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DEVELOPMENT OF RICE SOWING TECHNOLOGY WITH SEEDLINGS IN KARAKALKALPAKSTAN

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Abstract. The purpose of this research is to scientifically substantiate and evaluate the possibilities of introducing into production a water-saving and high-quality yield technology of cultivating rice by the seedling method as a successive crop after winter wheat under the arid and saline-prone conditions of Karakalpakstan. The experiments were carried out in the fields of the Grain and Rice Scientific Production Association. The ultra-early maturing variety “Gulistan” and the long-grain variety “Almaz” were grown in a nursery for 30–35 days and then transplanted into the field. Among the seedling planting schemes, the 15×10×3 cm scheme (three seedlings per hill) proved superior in terms of the main biometric indicators (number of productive stems, panicle length, number of grains per panicle, 1000-grain weight) and final yield compared to the control — hand broadcasting of seeds into water. Measurements made with water meters installed at the water inlet of the field showed that the total irrigation norm under the seedling method was reduced by about 9,000 m³/ha. Economic calculations confirmed a decrease in total costs, an increase in gross income and net profit, as well as a significant improvement in profitability. The results indicate that the introduction of the seedling method of rice cultivation as a successive crop contributes to increasing water productivity and farmers’ income.

Keywords: rice, irrigation, seedling, nursery, successive cropping, water measurement, winter wheat, growth stage, rice variety, traditional method, technology.

1 Introduction.

Global climate change and the limitation of water resources are among the most pressing challenges in agricultural production, especially in irrigated farming areas. In the Aral Sea region, particularly in the Republic of Karakalpakstan, the last decades have been characterized by a sharp increase in air temperature, a decrease in precipitation, intensification of wind erosion, and expansion of salinization processes. These factors have reduced soil fertility in croplands and negatively affected the yields of wheat, rice, and other major cereal crops. Therefore, the efficient use of available water resources, the development of innovative technologies that allow water saving, and their introduction into production are considered priority tasks today.

Rice is a strategic crop that plays an important role in ensuring food security for the population of Karakalpakstan. In the traditional method of broadcasting rice seeds into water, a large amount of irrigation water is consumed. Some sources indicate that up to 18–20 thousand m³ of water is required to cultivate one hectare of rice fields. Thus, under water scarcity conditions, traditional sowing methods are becoming increasingly inefficient both economically and ecologically. In this situation, the technology of rice cultivation by the seedling method is considered an alternative and promising direction. This method has been widely applied in Asian countries such as China, India, Vietnam, and Thailand, making it possible to reduce water consumption by 25–35% while ensuring stable yield levels.

Under the conditions of Karakalpakstan, rice cultivation by the seedling method is a relatively new research direction and has not been sufficiently covered in the available scientific literature. The seedling method may be of particular importance as a successive crop in fields vacated after winter wheat. This method provides for germinating and growing rice seeds in a nursery, followed by transplanting 25–30 day-old seedlings into the field. As a result, the rice growing period is shortened, water consumption is reduced, weed infestation is limited, and yield stability is improved. Moreover, cultivating rice as a successive crop by the seedling method helps to improve the agrobiological properties of the soil, optimize resource use, and increase the economic efficiency of farms.

In Karakalpakstan and the wider Aral Sea region, under conditions of climate warming and water scarcity, rice cultivation by the seedling (transplanting) method is one of the most promising directions in terms of water saving and yield stability. International meta-analyses indicate that the seedling method generally outperforms direct-seeded rice (DSR) in terms of yield [1]; for example, a comprehensive analysis of field trials from 1980 to 2017 showed that DSR produced on average ~12% lower yields [2].

The agronomic subtleties of the seedling method are seedling age and density [3]. Field trials have shown that when working with 25–35 day-old seedlings, especially in cases of delayed transplanting, increasing seedling density significantly improves grain yield [4]. In addition, the use of "young seedlings" has been shown to increase grain yield due to earlier and more productive tillering [5].

In terms of water saving, AWD — alternate wetting and drying — when combined with the seedling method, is one of the most powerful tools [6]. Large reviews have shown that AWD can save up to 25–70% of water compared to traditional continuous flooding [7]. Optimizing field water management regimes also improves grain quality and economic indicators [8].

