



## Results and prospects of wheat breeding in Kyrgyzstan

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**Abstract.** Wheat plays a crucial role in ensuring food security in the Kyrgyz Republic. Annually, approximately 250,000 hectares are allocated for wheat cultivation, with the area reaching up to 535,000 hectares in certain years (e.g. 1996). Wheat is grown on irrigated, semi-irrigated, and rainfed lands across the country and is used to produce bread and related products. The development and use of initial breeding material at the early stage of breeding programmes is a key factor in improving their effectiveness. This study aimed to evaluate the outcomes of wheat breeding programmes in Kyrgyzstan from 1935 to 2024, focusing on the development of high yielding and well-adapted varieties, and identifying future directions for their enhancement under the conditions of the Kyrgyz Research Institute of Agriculture. It was established that both cultivated and wild platforms are used as initial breeding material. The main methods employed in wheat breeding include the use of natural and hybrid populations, as well as induced mutations and polyploid forms. The use of both intraspecific and distant hybridisation in the breeding activities of the Department of Wheat Breeding and Primary Seed Production has enabled the development of original genetic material. Through individual selection, this material has led to the creation of varieties approved for cultivation in the Kyrgyz Republic, including *Lutescens 46*, *Adyr*, and *Erythrospermum 13*. In global climate change, the development of varieties adapted to local soil and climatic conditions remains a key objective. Individual selection helps to identify forms with increased adaptability, while the adaptive potential of winter wheat is enhanced by genetic recombination. Primary seed production remains a vital factor in the sustainable development of the sector. The Green Evolution of wheat breeding in Kyrgyzstan is associated with the introduction of high-yielding winter and spring wheat varieties possessing valuable agronomic traits. The study highlighted the need for further improvement in breeding programmes to ensure resilient agricultural production under changing climate conditions

**Keywords:** food; security; irrigation; initial material; the Green revolution; variety; primary seed production

### Introduction

Wheat plays a crucial role in ensuring food security in the Kyrgyz Republic. As the main food crop in Kyrgyzstan, wheat occupies between 250,000 and 535,000 hectares in certain years (National Statistical Committee of the Kyrgyz Republic, n.d.). A significant

proportion of these wheat crops are situated on non-irrigated or semi-irrigated lands. Increasing grain production and enhancing its economic efficiency are closely tied to the development and implementation of superior, high-yielding varieties (Urazaliev &

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Yesimbekova, 2016) As far back as the 20<sup>th</sup> century, scientists such as M. Tovstik *et al.* (1983) established that the yield of cereal crops depends by 25%-30% on the correct varietal choice, provided essential agricultural practices and cultivation technologies are adhered to.

The substantial growth in global grain production during the 20<sup>th</sup> century, exceeding 40%, is attributed to the selective improvement of cereals, with outstanding examples of wheat breeding efforts termed the Green Revolution (Pingali, 2024) Global climate change, manifesting as soil and atmospheric drought, alongside reduced water flow due to the disappearance of certain glaciers within the Kyrgyz Republic, has necessitated the creation of new wheat varieties possessing enhanced heat and drought tolerance Under irrigated conditions, there is a need to develop varieties that efficiently utilise high-input agricultural environments to boost their yield potential (Afanasyeva *et al.*, 2023). This necessitates a local adjustment of breeding programmes. For instance, late spring frosts often lead to erratic grain development and a sharp decline in yields, a problem particularly prevalent in early-maturing wheat varieties. Conversely, a shift in the frost-free period, extending it later into autumn, requires an adjustment of sowing dates, especially for facultative varieties. As the FAO (2016) notes, in the face of climate change, heat and drought resistance will become critical traits for cereal crops. Several countries have already introduced heat-tolerant wheat varieties developed from germplasm stored at CIMMYT (International Maize and Wheat Improvement Center) and the International Center for Agricultural Research in the Dry Areas (ICARDA). The CIMMYT-supported wheat improvement network is actively researching the possibility of developing high-yielding wheat varieties capable of thriving in Kazakhstan's increasingly hot summer seasons.

Research undertaken as part of the "Formation of the Gene Pool of Agricultural Crops for Sustainable and Competitive Development of the Agro-Industrial Complex of the Republic of Kazakhstan" project from 2012-2014 focused on establishing a gene pool adaptive to both biotic and abiotic stresses across Kazakhstan's main agro-climatic zones (Yesimbekova *et al.*, 2015). The intensification of the continental climate, which began in the Don region of Russia in the late 20<sup>th</sup> century, has continued even more significantly into the 21<sup>st</sup> century. This primarily leads to a greater amplitude in the manifestation of negative environmental factors, with drought emerging as the foremost concern, according to A. Grabovets & M. Fomenko (2015). In this situation, there is a growing need to create populations with more pronounced genetic variability. They recommend that ecological plasticity should be assessed primarily by the potential productivity of new varieties.

In the Kyrgyz Republic, the primary focus for wheat breeding aimed at drought resistance is the creation of varieties characterised by rapid development

during the spring, prior to the onset of summer drought. These varieties are designed to effectively utilise autumn-winter and spring soil moisture reserves. This strategy allows the grain-filling stage to conclude before the summer drought takes hold, a consideration that has guided the breeders (Lyubavina, 1984). Developing and creating an optimal varietal model, adapted for specific soil and climatic conditions, as well as for a broader geographical range, remains a pertinent challenge in winter wheat breeding (Korkhova *et al.*, 2023). The application of reliable quantitative criteria for trait expression, underpinned by a deep understanding of plant morpho-physiology and genetics, enables the prediction of a scientifically sound model for the ideal winter wheat variety for its intended cultivation zone, proving useful for breeders (Krishnappa *et al.*, 2021). Enhancing the adaptive potential of winter wheat varieties is achievable through the genetic mechanism of recombination. Obtaining unusual recombinations – known as transgressions – and then stabilising them in subsequent generations is currently a key area of focus.

