American Journal Of Agriculture And Horticulture Innovations

VOLUME Vol.06 Issue06 2026
PAGE NO. 19-23
DOI 10.37547/ajahi/Volume06Issue06-05

Seedling Method of Rice Sowing and Its Effect on Yield and Irrigation Rate Under Conditions of The Republic of Karakalpakstan

Khozhambergenov Ganibay Ametovich
Head of Laboratory, SPA 'Grain and Rice', Nukus, Uzbekistan

Utambetov Duysenbay Usnaгdinovich
Director, SPA 'Grain and Rice', Nukus, Uzbekistan

Received: 28 April 2026; **Accepted:** 26 May 2026; **Published:** 12 June 2026

Abstract: The purpose of this study is to scientifically justify and evaluate the feasibility of introducing a water-saving, high-productivity technology for growing rice by the seedling method as a repeated crop after winter wheat under the arid and saline conditions of Karakalpakstan. The planting scheme of 15×10×3 cm (three plants per hole) demonstrated the best biometric indicators and yield compared to the control — hand broadcast sowing in water. The irrigation rate for rice under the seedling method was reduced by approximately 9,000 m³/ha. Economic calculations confirmed reduced costs, increased revenue and net profit, and a significant improvement in profitability.

Keywords: Rice, irrigation, seedling, nursery, repeated sowing, water accounting, winter wheat, growth phase, rice variety, traditional method, technology.

Introduction: Global climate change and limited water resources are among the most pressing problems in agricultural production, especially under irrigated farming conditions. In the Aral Sea region, particularly in the Republic of Karakalpakstan, recent decades have been characterized by a sharp rise in air temperatures, declining precipitation, intensified wind erosion, and the expansion of salinization processes. These factors have reduced soil fertility and negatively affected the yield of wheat, rice, and other crops. Therefore, the efficient use of water resources, the development of water-saving technologies, and their implementation in production are considered priority tasks in this region.

Rice is a strategic crop playing an important role in ensuring food security for the population of Karakalpakstan. With the traditional method of broadcasting rice seeds in water, up to 18–25 thousand m³ of water per hectare is consumed. In this context, the rice seedling cultivation technology is considered an alternative and promising approach, capable of reducing water consumption by 25–35% while maintaining stable yields.

In Karakalpakstan, the seedling method involves germinating and growing seeds in a nursery followed by transplanting 30–35-day-old seedlings to the field. As a result, the vegetation period is shortened, water consumption is reduced, weed infestation is limited, and yield stability is increased.

International meta-analyses show that the seedling method outperforms direct-seeded rice in yield; analysis of field experiments from 1980–2017 showed that DSR (Direct Seeded Rice) provided on average approximately 12% lower yields [2]. Alternate Wetting and Drying (AWD) combined with the seedling method allows saving 25–70% of water compared to continuous flooding [6,7]. Therefore, the combined use of the seedling method with technologies such as AWD is recommended as an agronomically and economically sound approach [10].

METHODS

The experimental study was conducted on the experimental fields of SPA 'Grain and Rice' of the Republic of Karakalpakstan — an arid zone region of the Aral Sea basin, where soils are characterized by moderate to high salinity and low fertility.

The experiment was designed according to: 'Methodology for conducting field experiments' (UzPITI, Tashkent, 2007); 'Recommendations for rice cultivation in the Republic of Karakalpakstan' (Nukus, 2018); V.B. Zaitsev 'Rice Irrigation System' (Moscow: Kolos, 1975); 'Methodology for hydro-reclamation research in rice irrigation' (Krasnodar, 1977).

Two rice varieties were selected for the study: the early-ripening 'Gulistan' and the long-grain 'Almaz'. Prior to sowing in nurseries, germination energy and germination rate of seeds of both varieties were assessed under laboratory conditions.

In early spring, a nursery was established (a plot of 5×2 m for each variety). Seeds were sown at the end of May. Seedlings were grown for 30–35 days with regular soil moisture maintenance.