In arid and saline-prone regions, where water resources are limited, the introduction of water-saving sowing and irrigation practices is of particular importance [9]. Therefore, the combined use of the seedling method and technologies such as AWD is recommended as an agronomically and economically sound approach [10]. Practical innovations for stabilizing rice production in Central Asia have been analyzed in the example of Khorezm [11]. At the regional level, precision mapping and monitoring of crops also contribute to the targeted distribution of water [12].

2. Materials and Methods

The experimental study was carried out in the experimental fields of the Grain and Rice Scientific Production Association located in the Republic of Karakalpakstan. This region belongs to the arid zone of the Aral Sea basin, where soils are moderately to highly saline and characterized by low fertility, unstable moisture conditions, and frequent occurrence of foliar diseases in cereal crops. The agro-climatic context makes it an ideal environment for testing new rice cultivation technologies that can ensure sustainable productivity under conditions of water scarcity and soil salinity.

Research basis and methodology

The experiment was designed and implemented according to widely recognized methodological guidelines. These included the Methods of Conducting Field Experiments (UzPITI, Tashkent, 2007, pp. 8–51); Recommendations on Rice Cultivation in the Republic of Karakalpakstan (Nukus, 2018); V.B. Zaitsev's Rice Irrigation System (Moscow: Kolos, 1975); Methods of Hydromeliorative Research in Rice Irrigation (Krasnodar, 1977); and B.A. Dospekhov's Methodology of Field Experiment (Moscow: Kolos, 1985). These references provided the experimental framework, data collection standards, and statistical approaches for interpreting results.

Experimental objects

Two rice varieties were selected for the study: Gulistan, an ultra-early maturing variety widely adapted to local conditions, and Almaz, a long-grain variety known for its grain quality. Prior to field transplanting, the germination ability and growth energy of seeds from both varieties were evaluated under laboratory conditions to ensure seed quality.

Nursery preparation and seedling raising

In early spring, a nursery was established to raise seedlings. For each variety, a plot measuring 5 × 2 m was prepared. The soil was manually tilled, leveled, and watered before sowing. Seeds were sown on May 25–26, and seedling emergence occurred by the end of May. During the nursery phase, regular irrigation was applied to maintain favorable moisture conditions, and weeds were manually removed. The seedlings were grown for about 30–35 days until they reached the appropriate stage for transplanting.

Field transplantation and experimental design three

After harvesting the preceding winter wheat crop, rice seedlings were transplanted from the nursery to the field on July 1–2. The experiment was conducted in plots of 6 m² with replications, arranged in a randomized block design. The following treatments were tested:

1. Control – manual broadcasting of seeds into water;
2. Transplanting at a density of 15 × 10 × 3 (three seedlings per hill, 15 cm between rows, 10 cm between plants);
3. Transplanting at a density of 10 × 10 × 3 (three seedlings per hill, 10 cm spacing both ways).

Data collection and biometric measurements

Observations on plant growth and development were recorded throughout the growing season. Phenological observations (dates of emergence, tillering, panicle initiation, flowering, and maturity) were documented. Morphovisual assessments were conducted to evaluate plant height, number of stems, productive stems, panicle length, number of grains per panicle, weight of one panicle, and 1000-grain weight. These biometric indicators were measured according to standard procedures on randomly selected plants from each plot.

Water consumption

Irrigation water use was measured under both methods—manual broadcasting and seedling transplantation. Water meters installed at the pump and field inlets were used to record irrigation volumes at each application. Water use efficiency was then calculated by comparing total water consumption with the yield obtained under each treatment.

Economic efficiency

An economic assessment was carried out by calculating the total costs of each treatment (including seed consumption, fertilizer application, irrigation, and labor), gross income based on the market price of rice grain, net profit, and profitability index (%). The selling price of rice grain was fixed according to the prevailing regional market value at the time of harvest.

Statistical analysis

Data were statistically processed using the methods of B.A. Dospekhov (1985). The means of replications were analyzed, and significant differences among treatments were tested using standard analysis of variance (ANOVA). Biological efficiency of the fungicide and planting method was calculated as the percentage reduction of disease incidence or yield improvement compared with the untreated control.

Timeframe

The research was conducted during the summer growing season of 2024, with nursery establishment in May, transplanting in early July, and harvesting at the end of September. This period corresponded to the secondary cropping system in Karakalpakstan, where rice is cultivated after the harvest of winter wheat.

3 Results and Discussion.

In rice cultivation, the complete germination of seeds and the establishment of seedlings at a sufficient density is one of the most challenging tasks, requiring good field preparation for sowing and the creation of favorable conditions for seed germination.

