

Selection Of Promising Rice Samples Based On Technological Quality Indicators In Rice Breeding

 Kamalov Miyirbek Murat ugli

PhD student, Karakalpakstan Institute of Agriculture and Agrotechnologies, Uzbekistan

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Abstract: The article evaluates the technological quality indicators of selected rice samples. The study determined grain translucency, bran yield, total milled rice yield, whole grain yield, and broken rice content, with the Sanam variety used as the standard. The results revealed significant differences among the samples in key technological traits. Some samples demonstrated total rice yield and whole grain percentages comparable to or higher than those of the standard variety. Variations in broken rice content were found to have a substantial effect on overall grain quality. The obtained results make it possible to identify promising rice samples with high technological quality for further use in rice breeding programs.

Keywords: Rice, technological quality, milling yield, whole grain yield, broken rice, breeding.

Introduction: Rice (*Oryza sativa* L.) is one of the most widely cultivated cereal crops worldwide and plays a crucial role in food security and economic development. In rice breeding programs, not only yield performance but also the technological quality of the grain is considered a key criterion. Technological quality indicators include grain hullability, translucency, grain breakage, total milled rice yield, and head rice yield, all of which determine processing efficiency, product quality, and consumer acceptance.

In recent years, greater attention has been paid in rice breeding to quality traits such as mechanical strength of the grain, degree of translucency, and susceptibility to breakage, as these characteristics directly affect milling efficiency and head rice recovery. High grain breakage leads to increased fragmentation during processing, resulting in greater losses and reduced product quality. Therefore, the assessment of technological quality parameters and comparative evaluation among varieties constitute an integral part of the rice breeding process.

Furthermore, the use of standard varieties for evaluating new breeding lines enables scientifically sound decision-making and facilitates the identification of promising genotypes. In this context, technological quality indicators serve as key criteria in selecting donor varieties and developing high-quality, export-

oriented rice cultivars.

Studies conducted in Karakalpakstan indicate that although some promising rice varieties and lines exhibit high yield potential, their grain quality characteristics are often unsatisfactory. In such cases, increased bran yield, reduced head rice recovery, or a high proportion of broken rice are observed, which fail to meet the requirements of processing enterprises and consumers.

Abiotic stresses—including drought, extreme temperatures, heavy metals, and salinity—have a significant impact on plant biochemical processes, growth, and development, ultimately leading to reduced agricultural productivity and posing risks to food security. Among these factors, soil salinity is recognized as one of the major global constraints limiting crop productivity, as it directly affects soil properties, plant physiological processes, and yield formation [3].

Selection for tolerance to abiotic and biotic stresses is therefore considered an effective strategy to mitigate yield losses. Rice is the most widely grown cereal crop in Asia and serves as a staple food for a large proportion of the world's population, with more than 90% of global rice production and consumption concentrated in this region [4].

Under the harsh soil and climatic conditions of Karakalpakstan, rice varieties must be capable of producing stable yields and exhibiting tolerance to multiple stress factors [1]. At the same time, water scarcity represents a serious challenge in the region, as irrigation resources are often insufficient, further complicating rice cultivation for farmers [2].

Therefore, the main objective of this study is to evaluate the technological grain quality indicators of rice samples selected from a collection nursery, to compare them with the Guliston standard variety, and to identify promising genotypes for use in breeding programs. The obtained results provide an important scientific basis for the future development of high-yielding, stress-tolerant, and high-quality rice varieties.

METHODS

The study was conducted at the Grain and Rice Scientific Production Association. Methods based on the standards of the International Rice Research Institute (IRRI) were applied for the quantitative and qualitative evaluation of rice grain forms.

Rice grains were dehulled and polished using a micromputer RicePolisher SKZ 111 B-4 milling device. Grain shape was determined using the length-to-width ratio (L/W). The external characteristics of rice grains were visually assessed without the use of specialized instruments.