After harvesting winter wheat, rice seedlings were transplanted in early July. The experiment was conducted on plots of 6 m² in a randomized design: 1) control — hand broadcast in water; 2) 15×10×3 (three plants per hole); 3) 10×10×3.

Phenological observations and morpho-visual assessments were recorded. Flow meters on the pump provided water consumption accounting. Economic evaluation included calculation of costs, gross revenue, net profit, and profitability. Statistical processing of yield data was performed by the methods of B.A. Dospekhov (1985), ANOVA.

RESULTS AND DISCUSSION

In our experimental studies, the objective was to prepare seeds of rice varieties for seedling sowing. To this end, laboratory seed germination was first tested; the results are presented in Table 1.

Table 1. Germination and survival rates of rice seeds under laboratory and field conditions

Rice Variety	Indicator, %	Laboratory Conditions	Field Conditions
Gulistan	Germination energy, %	93	—
	Germination rate, %	97	49
	Survival rate, %	—	71
Almaz	Germination energy, %	94	—
	Germination rate, %	98	52
	Survival rate, %	—	63

According to Table 1 data, under laboratory conditions the germination energy of the 'Gulistan' variety was 93%, and germination rate was 97%. For the 'Almaz' variety, these indicators were higher by 1%. Field germination was 49–52%, respectively. Both varieties fully meet the germination and survival requirements for nursery sowing. By the end of the growing season, the survival rate was 71% for 'Gulistan' and 8% lower for 'Almaz'. These indicators also correspond to the permissible plant count.

Among the key indicators of rice yield are its biometric characteristics: panicle length, number of filled grains per panicle, and 1,000-grain weight [8]

Table 2. Effect of different rice sowing methods on biometric yield components

#	Sowing / Planting Scheme	Plant Height, cm	Total Tillers	Productive Tillers	Panicle Length, cm	Grains per Panicle	Panicle Weight, g	1000-Grain Weight, g
Variety: 'Gulistan'								
1	Hand broadcast in water	73.2	85.6	54.3	15.6	107.2	3.4	33.0
2	Transplanting 15×10×3	77.6	83.3	67.0	16.7	157.8	4.8	33.4
3	Transplanting 10×10×3	79.1	79.3	61.5	16.5	150.0	4.1	33.1

Variety: 'Almaz'								
1	Hand broadcast in water	75.7	112.1	77.1	16.2	89.6	2.5	29.3
2	Transplanting 15×10×3	82.5	110.1	83.3	18.2	95.0	2.6	32.4
3	Transplanting 10×10×3	82.8	110.6	78.9	17.5	90.6	2.5	29.6

Biometric assessment revealed significant variation in indicators. For the 'Gulistan' variety under hand broadcasting: plant height 73.2 cm, number of productive tillers 54.3, panicle weight 3.4 g. Transplanting at scheme 15×10×3: height 77.6 cm, productive tillers 67.0, panicle length 16.7 cm, grains per panicle 157.8, weight 4.8 g, 1,000-grain weight 33.4 g. For the 'Almaz' variety, scheme 15×10×3 also gave the best results: productive tillers 83.3, panicle length 18.2 cm, grains 95.0, 1,000-grain weight 32.4 g.

Table 3. Rice grain yield under different planting methods

Planting Method	Rep. 1	Rep. 2	Rep. 3	Average Yield, dt/ha
Variety: 'Gulistan'				
Hand broadcast in water	65.7	63.6	68.1	65.8
Transplanting 15×10×3	71.3	76.1	71.9	**73.1**
Transplanting 10×10×3	66.2	70.2	70.6	69.0
Variety: 'Almaz'				
Hand broadcast in water	56.3	54.9	58.9	56.7
Transplanting 15×10×3	68.4	62.2	61.7	**64.3**
Transplanting 10×10×3	60.9	58.3	61.7	60.1

For 'Gulistan': LSD% = 7.04; LSD dt/ha = 4.88. For 'Almaz': LSD% = 8.81; LSD dt/ha = 5.32.