In our experimental studies, under the conditions of Karakalpakstan, the objective was to examine the effect of seedling transplantation and seedling density, when used as a successive crop, on the growth and development of rice plants. For this purpose, the germination ability of rice seeds was first tested under laboratory conditions.

Table 1.

Germination of rice seeds in the nursery and survival of plants at the end of the vegetation period

Varieties	Indicators, %	Under laboratory conditions	Under field conditions
Gulistan	Growth energy, %	93	-
	Germination, %	97	49
	Survival, %	-	71
Almaz	Growth energy, %	94	-
	Germination, %	98	52
	Survival, %	-	63

According to the data from Table 1, under laboratory conditions, the growth energy of the seeds of the selected rice variety Gulistan was 93%, and germination was 97%. For the variety Almaz, these indicators were higher by 1%, respectively. In field conditions, the germination rate for the varieties was 49–52%. By the end of the vegetation period, when the survival rate of rice plants was determined, the number of surviving plants was 71% in the variety Gulistan, while in the variety Almaz this figure was 8% lower.

It was established that the seeds of the local ultra-early maturing variety Gulistan and the long-grain variety Almaz fully meet the requirements in terms of germination and plant survival when sown in the nursery and throughout the vegetation period.

One of the main indicators determining rice yield is its biometric characteristics. It has been confirmed that yield is determined by parameters such as the length of the panicle, the number of filled grains per panicle, and the weight of 1000 grains [8]. In the experiment, samples were taken to analyze the biometric indicators of rice plants, and the biometric parameters of the yield elements were determined.

Table 2.

Effect of different rice planting methods on the biometric indicators of yield components

Variants	Planting scheme	Plant height, cm	otal number of stems	Number of productive stems	Panicle length, cm	Number of grains per panicle	Weight of one panicle, g	1000-grain weight, g
"Gulistan" variety								
1	Manual water broadcasting	73,2	85,6	54,3	15,6	107,2	3,4	33,0
2	15x10x3	77,6	83,3	67,0	16,7	157,8	4,8	33,4
3	10x10x3	79,1	79,3	61,5	16,5	150,0	4,1	33,1
"Almaz" variety								
1	Manual water broadcasting	75,7	112,1	77,1	16,2	89,6	2,5	29,3
2	15x10x3	82,5	110,1	83,3	18,2	95,0	2,6	32,4
3	10x10x3	82,8	110,6	78,9	17,5	90,6	2,5	29,6

The biometric evaluation of Gulistan and Almaz rice varieties under different planting methods showed significant variation in growth and yield components. For Gulistan, manual broadcasting produced shorter plants (73.2 cm), fewer productive stems (54.3), and lighter panicles (3.4 g). Transplanting at 15×10×3 density improved these traits: plant height reached 77.6 cm, productive stems increased to 67.0, panicle length extended to 16.7 cm, and grains per panicle rose to 157.8. Panicle weight also increased to 4.8 g, and 1000-grain weight was 33.4 g. At 10×10×3 density, values were lower than at 15×10×3.

For Almaz, manual broadcasting produced 77.1 productive stems, panicle length of 16.2 cm, and 89.6 grains per panicle. Transplanting at 15×10×3 improved performance, with 83.3 productive stems, 18.2 cm panicle length, 95.0 grains per panicle, and 1000-grain weight of 32.4 g.

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Overall, the 15×10×3 density provided superior biometric indicators, confirming the advantages of optimized transplanting. Grain yield results are shown in Table 3.

Table 3.
Grain yield of rice grown under different planting methods

Planting method	Replications			Average yield, q/ha
	I	II	III	
"Gulistan" variety				
Manual water broadcasting	65,7	63,6	68,1	65,8
Transplanting at 15×10×3 density	71,3	76,1	71,9	73,1
ransplanting at 10×10×3 density	66,2	70,2	70,6	69,0
"Almaz" variety				
Manual water broadcasting	56,3	54,9	58,9	56,7
Transplanting at 15×10×3 density	68,4	62,2	61,7	64,3
ransplanting at 10×10×3 density	60,9	58,3	61,7	60,1

For the variety Gulistan, LSD05 = 4.88.
For the variety Almaz, LSD05 = 5.32.