One of the principal threats to food security stems from crop diseases and pests. For wheat, which provides 20% of the world's consumed calories, diseases play a significant role. M. Koysybaev (2018) notes that in the Central Asian republics, particularly the southern and south-eastern regions of Kazakhstan, yellow rust, septoria, and yellow spot are especially dangerous diseases for winter wheat. During years of epiphytotic yellow rust development in Tajikistan and Uzbekistan, grain losses on untreated fields could reach 30%-40% or more. This disease periodically appears in wheat crops within the Kyrgyz Republic. This necessitates an effective strategy for breeding for disease resistance. Several authors have developed principles and approaches for implementing precise disease control in wheat agro-phytocoenoses (Bespalova *et al.*, 2019). They emphasise that chemical treatments should only be applied when varieties are unable to cope with the disease independently.

The Italian scientist G. Azzi (1922) was the first to clearly articulate the idea of an ecological classification of wheat, characterising varieties based on their geographical distribution. To determine their adaptive potential, new Kyrgyz-bred varieties undergo ecological testing in the conditions of the Issyk-Kul basin (IEBS) and the Naryn zone (NES). For the identification of drought-resistant varieties, breeding material is sown under harsh rainfed conditions in the lowland area of the Chüy Valley (Zhany-Pakhta breeding farm). This study aimed to assess the effectiveness of wheat breeding efforts in Kyrgyzstan between 1935 and 2024, as well as to analyse the outcomes and future prospects of wheat breeding at the Kyrgyz Research Institute of Agriculture. The study employed methods of retrospective analysis of the Institute's breeding programmes from 1935-2024. This included evaluating the effectiveness

of using intraspecific and distant hybridisation, individual selection, and genetic recombinogenesis to develop adapted wheat varieties. A review of breeding prospects, considering climatic changes and primary seed production, was also conducted.

### Main directions in wheat breeding

In N. Vavilov's (1962) seminal work, *Scientific Bases of Wheat Breeding*, the practical application of dwarfing in wheat was set as a crucial objective. During the 1960s, this strategic challenge in the microevolution of the genus *Triticum* L. was successfully addressed by the distinguished breeder N. Borlaug. The highly productive semi-dwarf wheat varieties he developed are intrinsically linked to the Green Revolution – a significant increase in wheat yields achieved through breeding (Dorofeev *et al.*, 1987).

The alteration of plant architecture, notably in the 1930s when the Italian breeder Nazareno Strampelli used the Japanese variety Akakomyghi in crosses to create the short-stemmed winter wheat varieties, Ardito and San Pastore, can be considered the first Green Revolution. A striking example of effective breeding work is the creation of the winter wheat variety Bezostaya 1, a masterpiece of global breeding, by Academician P. Lukyanenko at the Krasnodar Research Institute of Agriculture. This variety, alongside Bezostaya 4, was cultivated in numerous countries worldwide for many years, leading to a doubling of yields through varietal replacement, which can rightly be termed the second Green Revolution (Bespalova, 2001). An analysis of the pedigree of many wheat varieties has revealed that the genetic lineage of Bezostaya 1, Bezostaya 4, Kavkaz, and Aurora flows through over 300 varieties developed worldwide (Rabinovich, 1972). The rapid, dramatic increase in yields in many countries during the early 1960s (particularly in India and Pakistan), achieved through the short-stemmed varieties created in Mexico (CIMMYT) by 1970 Nobel laureate N. Borlaug, became known as the Green Revolution. The origins of scientific breeding in Kyrgyzstan trace back to 1928 with the breeding and seed production department of the Republican Experimental Station. However, its work ceased in 1930, and all materials were transferred to the Central Asian Breeding Centre. Wheat breeding resumed in 1934 at the Frunze Integrated Agricultural Experimental Station, which was subsequently reorganised in 1937 into the Kyrgyz State Breeding Station, and then in 1956 into the Kyrgyz Research Institute of Agriculture. The Kyrgyz Breeding Centre was established there in 1971.

From 1938 onwards, breeding activities also commenced at key field stations in Przhhevalsk, Naryn, Nurus, and Uzgen. Pioneers in this field included G. Kuzmin, N. Konovalov, N. Moskvina, I. Ryzhey, V. Lyubimova, V. Nikolayev. In the initial years of this breeding work, varieties were developed using mass and individual

