46.9 percent, mineral fertilizer savings from 46.6 to 53.7 percent, and cotton yields from 38 to 45 centners per hectare [15]. These results indicate that resource savings should be considered together with cotton productivity when assessing the effectiveness of drip irrigation technology.

The results of the technical comparison also confirm the importance of a comprehensive assessment. Turkish and domestic technologies operated under the same water discharge and irrigation rates, while their daytime and nighttime productivity indicators were relatively close. Therefore, the assessment of technologies should consider technical and operational indicators together with resource-saving results.

The analysis also indicates that technical indicators should not be considered separately from economic results [16]. The overall efficiency of a technology depends on the relationship between investment and operating costs, resource savings, productivity, and the resulting economic effect.

Another important result of the study is that actual operational efficiency depends on the utilization of working time [17]. Along with the main operating time, maintenance, repair, and downtime affect the actual efficiency of the technology. Therefore, it is advisable to distinguish between nominal productivity and actual operational efficiency.

Overall, the results obtained demonstrate the interrelationship between resource conservation, productivity, and technical and operational indicators under the conditions of cotton growing in Uzbekistan [18]. The practical significance of the study lies in assessing drip irrigation technology not only by the amount of water saved, but also by mineral fertilizer savings, cotton productivity, working-time utilization, and economic results.

5. Conclusion

Research conducted in the cotton industry of Uzbekistan has shown that the introduction of drip irrigation technology improves the efficiency of water and mineral fertilizer use and contributes to maintaining cotton productivity under different production conditions.

In the Fergana region, drip irrigation was introduced on an area of 1,487 hectares. The average cotton yield reached 37 c/ha, while water consumption decreased by 42.1%, mineral fertilizer consumption by 46.0%, and electricity consumption by 7.0%. Absolute water savings amounted to 4.8 million m^3.

In the Namangan region, drip irrigation was implemented on 550.8 hectares. The average cotton yield reached 33.1 c/ha, while water consumption decreased by 39.6%, mineral fertilizer consumption by 43.0%, and electricity consumption by 2.0%. Absolute water savings amounted to 1.4 million m^3.

In the Andijan region, drip irrigation was implemented on 1,383 hectares. The average cotton yield reached 31 c/ha, while water consumption decreased by 46.8%, mineral fertilizer consumption by 46.9%, and electricity consumption by 1.5%. Absolute water savings amounted to 4.2 million m^3.

At the farm level, water savings ranged from 40.0 to 46.9%, mineral fertilizer savings from 46.6 to 53.7%, and cotton yields from 38 to 45 c/ha. These results demonstrate that drip irrigation contributes to substantial resource savings while supporting cotton productivity at the farm level.

The technical and operational analysis showed relatively close productivity indicators for domestic and imported technologies. Daytime productivity ranged from 0.338 to 0.341 ha/h, while nighttime productivity ranged from 0.217 to 0.220 ha/h. The time utilization coefficients were 0.792 for the Turkish technology and 0.786 for the domestic technology.

Based on the research results, the technical and economic efficiency of drip irrigation technology should be assessed through a combination of resource-saving, productivity, technical, and operational indicators. Such an integrated approach provides a comprehensive assessment of the effectiveness of drip irrigation technology in cotton production under conditions of limited water resources.

REFERENCES

[1] M. Bekchanov, J. P. A. Lamers, and C. Martius, "Pros and cons of adopting water-wise approaches in the lower reaches of the Amu Darya: A socio-economic view," *Water*, vol. 2, no. 2, pp. 200–216, 2010.

[2] J. E. Ayars et al., "Subsurface drip irrigation of row crops: A review of 15 years of research at the Water Management Research Laboratory," *Agric. Water Manag.*, vol. 42, no. 1, pp. 1–27, 1999.

[3] R. G. Allen, L. S. Pereira, D. Raes, and M. Smith, *Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements*, FAO Irrigation and Drainage Paper 56. Rome, Italy: FAO, 1998.

[4] V. A. Dukhovny, "Drip irrigation: Prospects and obstacles," in *Collection of Scientific Works on Drip Irrigation*. Tashkent, Uzbekistan, 1995, pp. 3–12.

[5] G. A. Bezborodov and B. S. Kamilov, "Water and nutrient regime of the soil during drip irrigation of cotton," in *Collection of Scientific Works on Drip Irrigation*. Tashkent, Uzbekistan, 1995, pp. 60–68.

[6] M. G. Horst and R. K. Ikramov, "Basic principles of irrigated land zoning in Uzbekistan by application of drip irrigation," in *Collection of Scientific Works on Drip Irrigation*. Tashkent, Uzbekistan, 1995, pp. 13–24.

[7] R. G. Lyubar and E. E. Malaev, "Typical diagrams of drip irrigation systems on fallow crops," in *Collection of Scientific Works on Drip Irrigation*. Tashkent, Uzbekistan, 1995, pp. 150–155.

[8] G. A. Bezborodov, R. K. Ikramov, and S. M. Gapparov, "Field experiments on irrigation techniques and regimes in cotton cultivation based on resource-saving technologies (the case of the Mirzacho'l conditions)," *Agro Ilm*, no. 2(22), pp. 19–20, 2012.

[9] N. Ibragimov, S. R. Evett, Y. Esanbekov, B. S. Kamilov, L. Mirzaev, and J. P. A. Lamers, "Water use efficiency of irrigated cotton in Uzbekistan under drip and furrow irrigation," *Agric. Water Manag.*, vol. 90, no. 1–2, pp. 112–120, 2007.

[10] M. A. Avliyoqulov and B. Sh. Matyakubov, "Problems of improving irrigation technology in conditions of water scarcity," in *Proc. Republican Sci.-Pract. Conf.*, Tashkent, Uzbekistan, 2011, no. 4, pp. 31–34.

[11] M. Kh. Khamidov and B. U. Suvonov, "Application of drip irrigation technology in cotton irrigation," *Irrigatsiya va Melioratsiya*, no. 4, pp. 9–14, 2018.

[12] S. M. Gapparov, L. Kh. Shezdukova, and Z. T. Dzhumaev, "Economic efficiency of cotton irrigation methods," *Agro-Economics*, Special issue, pp. 47–50, 2018.

[13] T. Kh. Farmanov et al., *Ways to Increase the Efficiency of Using Innovative Water-Saving Technologies in Agriculture*. Tashkent, Uzbekistan, 2020.
[14] B. F. Sultanov, "Improving the scientific and methodological foundations for increasing the efficiency of land reclamation measures in agriculture," D.Sc. dissertation, Tashkent, Uzbekistan, 2020.
[15] S. R. Umarov, "Improving the scientific and practical foundations for the development of innovative activities in the water management system," D.Sc. dissertation, Tashkent, Uzbekistan, 2017.
[16] Z. S. Shokhodjaeva, "Scientific and methodological foundations for increasing the economic efficiency of water use in agriculture," abstract of D.Sc. dissertation, Tashkent, Uzbekistan, 2021.
[17] F. M. Yusupova, *Improving the Efficiency of Applying Drip Irrigation Technology in Agriculture*. Tashkent, Uzbekistan: Ilm-ziyo-zakovat, 2020.
[18] D. D. Jalalova, "Improving organizational and economic mechanisms for stimulating the introduction of innovative technologies in agriculture," abstract of Ph.D. dissertation, Tashkent, Uzbekistan, 2021.