Each fraction was weighed using an electronic balance with an accuracy of 0.01 g, and the results were expressed as percentages according to the following formula:

$$\text{Percentage (\%)} = (\text{Fraction weight} / 100 \text{ g}) \times 100$$

Based on these measurements, the following key

indicators were calculated:

$$\text{Total milled rice yield (\%)} = \text{Head rice} + \text{Cracked rice} + \text{Broken rice}$$

$$\text{Bran yield (\%)} = (\text{Bran weight} / 100) \times 100$$

$$\text{Broken rice content (\%)} = (\text{Broken rice} / 100) \times 100$$

$$\text{Head rice yield (\%)} = (\text{Head rice} / 100) \times 100$$

RESULTS AND DISCUSSION

The evaluation of technological quality indicators of newly developed rice breeding lines and varieties represents an important stage in assessing the practical value of breeding outcomes. In rice breeding, not only yield performance but also processing suitability, grain quality, and compliance with market and export requirements are considered priority criteria. Technological quality parameters—such as complete grain maturity, grain translucency, bran and milled rice yield, and the proportions of whole and broken grains—provide a comprehensive assessment of the genetic and agronomic advantages of breeding materials. Based on these indicators, it becomes possible to recommend highly efficient and economically profitable varieties for production, to further improve breeding programs, and to identify rice genotypes best adapted to local agroecological conditions (see Table 1).

The T-1/10 and T-20-11 lines showed grain maturity values of approximately 95 ± 1.3%, indicating a high level of complete grain development. Although the T-69 and T-136 lines exhibited relatively lower values (92 ± 1.2%), they were also characterized by an optimal grain structure. At an LSD_{0.05} value of 1.5, the observed differences among the lines were assessed as statistically significant.

Table 1

Classification of technological quality indicators of selected rice lines

No	Sample Name	Grain type	Grain Translucency (%)	Rice bran yield, g	Total milled rice yield, g	Head rice yield, g	Broken rice yield, g
1	Sanam (st)	d/z	96 ±1.25	22.5 ±0.42	77.5 ±0.98	70.2 ± 0.83	7.3 ± 0.15
2	T-1/10	d/z	95 ±1.35	22.0 ±0.48	78.0 ± 0.86	57.0 ± 1.42	21.0 ± 0.66
3	T-69	d/z	92 ±1.22	31.7 ±0.61	68.3 ± 0.94	59.0 ± 1.23	9.3 ± 0.21
4	T-20-11	d/z	95 ±1.28	24.2 ±0.39	75.8 ± 0.88	63.6 ± 1.04	12.2 ± 0.28
5	T-136	d/z	92 ±1.18	28.3 ±0.54	71.7 ± 0.91	61.3 ± 0.97	10.4 ± 0.25
LSD _{0.05}			1,5	1,7	1,6	1,8	1,5
CV %			1.3–1.4	1.6–2.2	1.1–1.4	1.2–2.5	2.0–3.1

Grain translucency is an important indicator that determines the external appearance of rice grains and their susceptibility to breakage during milling. In the present study, this parameter ranged from 22.0 to 31.7%, with the highest value observed in the T-69 line ($31.7 \pm 0.61\%$). This indicates a relatively higher amylopectin content in the starch structure of this line. In contrast, the Sanam standard, T-1/10, and T-20-11 lines exhibited translucency values within the range of 22–24%, classifying them as semi-translucent grain types. The coefficient of variation (CV = 1.6–2.2%) was low, indicating limited variability of this trait and strong genetic control.

Bran yield (hull fraction) reflects the amount of bran obtained during mechanical rice processing. This indicator varied between 68.3 and 78.0%, where higher values suggest dense and well-formed grains. The T-1/10 line recorded the highest total milled rice yield ($78.0 \pm 0.86\%$), distinguishing it as a valuable raw material for processing. The Sanam standard showed a similar result ($77.5 \pm 0.98\%$). The lowest value was observed in the T-69 line ($68.3 \pm 0.94\%$), which can be explained by relatively lower grain mass in this genotype.

Head rice yield (percentage of unbroken grains) is a key determinant of final product quality. According to the results, the Sanam standard exhibited the highest head rice yield ($70.2 \pm 0.83\%$). The T-20-11 line recorded $63.6 \pm 1.04\%$, followed by T-136 ($61.3 \pm 0.97\%$), T-69 ($59.0 \pm 1.23\%$), and T-1/10 ($57.0 \pm 1.42\%$). These results indicate that some newly developed lines have not yet achieved full breeding stability in maintaining an optimal balance between yield and grain quality. Nevertheless, at $LSD_{0.05} = 1.5$, the observed differences were statistically significant, suggesting that quality stability in certain lines can be enhanced through further selection.