selection from existing local varieties. Subsequently, methods of intraspecific and intergeneric hybridisation were employed, followed by single or multiple selections. For example, the first spring-type varieties – Erythrosperrum 41, Erythrosperrum 14 (authored by M. Linchenko), and Ferrugineum 87 (authored by V. Lyubimova) – were derived through individual and mass selection from local wheat and subsequently regionalised between 1946 and 1954 for the Issyk-Kul and Tian Shan regions. In the late 1940s, new locally bred winter wheat varieties were developed in Kyrgyzstan, including Erythrosperrum 9 (I. Ryzhey and V. Nikolayeva), Erythrosperrum 72, and Erpitospermkum 115 (I. Ryzhey). Towards the end of the 1960s, a new rainfed winter wheat variety, Kyrgyzskaya 16, was created by M. Tovstik. During the same period, Kyrgyzskaya 3 (I. Ryzhey, R. Lyubavina) was developed and regionalised in 1960, along with Batkan Krasnaya (N. Bataleva, S. Batalev, V. Kantemirov), regionalised in 1957. Additionally, spring soft wheat varieties were developed at the Osh field station by M. Tovstik (Oshskaya or Taldykskaya) and at the Issyk-Kul experimental station by M. Nesterov (Przhevalskaya 1). In 1965, at the Osh Pedagogical Institute, I. Shuvalov bred the winter durum wheat variety Oshskaya 60. From 1968, a new Kyrgyz-bred variety, Dzhany-Budai (selected from Krasnodarskaya 362), was regionalised. Between 1961 and 1970, almost the entire wheat acreage in Kyrgyzstan (350,000 hectares) was sown with the Bezostaya 1 variety. Among the winter wheat varieties, only Kyrgyzskaya 16, grown under rainfed conditions, managed to withstand the dominance of Bezostaya 1 (Tovstik, 1969). Subsequently, from 1970 to 1980, Kyrgyz breeders extensively used Bezostaya 1 and other sources in hybridisation to develop and submit six new intensive-type varieties for State Trials, four of which were regionalised: Kyrgyzskaya 100, Intensivnaya, Erythrosperrum 80, and Frunzenskaya 60. During this same period, spring varieties were also bred and regionalised: Kyrgyzskaya Yubileynaya, a soft, semi-intensive type, and Kyrgyzsky Polukarlik, a durum wheat. At the Przhhevalsk irrigated variety testing plot, V. Mishchenko used Bezostaya 1 in hybridisation to create the winter soft wheat variety Przhevalskaya. In 1973, this variety yielded a record harvest of 11.05 tonnes per hectare, the highest in the entire previous history of State Variety Trials in the USSR. From 1975, Przhevalskaya was regionalised for the Issyk-Kul region.

Working as the director of the Main Botanical Garden of the USSR Academy of Sciences, N. Tsitsin utilised distant hybridisation – specifically crossing cultivated plants with wild relatives, such as wheat with couchgrass. This approach yielded a vast diversity of forms, including perennial and annual grain-forage wheat, which exhibited significant biological and morphological differences from all existing wheat species (Golikov, 2020). M. Tovstik, in collaboration with R. Lyubavina at the Kyrgyz Research Institute of Agriculture,

incorporated Bezostaya 1 into intergeneric hybridisation with elongated couch grass (*Agropyrum elongatum*) and the Tibetan dwarf wheat Tom Pouce. This effort resulted in large-eared, short-stemmed forms that were subsequently integrated into further breeding programmes. However, the first variety derived from this material, Lutescens 46, despite achieving a record yield of 11.85 tonnes per hectare at the Przhevalsk irrigated State Variety Trial site in 1984, exhibited poor grain quality due to weak gluten. Nevertheless, it was regionalised across all agricultural zones of the republic from 1987 (Udachin & Shakhmedov, 1984).

Among other Kyrgyz-bred varieties, Dzhanly-Budai (selected from Krasnodarskaya 362) has been regionalised since 1968. Wheat varieties developed in subsequent years for irrigated conditions – Erythrospermum 13, Tilek, Kyyal, Asyl, Dzhamin, Dank, Araket, Kasiyet, Almira, Melyanopus 223, Vassan and Nazdan – have demonstrated high efficiency and profitability in organised seed-producing, peasant, and other types of farms. The winter wheat variety Bermet was also recommended for use in the Kyrgyz Republic. However, due to its severe susceptibility to yellow rust and a drastic reduction in yield during an epiphytotic outbreak in the early 21<sup>st</sup> century, its production was discontinued. Conversely, varieties of soft winter wheat with plasticity, adapted for use in both arid, rainfed conditions and irrigated lands, have gained widespread adoption. These include Erythrospermum 760, Adyr, Kayrak, Ralyub, EHOL, and Taazhy (Ministry of Agriculture of the Kyrgyz Republic, 2023).

As of 2025, the older winter wheat varieties Erythrospermum 80 and Frunzenskaya 60 remain approved for use in the Kyrgyz Republic and are recommended for cultivation on both rainfed and irrigated lands. Annually, a significant acreage is dedicated to the facultative wheat variety Intensivnaya, which is recommended for cultivation under both rainfed and irrigated conditions.

### Soil and climatic conditions for research in the Kyrgyz Republic

The Kyrgyz Republic is situated in the north-eastern part of Central Asia, nestled between two major mountain systems: the Tian Shan and the Pamir-Alay. Only a tenth of the Republic's total area (198,500 km<sup>2</sup>) comprises intermontane pastures and basins, where the majority of agricultural activity is concentrated (Prokhorov, 1979). In some years, the total arable land in the Republic exceeds 1.2 million hectares. The climate of the Kyrgyz Republic is distinctly continental, characterised by significant fluctuations in air temperature, low humidity, moderate atmospheric precipitation, minimal cloud cover, and extensive periods of sunshine (averaging 2,600 hours annually).

The mountainous terrain dictates a pronounced vertical zonation in the distribution of climatic indicators, such as heat, moisture, and temperature. Desert and semi-desert climates prevail in the lowland areas, while the mountains experience steppe, forest-steppe,

meadow, and high-altitude tundra climates. The annual moisture regime is divided into two distinct periods: from October to April, moisture accumulates in the soil due to melting snow, as well as late autumn and early spring precipitation; and from late April to September, there is intense moisture depletion due to increased temperatures and strong winds, leading to high evaporation and plant uptake. The average annual relative humidity across Kyrgyzstan ranges from 50% to 70%. The lowest levels are typically recorded between July and September, while the highest values are observed between January and March (Mamytov *et al.*, 1966).

