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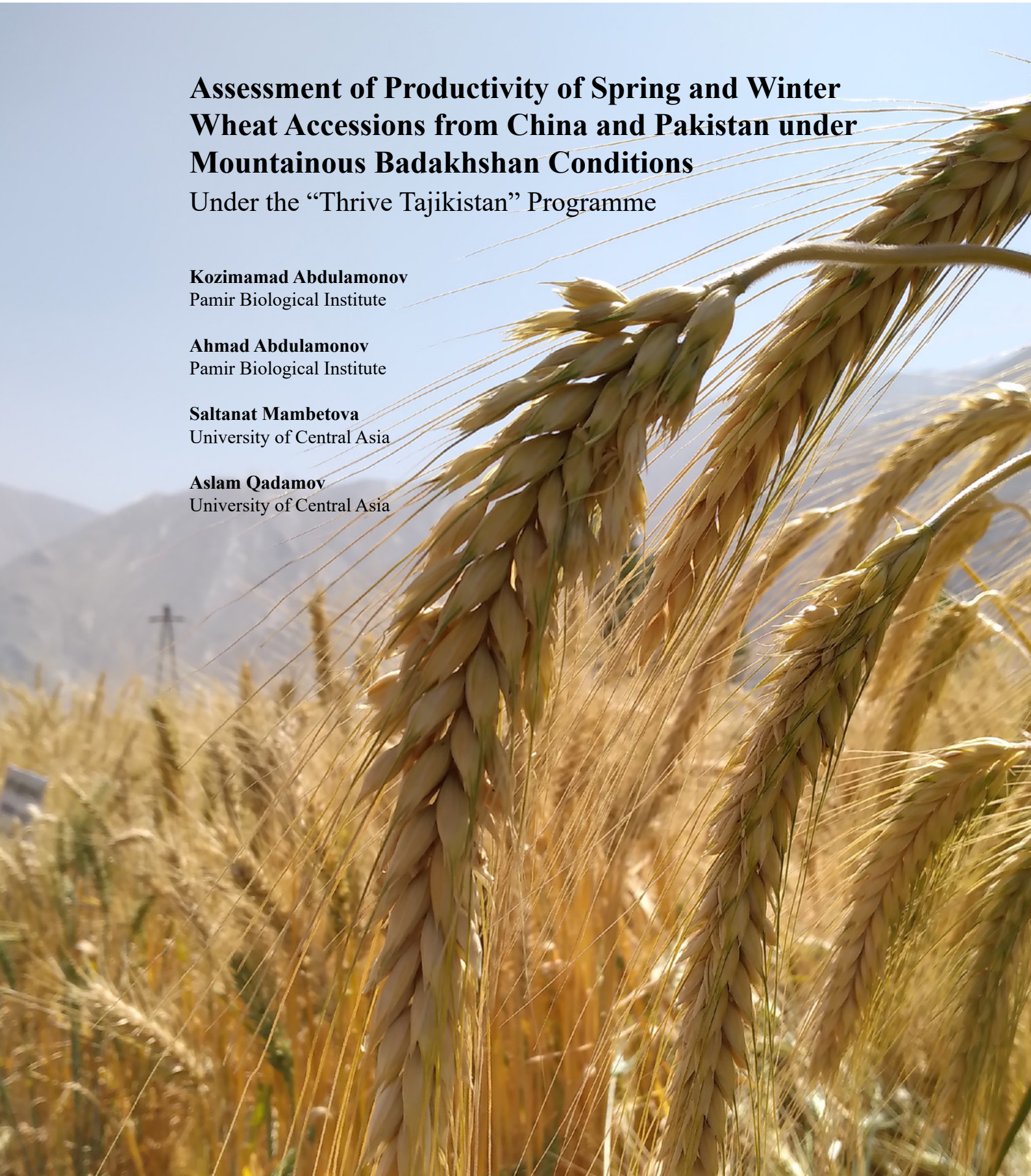

Assessment of Productivity of Spring and Winter Wheat Accessions from China and Pakistan under Mountainous Badakhshan Conditions