The technological quality indicators presented in Table 1 enable a comprehensive analysis of rice varieties during processing. Each line was evaluated in terms of its specific biochemical and mechanical characteristics, overall yield, grain density, grain integrity, and stability of product quality. The results demonstrate that technological traits of rice varieties are influenced not only by genetic factors but also by regional agroecological conditions and cultivation practices. For example, high total yield combined with low broken rice content is typically achieved when crops grow under favorable conditions with appropriate agronomic management throughout the entire growing season. Conversely, varieties with a high breakage rate often exhibit reduced nutrient density and weaker mechanical grain structure.

These findings highlight that rice breeding should focus not only on yield potential but also on grain structure and integrity to meet processing and export requirements. Grain translucency and bran yield also affect product quality during industrial processing and storage duration. In some newly developed breeding lines, high technological performance may not yet reflect complete genetic stability; however, low CV values indicate strong genetic regulation of quality traits, providing a solid basis for future breeding improvement.

The high total milled rice yield observed in the T-1/10 line and the high head rice yield of the Sanam standard represent an important foundation for hybridization programs and donor selection. Moreover, the application of appropriate laboratory and field evaluation methods, along with reliable statistical criteria ($LSD_{0.05} = 1.5$), enhances the objectivity of the results. The technological characteristics of rice varieties developed in the region are closely linked to agroecological factors such as soil salinity, fluctuating spring temperatures, wind intensity, and salt deposition. Many biological and technological parameters of these lines are therefore of strategic importance for adapting breeding programs to market demands and export standards.

Broken rice yield, which negatively affects processing efficiency, ranged from 7.3 to 21.0%. The lowest value was recorded in the Sanam standard ($7.3 \pm 0.15\%$), indicating high mechanical grain strength. The highest breakage rate was observed in the T-1/10 line ($21.0 \pm 0.66\%$), suggesting greater susceptibility to mechanical damage during milling. The T-20-11, T-136, and T-69 lines showed intermediate values of $12.2 \pm 0.28\%$, $10.4 \pm 0.25\%$, and $9.3 \pm 0.21\%$, respectively.

Overall, the technological quality traits of the developed rice lines exhibited low variability (CV = 1.1–3.1%), confirming their genetic stability. Compared with the Sanam standard, some lines (particularly T-1/10) showed higher total milled rice yield, whereas others (T-20-11 and T-136) demonstrated more stable head rice yield. Consequently, the T-1/10 line is promising in terms of processing efficiency and high total yield; the T-69 line is distinguished by strong grain structure associated with translucency and bran fraction; and the T-20-11 and T-136 lines are economically advantageous due to high head rice yield and low breakage rate.

Thus, each line corresponds to specific breeding objectives:

T-1/10 – for high total yield and export-oriented rice production;

T-69 – for breeding programs targeting high starch

content and translucent grains;

T-20-11 and T-136 – for developing processing-resistant varieties with a high proportion of whole grains.

The results indicate that under the conditions of Karakalpakstan, the technological quality indicators of the developed rice lines show a clear improvement trend compared with the standard variety. Total milled rice yield ranged from 68.3 to 78.0%, while head rice yield varied between 57.0 and 70.2%, with all lines meeting export quality requirements exceeding 60%. Broken rice yield ranged from 7.3 to 21.0%, reflecting different levels of mechanical stability during processing.

CONCLUSION

The results demonstrated significant genotypic differences among the selected rice lines in terms of technological quality indicators. The T-1/10 line was distinguished by high total milled rice yield, whereas the T-20-11 and T-136 lines showed higher head rice yield and lower broken rice content. The low variability of technological traits (CV = 1.1–3.1%) confirms their genetic stability. These findings indicate that the evaluated lines can be recommended as promising genetic resources for breeding high-quality and processing-resistant rice varieties.

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