Cereal crops are cultivated across all agricultural zones in Kyrgyzstan. In the low and midmountain valleys, which benefit from extended frost-free periods, both winter and spring cereals, as well as maize, are grown. Higher-altitude valleys, with their shorter frost-free seasons, primarily focus on cereal crops. In certain regions experiencing harsh winters and brief summers, only spring cereals, predominantly barley, are cultivated. Wheat breeding in Kyrgyzstan is conducted for four distinct zones, each presenting varying natural and climatic conditions:

- rainfed conditions in hot and dry lowland valleys, which receive the highest amount of precipitation, mainly in winter and spring, and experience moderately severe, unstable winters. Varieties developed for this zone must be resistant to both soil and atmospheric drought, and exhibit rapid growth and development during the spring months;

- irrigated conditions in lowland valleys, where intensive-type varieties are required. These must respond well to irrigation and fertilisation, and possess high heat tolerance along with improved resistance to lodging and disease;

- mild conditions of the central and eastern Issyk-Kul basin, which call for intensive-type varieties suitable for both rainfed and irrigated systems, with good disease and lodging resistance;

- high-altitude valley conditions with short frost-free periods and cool summers, where varieties must be tolerant to night-time temperature drops.

In the Fergana, Chüy, and Talas valleys, as well as Eastern Issyk-Kul – regions that encompass the majority of the country's wheat-growing areas connection – there is an optimal balance of air temperature, daylight length, and solar radiation. These conditions provide a favourable climatic environment for the development of the agricultural seed production sector. The low atmospheric humidity during the summer (30%-32%), combined with other climatic factors, inhibits the development of plant pathogens. As a result, the produced agricultural seed material tends to be healthy. Furthermore, the sierozem soil and its subtypes, where the main wheat cultivation areas are located, yield high wheat harvests when recommended agricultural practices are followed. Therefore, greater attention should be given to the development of the agricultural seed production sector, including wheat, in Kyrgyzstan. This

would open avenues for intensification and make agriculture more profitable, thereby significantly elevating the economic standing (FAO, 2018).

Based on annual precipitation, rainfed lands are conventionally categorised into zones: one classification distinguishes between under-supplied (250-350 mm per year), partially supplied (350-500 mm), and well-supplied (over 500 mm); another uses classifications of 200-300 mm and over 400 mm, respectively (Borzyko & Simonov, 1935). The highest wheat yields (7-8 tonnes per hectare) are achieved on rainfed lands in the foothills and Eastern Issyk-Kul, where sufficient rainfall (450-800 mm per year) occurs. In the under-supplied rainfed areas of the country's valley regions, with insufficient moisture (200-350 mm per year), yields rarely exceed 1.5-2.5 tonnes per hectare. Furthermore, droughts occurring every 2-3 years frequently negate all efforts made by farmers. Achieving high yields under rainfed conditions is only possible with the use of droughtresistant and heat-tolerant varieties bred by the Kyrgyz Research Institute of Agriculture, such as Erythrosperrum 760, Erythrosperrum 80, Intensivnaya, and Taazhy.

### Research at the Kyrgyz Research Institute of Agriculture

In recent years, the wheat breeding programme at the Kyrgyz Research Institute of Crop Production, which focused on both winter and spring wheat varieties, has primarily employed hybridisation. This involves crossing introduced genetic material obtained from international centres such as CIMMYT-ICARDA, along with local varieties and lines (Pakhomov *et al.*, 2023). Various crossing types are utilised, including simple, paired, backcross, and saturating. Forced pollination is the standard method. Hybridisation is carried out in field conditions, with the selection of elite spikes, possessing desired characteristics, occurring within the F3 to F5 hybrid populations. The selected progenies are then studied in the first-year breeding nursery. Here, they are rigorously compared against the best-regionalised varieties. Stable lines demonstrating high productivity and resistance to lodging and diseases are advanced to the second-year breeding nursery. Promising lines identified from the second-year nursery are then moved to the control nursery. The final stage of evaluating selected varieties involves preliminary and competitive variety trials. Successful varieties are subsequently submitted for State Variety Trials, based on the results

of which they are approved for use. To obtain a patent for a new variety, the Department for the Examination of Agricultural Crops conducts a DUS examination over two years, following which Kyrgyzpatent issues a conclusion on the variety's protectability.

The wheat breeding and primary seed production department at the Kyrgyz Research Institute of Agriculture is currently focused on: "Creating wheat varieties adapted to environmental stress factors for both irrigated and rainfed lands, possessing a high level of economically valuable traits and characteristics, and conducting ecological testing". The considerable diversity of soil and climatic conditions, coupled with sharply defined vertical zonation, dictates two primary directions for wheat breeding in Kyrgyzstan: a) developing highly intensive varieties for irrigated agriculture, aiming for yields of up to 10 tonnes per hectare and above; b) creating varieties adapted to arid rainfed conditions, targeting yields of 3-5 tonnes per hectare and above.

Field experiments and seed production plantings are established on the semi-irrigated lands of the Kyrgyz Experimental Breeding Station, as well as on the rainfed experimental plot at Zhany-Pakhta breeding farm in Sokuluk District, Chüy Region. Ecological testing is also carried out at the Issyk-Kul Experimental Breeding Station and the Naryn Experimental Station. Breeding work follows a comprehensive scheme of the selection process: a study of the germplasm collection; hybridisation; cultivation and selection of hybrid populations (F2-F5); first-year breeding nursery; second-year breeding nursery; control nursery; preliminary trials; competitive variety trials; environmental and production testing; multiplication of promising varieties; submission of advanced lines for State Variety Trials; and submission of new varieties for DUS testing.