The study revealed distinct yield differences between manual broadcasting and transplanting methods. For Gulistan, manual broadcasting produced 65.8 q/ha, while transplanting at 15×10×3 increased yield to 73.1 q/ha; at 10×10×3 density, yield was 69.0 q/ha. In Almaz, manual broadcasting resulted in 56.7 q/ha, whereas transplanting at 15×10×3 produced 64.3 q/ha, and 10×10×3 yielded 60.1 q/ha. In both varieties, the highest yields were obtained at the 15×10×3 transplanting density.

These improvements are linked to stronger biometric indicators, including productive stem number, panicle length, grains per panicle, and 1000-grain weight. In Gulistan, transplanting at 15×10×3 provided 7.3 q/ha more than broadcasting and 3.2 q/ha above 10×10×3. Similarly, in Almaz, gains of 7.6 and 4.2 q/ha were observed. Notably, higher yields were achieved with fewer seedlings per hectare, making the method resource-efficient.

Water use efficiency was also assessed with pump-installed meters, ensuring precise irrigation calculations under each planting method.

Table 4.

Effect of different rice planting methods on irrigation water consumption

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Months	June	July			August			Sep-tembe	Plot area, m^2	Water consumption, m^3	Irrigation rate, m^3/ha
	III	I	II	III	I	II	III	I			
Planting method	Manual water broadcasting – control										
Water consumption, m^3	5,8	4,8	5,9	5,6	7,8	6,9	5,8	5,8	205,2	48,4	23592
Planting method	Transplanted										
Water consumption, m^3	-	3,8	4,2	4,6	3,9	3,6	3,4	-	161,6	23,5	14542

In the manual broadcasting method, rice fields were flooded in late June with 5.8 m³ of water. Consumption rose through July to 5.9 m³, peaked at 7.8 m³ in early August, and declined to 5.8 m³ in September. The total irrigation norm reached 23.5 thousand m³/ha. In the transplanting method, water use began in July at 3.8 m³, increased slightly to 4.6 m³, then declined to 3.4 m³ in August. The total norm was 14.5 thousand m³/ha—9,000 m³/ha less than broadcasting. Savings resulted from nursery growth and no thick water layering. Economic results are shown in Table 5.

Table 5.

Economic efficiency of rice cultivation by the seedling method

№	Crop type	Area, ha	Yield, q/ha	Total production, tons	Total expenses, thousand UZS	Including						Water expenses	Gross income, thousand UZS	Net profit, thousand UZS	Profitability, %
						Seed consumption		Mineral fertilizer		Chemical products					
						kg	Amount	kg	Amount	kg	Amount				
1.	Manual broadcasting	1	61,2	6,1	25615	250	3125	600	1614	1	2000	2400	46250	20510	80
2.	Transplanted	1	66,6	6,6	19962	70	875	450	1211	-	-	14,00	49875	29913	149

According to the data from Table 5, in the manual broadcasting method, the average yield was 61.2 q/ha. For cultivating 1 ha, a total cost of 25,615 thousand UZS was spent, including 1,456 thousand UZS for fuel, 1,614 thousand UZS for mineral fertilizers, 3,125 thousand UZS for seed, 2,000 thousand UZS for chemicals, and 2,400 thousand UZS for water. The total harvested product was 6.1 tons, which was sold at 7,500 UZS per kilogram, providing a total income of 46,250 thousand UZS. Based on the calculations, net profit amounted to 20,510 thousand UZS, and profitability was equal to 80%.

When these data were compared with the transplanting variant, it was found that in this variant, yield was higher by 5.4 q/ha, total costs were reduced by 4,653 thousand UZS, income was higher by 3,625 thousand UZS, net profit increased by 9,403 thousand UZS, and profitability was 69% higher.

Water-related expenses were 2,400 thousand UZS per hectare in the manual broadcasting method and 1,400 thousand UZS in the transplanting method.

The reason for the higher economic efficiency in the transplanting variant was the higher yield combined with reduced expenses for seed, fertilizer, and irrigation water.

The results of our experiments in Karakalpakstan align with international and regional studies on rice transplanting and water-saving technologies. Transplanting seedlings at a density of 15×10×3 increased yield by 7.3 q/ha in the Gulistan variety and 7.6 q/ha in Almaz compared with manual broadcasting, while irrigation water use declined by about 9,000 m^3/ha.

Similar effects of transplanting have been widely reported. Liu et al. [1] and Pasuquin et al. [2] showed that younger seedlings transplanted at proper densities improved tillering and yields in Asian environments. Xu et al. [3], through a meta-analysis, confirmed that transplanting consistently outperforms direct seeding in yield stability. Our findings with Gulistan and Almaz are in full agreement.