The study revealed significant differences in yield. 'Gulistan' variety: hand broadcast — 65.8 dt/ha, scheme 15×10×3 — 73.1 dt/ha (+7.3 dt/ha), scheme 10×10×3 — 69.0 dt/ha. 'Almaz' variety: hand broadcast — 56.7 dt/ha, scheme 15×10×3 — 64.3 dt/ha (+7.6 dt/ha), scheme 10×10×3 — 60.1 dt/ha.

Water use efficiency was also assessed using installed flow meters. The results are presented in Table 4.

Table 4. Effect of different rice sowing methods on water consumption

Month	June	July			August			September	Plot Area, m²	Water Use, m³	Irrigation Rate, m³/ha
		III	I	II	I	II	III				
Planting Method: Hand Broadcast in Water — Control											
Water consumption, m³	5.8	4.8	5.9	5.6	7.8	6.9	5.8	5.8	205.2	48.4	23,592
Planting Method: Seedling Transplanting											
Water consumption, m³	—	3.8	4.2	4.6	3.9	3.6	3.4	—	161.6	23.5	14,542

According to Table 4, during rice cultivation under different sowing methods, water consumption throughout the growing season differed significantly. In the control variant with hand broadcasting in water, 5.8 m³ of water was consumed in the third decade of June, while in July this indicator ranged from 4.8 to 5.9 to 5.6 m³. In August, water consumption increased, reaching 7.8 m³ in the first decade. This is explained by rising air temperatures, increased evaporation intensity, and the transition of plants to the generative phase, which led to increased water demand. In September, water consumption was 5.8 m³ per decade.

In this variant, total water consumption per plot was 48.4 m³, which translates to an irrigation rate of 23,592 m³/ha. These figures reflect significant water losses due to infiltration and evaporation under the traditional method, which involves maintaining a continuous water layer on the field.

With the seedling transplanting method, water consumption was significantly reduced. In July it was 3.8–4.2–4.6 m³ per decade, in August — 3.9–3.6–3.4 m³. Each decade's figures were on average 1.5–2.5 m³ lower than in the control. Total water consumption per plot was 23.5 m³, corresponding to an irrigation rate of 14,542 m³/ha.

The difference between the two methods was 9,050 m³/ha, corresponding to water savings of 38–40%. This result is attributable to the fact that under the seedling method the field is not continuously flooded, the water regime is managed more rationally, and infiltration losses are substantially reduced. In addition, evaporation from the soil surface is decreased.

Table 5. Economic efficiency of rice cultivation by seedling method

#	Crop Type	Area, ha	Yield, dt/ha	Gross Yield, t	Total Costs, 000' sum	Seed Use		Mineral Fertilizers		Water Cost, 000' sum	Gross Revenue, 000' sum	Net Profit, 000' sum	Profitability, %
						kg	000' sum	kg	000' sum				
1	Hand broadcast in water	1	61.2	6.1	25,615	250	3,125	600	1,614	2,400	46,250	20,510	80
2	Seedling transplanting	1	**66.6**	6.6	19,962	70	875	450	1,211	1,400	49,875	**29,913**	**149**

Economic results are presented in Table 5. According to these data, under hand broadcasting the average yield was 61.2 dt/ha. Costs per 1 ha were 25,615 thousand sum (seeds — 3,125, mineral fertilizers — 1,614, chemical inputs — 2,000, water — 2,400 thousand sum). A gross yield of 6.1 t was sold at 7,500 sum/kg, revenue — 46,250 thousand sum, net profit — 20,510 thousand sum, profitability — 80%.

Under the seedling method: yield was higher by 5.4 dt/ha, total costs were reduced by 4,653 thousand sum, revenue was higher by 3,625 thousand sum, net profit increased by 9,403 thousand sum, profitability — 149% (higher by 69 percentage points). The economic advantage is explained by the combination of higher yield with reduced costs for seeds, fertilizers, and water.