The winter soft wheat variety Adyr was developed at the Kyrgyz Research Institute of Agriculture using a hybridisation method. It originated from a cross between the variety Erythrosperrum 80 and a line derived from a cross involving a wheat-wheatgrass hybrid [Lutescens 25 x (Bezostaya 1 x wheatgrass hybrid) x Tom Pouce x Polukarlik 49]. It has been approved for use in the Kyrgyz Republic since 2001. This variety exhibits resistance to lodging, is drought-tolerant, and shows resistance to rust pathogens and loose smut. Furthermore, it possesses good baking qualities. Its potential grain yield in rainfed conditions with sufficient precipitation is 6.67 tonnes per hectare, rising to 9.50 tonnes per hectare under irrigated conditions (Table 1).

**Table 1.** Yield potential and grain quality of wheat varieties bred by the Kyrgyz Research Institute of Agriculture

No.	Variety	Growing conditions	Yield, t/ha	Grain quality				1,000 grain weight, g	Vitreousness, %	Overall baking score, point
				Protein, %	Gluten, %	GDI	Test weight, g/L			
1	Adyr	Irrigated Rainfed	9.5 6.67	14.6	29.0	80	810	48.3 40.0	92.0	4.8
2	Erythrosperrum 760	Irrigated Rainfed	9.2 6.35	13.6-14.9	28.4	83	800	37.0 40.0	94.5	4.7

Table 1. Continued

No.	Variety	Growing conditions	Yield, t/ha	Grain quality				1,000 grain weight, g	Vitreousness, %	Overall baking score, point
				Protein, %	Gluten, %	GDI	Test weight, g/L			
3	Kayrak	Irrigated Rainfed	8.35 6.55	12.6-13.2	25.1-28.4	60	790	43.6-45.8	93.0	4.5
4	Ralyub	Irrigated Rainfed	9.02 6.5	13.1	26.6	39	700	40.0	91.0	3.8
5	EHOL	Irrigated Rainfed	8.7 6.45	13.5	28.8	90	810	43.4-47.1	96.0	5.0
6	Intensivnaya	Winter wheat Spring wheat	9.65 6.35	13.4-16.0	28.9-35.5	85	790	36.2-47.6	91.0	4.9
7	Taazhy	Irrigated Rainfed	8.75 6.15	13.8	27.5	85	820	40.0	94.0	4.7

Source: developed by the authors

The winter soft wheat variety *Erythrosperrum* 13 was also developed using material derived from distant hybridisation. This variety originated from a cross of [Red River 68 x Bezostaya 1] x [Bezostaya 1 x A9 elongatum] x Tom Pouce, followed by a single selection in the F2 generation. This variety boasts a potential grain yield of 9.36 tonnes per hectare and exhibits good baking qualities. Its grain contains up to 14.4% protein and 29.9% gluten. It is characterised by moderate susceptibility to brown rust and common bunt but is resistant to loose smut and powdery mildew, and possesses high winter hardiness.

Through individual selection from the introduced Romanian variety F 474 S 82, the winter soft wheat variety Almira was developed. Similarly, the facultative variety Dzhamin was bred from the introduced Yugoslavian variety NS-55-58/VEE. Both these varieties are approved for use within the Kyrgyz Republic. Under a joint

project, 20 winter wheat varietal samples obtained from the Kazakh Research Institute of Agriculture and Plant growing underwent trials. During a severe yellow rust epiphytotic in the 2024 season, these samples proved tolerant and delivered high yields, comparable to the standard variety Adyr (6.35 tonnes per hectare). For the 2025 harvest, these varieties have been sown in arid rainfed conditions at the Zhany-Pakhta breeding farm.

Testing of 350 varietal samples obtained from CIMMYT has shown that they are virtually unaffected by yellow rust. This material is undergoing further breeding development. Eight varieties bred by the Kyrgyz Research Institute of Agriculture, namely Adyr, Kayrak, Ralyub, EHOL, Dank, Nazdan, Vassan, and Taazhy, are protected by patents (Fig. 1). In 2024, two soft wheat varieties and one durum wheat variety were submitted for State Testing Trials. A new winter soft wheat variety, Taazhy, has also been approved for use across the Kyrgyz Republic.



Figure 1. Wheat varieties bred by the Kyrgyz Research Institute of Agriculture, supported by patents

Source: authors' photo

A crucial aspect of the wheat breeding department's work is primary seed production. In 2024, high-generation wheat seeds (P1, P2, R1, R2) were produced across 53 nurseries. These were primarily transferred to the Kyrgyz Experimental Breeding Station (KEBS) for Sugar Beet for further multiplication.

In summary, the breeding and seed production work within the wheat breeding and primary seed production department at the Kyrgyz Research Institute of Agriculture is being conducted to a high standard. In recent years, new wheat varieties such as Nazdan, Vassan, and Taazhy have been developed and approved for use in the Kyrgyz Republic. Three new varieties have been submitted for State Testing Trials. A patent has been obtained for one variety, Vassan, and patents for eight wheat varieties are maintained annually. The primary seed production of bred varieties is ongoing at the Kyrgyz Research Institute of Agriculture, ensuring the planned implementation of their varietal rotation and renewal.