Water savings were also significant. Ishfaq et al. [4], Brar et al. [5], and Mallareddy et al. [6] demonstrated that alternate wetting and drying (AWD) irrigation reduces water use by 20–40% without yield loss. Although AWD was not tested in our trials, transplanting alone achieved comparable efficiency. Studies by Suwanmaneepong et al. [7] and Howell et al. [8] also emphasized the feasibility of such practices under GAP standards.

Economically, transplanting showed 149% profitability, exceeding the 20–40% gains reported by Brar et al. [5]. In saline soils and secondary cropping systems, this method is particularly advantageous. The methodological framework relied on Zaitsev [13, 14], whose hydromeliorative recommendations remain relevant.

Thus, our results are locally and globally significant, supporting broader adoption of seedling transplanting in the Aral Sea basin.

4 Conclusions

1. As a result of cultivating rice by the seedling method in the Karakalpakstan region, the vegetation period lasted 90–100 days. In field conditions, seed germination was 49–52%, and by the end of the vegetation period, the number of surviving plants remained at 71–63%. Therefore, the ultra-early maturing variety Gulistan and the long-grain variety Almaz are recommended as suitable varieties for seedling preparation.

2. Rice seedlings has been grew in nursery conditions for 30–35 days. During the seedling preparation process, soil moisture was consistently maintained. As a result, in the

seedling method, the amount of irrigation water consumed decreased by approximately 9,000 m³/ha compared to the traditional method.

3. According to the biometric indicators of rice yield elements, when transplanted at a density of 15×10 cm (three seedlings per hill), the number of productive stems ranged from 6.2 to 15.7, and panicle length was longer by 1.1–2 cm. Consequently, yield was on average 7.5 q/ha higher compared to the traditional method.

4. Based on economic efficiency calculations, in the seedling method, income increased by 3,625 thousand UZS, net profit by 9,403 thousand UZS, and profitability was 69% higher compared to the traditional method.

References:

1. Liu, Q., Peng, S., Yang, J., & Wang, Z. (2017). Effects of seedling age and cultivation 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. Pasuquin, 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). Comparing the grain yields of 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 and eco-friendly 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, energy and economic analysis of transplanting methods with different irrigation regimes in Basmati rice. Agricultural Water Management, 158, 189–195. https://doi.org/10.1016/j.agwat.2015.04.018
6. Mallareddy, M., Reddy, P. S., & Malepati, R. R. (2023). Maximizing water use efficiency in rice farming: A comprehensive review of innovative irrigation management technologies. Water, 15(10), 1802. https://doi.org/10.3390/w15101802
7. Suwanmaneepong, S., Jeerachaipaisarn, K., Dumrongthai, S., & Prom-on, S. (2023). Alternate wetting and drying as water-saving technology: Adoption intention under GAP in Thailand. Water, 15(3), 402. https://doi.org/10.3390/w15030402
8. Howell, K. R., Shrestha, P., & Dodd, I. C. (2015). Alternate wetting and drying irrigation maintained rice yields despite half the irrigation volume, but faces adoption barriers for smallholders. Food and Energy Security, 4(2), 144–157. https://doi.org/10.1002/fes3.67
9. Carrijo, D. R., Li, C., Parikh, S. J., & Linquist, B. A. (2019). Irrigation management for arsenic mitigation in rice grain: Timing and severity of a single soil drying. 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). Exploring innovations to sustain rice production in Central Asia: A case study from the Khorezm region of Uzbekistan. In Restructuring Land Allocation, Water Use and Agricultural Value Chains (pp. 63–76). De Gruyter. https://doi.org/10.14220/9783737002974.63

11. Schlubach, J. (2021). Downscaling model in agriculture in Western Uzbekistan: Climatic trends and growth potential along field crops physiological tolerance. Heliyon, 7(5), e07028. https://doi.org/10.1016/j.heliyon.2021.e07028
12. Conrad, C., Schorcht, G., Tischbein, B., et al. (2010). Per-field irrigated crop classification in arid Central Asia using multi-temporal MODIS data. Remote Sensing, 2(4), 1035–1056. https://doi.org/10.3390/rs2041035
13. Zaitsev, V. B. (1975). Rice irrigation system. 3rd revised and expanded edition. Moscow: Kolos, 351 p.
14. Zaitsev, V. B. (1977). Methodology of hydromeliorative research during rice irrigation. Krasnodar, 109 p