The results are consistent with international research [1–5]. Although AWD was not tested in our experiments, the seedling method alone provided comparable water efficiency.

CONCLUSIONS

1. As a result of rice cultivation by the seedling method under Karakalpakstan conditions, the growing season was 90–100 days. Field germination was 49–52%, and survival rate by the end of the growing season was 71–63%. The 'Gulistan' and 'Almaz' varieties are recommended as suitable for seedling production.

2. Rice seedlings were grown in the nursery for 30–35 days under stable soil moisture. Under the seedling method, the volume of irrigation water was reduced by approximately 9,000 m³/ha compared to the traditional method.

3. Under transplanting at the 15×10 cm scheme (three plants per hole), the number of productive tillers ranged from 6.2 to 15.7, panicle length was greater by 1.1–2.0 cm. Average yield exceeded the traditional method by 7.5 dt/ha.

4. According to economic efficiency calculations, under the seedling method income increased by 3,625 thousand sum, net profit — by 9,403 thousand sum, and profitability was 69 percentage points higher compared to the traditional method.

REFERENCES

1. Liu K., Peng S., Yang J., Wang Z. (2017). Effects of seedling age and planting density on agronomic characteristics and grain yield of mechanically transplanted rice. Scientific Reports, 7, 14072. https://doi.org/10.1038/s41598-017-14672-7

2. Pasquin E.M., Lafarge T., Tubana B. (2008). Transplanting young seedlings in irrigated rice fields: early and high tiller production enhanced grain yield. Field Crops Research, 105(1–2), 141–155. https://doi.org/10.1016/j.fcr.2007.09.001

3. Xu L., Baldanzi G., Wang G. (2019). Yield comparison between direct seeded and transplanted rice: a meta-analysis. Agronomy,

9(11), 767. https://doi.org/10.3390/agronomy9110767

4. Ishfaq M., Akbar N., Zulfiqar U. et al. (2020). Alternate wetting and drying: a water-saving rice production system. Agricultural Water Management, 241, 106363. https://doi.org/10.1016/j.agwat.2020.106363
5. Brar A.S., Buttar G.S., Jhanji D. et al. (2015). Water productivity and economic analysis of basmati rice transplanting methods. Agricultural Water Management, 158, 189–195. https://doi.org/10.1016/j.agwat.2015.04.018
6. Mallaredy M., Reddy P.S., Malepati R.R. (2023). Maximizing water use efficiency in rice production. Water, 15(10), 1802. https://doi.org/10.3390/w15101802
7. Suvanmanippong S. et al. (2023). Alternate Wetting and Drying as a water-saving technology. Water, 15(3), 402. https://doi.org/10.3390/w15030402
8. Howell C.R., Shrestha P., Dodd I.C. (2015). AWD irrigation maintained yields with half the water. Food and Energy Security, 4(2), 144–157. https://doi.org/10.1002/fes3.67
9. Carrijo D.R. et al. (2019). Irrigation management to reduce arsenic content in rice grain. Science of the Total Environment, 649, 300–307. https://doi.org/10.1016/j.scitotenv.2018.08.393
10. Devkota K.P., Manschadi A.M., Lamers J.P.A. (2015). Innovations for sustainable rice production in Central Asia: a Khorezm case study. De Gruyter. https://doi.org/10.14220/9783737002974.63
11. Schluebach J. (2021). An upscaling model for agriculture in Western Uzbekistan. Heliyon, 7(5), e07028. https://doi.org/10.1016/j.heliyon.2021.e07028
12. Conrad C. et al. (2010). Classification of irrigated crops in arid Central Asia using MODIS data. Remote Sensing, 2(4), 1035–1056. https://doi.org/10.3390/rs2041035
13. Zaitsev V.B. (1975). Rice Irrigation System. 3rd ed. Moscow: Kolos, 351 p.
14. Zaitsev V.B. (1977). Methodology for Hydro-reclamation Research in Rice Irrigation. Krasnodar, 109 p.