In 2024, the competitive variety trial conducted on the semi-irrigated lands of the KEBS for Sugar

Beet involved the study of 55 wheat varieties, planted in three replicates. Each plot for yield assessment measured 12 m<sup>2</sup>. The average yield for the soft wheat standard, Tilek, was 5.96 tonnes per hectare, while the durum wheat standard, Melyanopus 223, yielded 4.00 tonnes per hectare (Table 2). The most significant increases in grain yield over the standard (tonnes per hectare) among the winter soft wheat varieties were observed in: Erythrosperrum 302 (0.62), Erythrosperrum 518 (0.92), Lutescens 1457 (0.87), Nazdan (0.72), 6 WONIR 03-222 (1.41), RWKLDN 03-49 (2.80), selection No. 24 – Erythrosperrum 13 (2.76), 8WONIR 05-334 (1.05), 16 FAWWON 0911 (1.34), Lutescens 1704 (1.52), Erythrosperrum 1708 (0.32), Lutescens 1687 (1.78), Lutescens 1694 (1.95), Lutescens 1706 (2.76), Grecum 1667 (1.94), CACWITIR 132 (1.09), 16IWWIYTIR 139830 (2.23), and Dostuk (0.51). Among the durum wheat varieties, the following showed the greatest yield increases relative to the standard: S/r 1 (1.81), S/4 (2.99), IDYT-SA 0502 (2.37), IDYTMD 05-35 (2.84), ICARASHA-1 (3.38), SWANA 32 IDYT MD (1.27), and 35 IDYT\_MD 11-2 (2.36).

**Table 2.** Characteristics of winter wheat varieties in competitive variety trial, 2024

Col.	Origin, variety, line	Harvest, t/ha	Deviation from avg. standard, t/ha	Vitreous ness, %	Number of spikes, pcs.	Number of grains in spike, pcs	Grain weight per spike, g	1,000-grain weight, g	Test weight, g/L
1	Erythrosperrum 302	6.58	0.62	87.0	19.0	48.0	2.5	50.4	778
2	Erythrosperrum 518	6.89	0.92	91.0	18.6	42.8	2.1	48.8	760
3	Erythrosperrum 976	5.67	-0.29	67.5	21.4	49.7	2.6	52.0	761
4	Lutescens 1457	6.83	0.87	86.0	20.6	52.2	2.5	47.2	785
5	Tilek, standard	5.89	-0.07	76.0	21.0	55.4	2.1	39.8	742
6	Erythrosperrum 13	6.13	0.17	82.0	22.3	63.7	3.0	47.2	785
7	Nazdan	6.68	0.72	45.5	21.0	53.5	2.3	41.6	776
8	Erythrosperrum 1627	5.56	-0.4	98.0	20.6	45.9	2.1	46.4	–
9	Erythrosperrum 1686	5.24	-0.72	83.0	19.7	45.1	1.6	39.4	–
10	7 EYTIR03-9882	5.11	-0.85	87.0	20.5	44.7	2.0	38.6	777
11	6 WONIR03-222	7.37	1.41	73.5	21.7	63.9	2.1	40.8	760
12	6 WONIR03-228	4.75	-1.21	66.0	21.1	43.4	1.7	40.8	741
13	8 EITIR 04-9868	5.3	-0.65	74.5	18.9	43.4	1.6	39.2	–
14	RWKLDN 03-49	8.76	2.8	89.0	20.3	58.9	2.6	43.2	768
15	Tilek, standard	5.4	-0.56	88.0	21.9	56.0	2.2	40.8	794
16	Erythrosperrum 13	6.51	0.55	87.0	22.1	62.7	2.4	39.4	754
17	8 WONIR 05-334	7.01	1.05	82.0	20.4	53.4	2.1	43.2	747
18	16 FAWWON 0911	7.3	1.34	86.0	21.7	47.8	2.0	41.6	768
19	Lutescens 1704	7.48	1.52	92.0	20.3	49.3	1.7	42.4	760
20	Erythrosperrum 1708	6.28	0.32	86.5	21.4	50.5	2.4	39.6	730
21	Lutescens 1687	7.74	1.78	91.0	22.4	55.8	1.7	42.6	772
22	Lutescens 1694	7.91	1.95	89.0	23.5	54.9	2.5	44.0	756
23	Tilek, standard	6.48	0.52	85.0	22.6	47.1	2.0	42.8	760
24	Erythrosperrum 13	8.72	2.76	79.5	22.3	70.5	3.0	42.4	752
25	Lutescens 1695	6.47	0.51	88.0	22.3	39.2	2.1	51.2	792
26	Grecum 1697	4.45	-1.51	84.5	20.7	49.0	2.2	45.6	–
27	Lutescens 1706	7.72	2.76	84.0	24.7	55.0	2.7	50.4	738
28	Grecum 1667	7.9	1.94	70.5	21.1	57.3	2.4	40.0	770
29	13 IWWYTIR 1057	5.87	-0.09	59.5	19.6	63.1	2.7	44.8	770
30	1 <sup>st</sup> CACWITIR 132	7.05	1.09	47.5	20.9	54.8	2.2	40.8	747
31	1 <sup>st</sup> CACWYTIR 1310	5.57	-0.39	61.0	19.7	47.2	2.0	43.2	782
32	1 <sup>st</sup> CACWYTIR 1337	5.87	-0.09	66.0	18.2	48.6	1.8	36.0	748

Table 2. Continued

Col.	Origin, variety, line	Harvest, t/ha	Deviation from avg. standard, t/ha	Vitreousness, %	Number of spikes, pcs.	Number of grains in spike, pcs	Grain weight per spike, g	1,000-grain weight, g	Test weight, g/L
33	Tilek, standard	6.06	0.1	80.0	20.4	58.7	2.5	43.2	750
34	Erythrosperrum 13	6.31	0.35	75.0	21.6	64.9	2.5	39.2	760
35	16 IWWYTIR 139819	5.09	-0.87	76.0	19.4	53.1	1.9	35.4	770
36	16 IWWYTIR 139830	8.19	2.23	56.5	19.9	58.1	2.5	44.8	760
37	12 IWWYT-SA 1040	4.42	-1.54	49.0	19.2	48.9	1.4	36.2	736
38	Adyr	6.0	-0.04	75.5	21.5	49.9	2.2	40.8	774
39	12 IWWYTSA 1054	4.82	-1.14	93.0	19.1	57.1	2.4	47.6	741
40	12 IWWYTSA 1057	4.96	-1	86.0	20.8	45.5	2.0	45.2	771
41	Leucurum 121	5.21	1.21	89.0	24.4	40.0	1.8	46.4	781
42	Melyanopus 223, avg. std.	4.0	–	84.5	22.6	34.5	1.1	35.7	725
43	S/r 1	5.81	1.81	90.0	25.1	47.4	2.2	44.0	778
44	S/r 4	6.99	2.99	93.0	19.3	55.3	2.6	46.4	754
45	Melyanopus 223, std.	4.31	0.41	87.0	23.2	31.6	1.2	37.6	735
46	Kyrgyz Polukarlik	4.84	0.84	75.5	18.9	43.0	2.0	52.6	776
47	IDYT-SA 05-02	6.37	2.37	73.0	19.0	55.1	2.9	52.0	754
48	IDYT_MD 05-35	6.84	2.84	79.5	19.5	50.6	2.7	50.4	768
49	ICARASHA 1	7.38	3.38	76.5	18.9	66.5	3.1	44.8	780
50	Melyanopus 223, std.	3.68	-0.32	82.0	21.9	27.3	0.9	33.8	715
51	SWANA 32 IDYT MD	5.27	10.27	74.5	18.8	50.1	2.4	46.4	784
52	35 IDYT – MD 11-2	6.36	2.36	71.5	18.7	49.8	2.3	46.6	770
53	Dostuk	6.47	0.51	65.0	20.7	56.1	2.3	40.8	770
54	Kyzyl-dan	4.76	-1.2	71.0	20.3	50.0	1.9	40.8	–
55	Bermet	3.35	-2.61	39.0	24.1	53.3	1.3	30.6	–
Avg.	Tilek, standard	5.96	–	83.0	21.5	54.3	2.2	41.7	762
	LSD 05		0.31						

Source: developed by the authors

Almost all varieties exhibited a high vitreousness of grain (60%-90%), except Bermet, which was severely affected by yellow rust. The test weight across all varieties ranged from 740 to 780 g/L, with Lutescens 1706 (738), 12 IWWYT-SA 1040 (736), and Melyanopus 223 (725) being exceptions. High 1000-grain weights were observed in the soft wheat varieties Erythrosperrum 302 (50.4 g), Erythrosperrum 518 (48.8 g), Erythrosperrum 976 (52.0 g), Lutescens 1457 (47.2 g), Erythrosperrum 13 (47.2 g), Lutescens 1706 (50.4 g), and Lutescens 1695 (51.2 g). Similarly, high values were seen in the durum wheat varieties Kyrgyz Polukarlik (52.6 g), IDYT-SA 05-02 (52.0 g), and IDYT-MD 05-33 (50.4 g). The tallest plants were found in the varieties Erythrosperrum 1708 (114 cm), Lutescens 1694 (111 cm), and Lutescens 1706 (117 cm).

The results of these investigations have been presented at numerous international scientific and practical conferences. In the view of the authors of this article, the entire process of developing new wheat varieties at the Kyrgyz Research Institute of Agriculture over the last 90 years (1934-2024) can be aptly described as the Green Revolution of wheat breeding in Kyrgyzstan. At the same time, it is considered necessary to strengthen efforts to establish licensing agreements with licensors in order to obtain commercial

compensation in the form of royalties for the use of patented varieties in seed production.

## Conclusions

The breeding and seed production work at the Kyrgyz Research Institute of Agriculture demonstrates consistent progress in developing high-yielding and adaptable wheat varieties for both semi-irrigated and rainfed lands. In recent years, three new soft wheat varieties – Nazdan, Vassan, and Taazhy – have been bred and approved for use across the Kyrgyz Republic, with a patent also secured for the Vassan variety. Patents for seven other varieties (Adyr, Kayrak, Ralyub, EHOL, Dank, Nazdan, and Taazhy) are consistently maintained, underscoring the high calibre of the breeding efforts. Two soft wheat varieties and one durum wheat variety have been submitted for State Testing Trials, and primary seed production ensures planned varietal rotation and renewal. The ecological trials of new varieties at the Issyk-Kul and Naryn experimental stations have allowed for an assessment of their adaptability to diverse soil and climatic conditions, including arid regions and areas with distinct vertical zonation. The use of hybridisation, individual selection, and the introduction of genetic material from international centres (CIMMYT, ICARDA) has been instrumental in creating

varieties with enhanced resistance to diseases, drought, and lodging, alongside superior baking qualities.

Future research will focus on intensifying efforts to create varieties with enhanced tolerance to climatic stresses, such as drought and extreme temperatures, by integrating modern genetic and biotechnological approaches. A key direction involves expanding collaboration with international breeding centres to introduce new genetic resources and implementing digital technologies for monitoring and analysing breeding material. It is also crucial to develop a robust system for licensing and securing royalties for the use of patented varieties, which will help improve the institute's material and technical resources. In the long term, plans include developing wheat varieties with improved nutritional characteristics to enhance food security in

Kyrgyzstan. The Green Revolution of wheat breeding in Kyrgyzstan over the past 90 years provides a solid foundation for sustainable agricultural development in the face of global challenges.

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### Conflict of Interest

None.

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## Кыргызстанда буудай селекциясынын жыйынтыктары жана келечеги

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**Аннотация.** Буудай Кыргыз Республикасында азык-түлүк коопсуздугун камсыз кылууда маанилүү роль ойнойт. Ар жыл сайын болжол менен 250 миң гектар жер буудай эгүүгө пайдаланылат, ал эми айрым жылдары (мисалы, 1996-жылы) бул көрсөткүч 535 миң гектарга чейин жеткен. Буудай республиканын шарттуу сугат жана кайракы жерлеринде өстүрүлүп, нан азыктарын өндүрүү үчүн колдонулат. Селекциялык иштин баштапкы этабында баштапкы материалды түзүү жана колдонуу анын натыйжалуулугун жогорулатуучу маанилүү фактор болуп саналат. Изилдөөнүн максаты – 1935-2024-жылдар аралыгында Кыргызстанда жогорку түшүмдүү жана жергиликтүү шарттарга ылайыкташкан буудай сортторун иштеп чыгуу боюнча селекциялык программалардын натыйжалуулугун баалоо жана Кыргыз дыйканчылык илимий-изилдөө институтунун шартында аларды өркүндөтүү мүмкүнчүлүктөрүн аныктоо болгон. Селекцияда баштапкы материал катары маданий жана жапайы өсүмдүктөрдүн формалары колдонулат. Буудай селекциясында баштапкы материалды алуу үчүн негизги ыкмалар катары жаратылыш жана гибриддик популяциялар, ошондой эле жасалма мутациялар жана полиплоиддик формалар пайдаланылат. Буудай селекциясы жана баштапкы үрөнчүлүк бөлүмүндө тукум ичиндеги жана алыскы гибриддештирүү ыкмаларын колдонуу оригиналдуу баштапкы материалды алууга мүмкүндүк берип, андан индивидуалдуу тандоо жолу менен Кыргыз Республикасында колдонууга уруксат берилген сорттор чыгарылган: Лютесценс 46, Адыр, Эритроспермум 13. Глобалдык климаттын өзгөрүшү шартында жергиликтүү топурак-климаттык шарттарга ылайыкташкан сортторду иштеп чыгуу актуалдуу маселе бойдон калууда. Индивидуалдуу селекция жогору адаптацияланган формаларды аныктоого өбөлгө түзөт, ал эми кышкы буудайдын адаптивдүүлүк потенциалын жогорулатуу генетикалык рекомбинация аркылуу жүзөгө ашырылат. Тармактын туруктуу өнүгүүсүнүн маанилүү фактору болуп баштапкы үрөнчүлүк калууда. Кыргызстандагы буудай селекциясынын “жашыл” эволюциясы жогорку түшүмдүүлүккө жана баалуу чарбачылык белгилерге ээ болгон кышкы жана жазгы буудай сортторун киргизүү менен байланыштуу. Изилдөө өзгөрүп жаткан климат шарттарында айыл чарба өндүрүшүнүн туруктуулугун камсыз кылуу үчүн селекциялык программаларды мындан ары өркүндөтүүнүн зарылдыгын көрсөттү

**Негизги сөздөр:** азык-түлүк; коопсуздук; сугат; баштапкы материал; “жашыл” эволюция; сорт; баштапкы үрөнчүлүк

## Результаты и перспективы селекции пшеницы в Кыргызстане

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**Аннотация.** Пшеница играет важную роль в обеспечении продовольственной безопасности Кыргызской Республики. Ежегодно под пшеницей занято 250 тысяч гектаров, а в отдельные годы (1996) площадь возделывания достигала 535 тысяч гектаров. Пшеница возделывается на орошаемых, условно орошаемых и богарных землях республики и используется для производства хлеба и хлебных продуктов. Создание и использование исходного материала на начальном этапе селекционной работы является важным фактором повышения ее эффективности. Целью исследования была оценка результативности селекционных программ по разработке высокопродуктивных и адаптированных сортов пшеницы в Кыргызстане за период с 1935 по 2024 годы, а также определение перспектив их совершенствования в условиях Кыргызского научно-исследовательского института земледелия. Установлено, что в качестве исходного материала в селекции используют культурные и дикие формы растений. В селекции пшеницы применяют следующие основные виды и способы получения исходного материала: естественные и гибридные популяции, а также искусственные мутации и полиплоидные формы. Использование внутривидовой и отдаленной гибридизации в селекционной работе отдела селекции и первичного семеноводства пшеницы позволило получить оригинальный исходный материал, из которого путем индивидуального отбора были созданы сорта, допущенные к использованию на территории Кыргызской Республики: Лютесценс 46, Адыр, Эритроспермум 13. В условиях глобального изменения климата актуальной задачей является разработка сортов, адаптированных к локальным почвенно-климатическим условиям. Индивидуальная селекция способствует выявлению форм с повышенной адаптивностью, а усиление адаптивного потенциала озимой пшеницы достигается за счет генетического рекомбинагеноза. Важным фактором устойчивого развития отрасли остается первичное семеноводство. «Зеленая» эволюция селекции пшеницы в Кыргызстане связана с внедрением высокопродуктивных сортов озимой и яровой пшеницы, обладающих ценными хозяйственными признаками. Исследование подчеркнуло необходимость дальнейшего совершенствования селекционных программ для обеспечения устойчивого сельскохозяйственного производства в условиях меняющегося климата

**Ключевые слова:** продовольствие; безопасность; орошение; исходный материал; «зеленая» эволюция; сорт; первичное семеноводство