Under the "Thrive Tajikistan" Programme

Kozimamad Abdulamonov
Pamir Biological Institute

Ahmad Abdulamonov
Pamir Biological Institute

Saltanat Mambetova
University of Central Asia

Aslam Qadamov
University of Central Asia

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Kozimamad Abdulamonov
Doctor of agricultural sciences, head of Genetics and Plant Breeding Laboratory at Pamir Biological Institute, corresponding member of National Academy of Science of Tajikistan

Ahmad Abdulamonov
Pamir Biological Institute

Saltanat Mambetova
Earth and Environmental Sciences, University of Central Asia

Aslam Qadamov
Mountain Societies Research Institute, University of Central Asia

Cover photo: Aslam Qadamov

University of Central Asia
125/1 Toktogul Street, Bishkek 720001, Kyrgyz Republic
Tel.: +996 (312) 910 822, E-mail: msri@ucentralasia.org

The Mountain Societies Research Institute (MSRI) was established in 2010 to conduct research for development with the goal to improve the well-being of mountain societies in Central Asia. MSRI is part of the Graduate School of Development, University of Central Asia. The University of Central Asia (UCA) was founded in 2000. The University of Central Asia (UCA) was founded in 2000. The Presidents of Kazakhstan, the Kyrgyz Republic, and Tajikistan, and His Highness the Aga Khan signed the International Treaty and Charter establishing this secular and private university, ratified by the respective parliaments, and registered with the United Nations.

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Introduction

Wheat (*Triticum aestivum* L.) belongs to family Gramineae and the tribe Hordeae. It is the third most important cereal crop in the world after rice and maize. Wheat is one of the most consumable cereal crops in Central Asia and almost every meal includes bread which is made of wheat. In Tajikistan in mountains regions such as Pamir (Mountains Badakhshan) wheat is also crucial crop and providing population with food and mainly with its own grain is a key issue in solving food security (Vavilov N.I. 1926). Therefore, is important to identify and select best wheat varieties that can be grown in mountains conditions as well as conduct breeding selection in such environment. This project's goal was to assess foreign accessions from China and Pakistan that carried traits such as high yield, disease resistance and short stem that would not lodge before harvest.

Pamir or Gorno-Badakhshan Autonomous Oblast (GBAO) territory is occupied by rocks and glaciers and agricultural arable lands are small. There are 0.07 ha of land per capita. There is not enough arable land to expand agricultural fields in GBAO and therefore introducing high yielding wheat varieties are crucial.

GBAO is a unique, natural science laboratory and where number of crops were formed including wheat (, Vavilov N.I. 1964). In the 1950s scientist have tested foreign breeding lines in Pamir and found that their yield was less compared to the local varieties. These findings were confirmed by the scientist from Pamir Biological Institute (PBI) (Abdulamonov K., Bahronov A.Ya. et al., 2013).

The Ishkashim experimental station, where the research was carried out, is the only institution that has 17 ha of arable land, and their interest is in creating and saving local varieties and their gene pools (Fig.1). Currently, in the collection there are more than 100 local wheat varieties including 30 varieties from Badakhshan, 15 from Tajik and 15 from Afghan part. Ishkashim experimental station provide farmers in GBAO by best local spring, soft wheat varieties. There are number of best locally grown varieties such as Safedaki Ishkashimy, Surkhkhush, Bobillo, Safedaki Bartang, and Kilak Bartang, as well as best local varieties from Afghan Badakhshan such as Sadiras, Pandaki (facultative) and Bludon (from the province Tahor of Afghanistan). In recent years scientist from PBI and breeders from other Tajik institution have been involved with hybridization of local and foreign varieties/accessions to improve breeding materials at the Ishkashim experimental station. As a result of this work hybrid lines that combined economically valuable traits have been created.

**Figure 1-3. Ishkashim experimental station,
Gorno Badakhshan Autonomous Oblast, Tajikistan.**



Research Objectives

The objectives of this project were:

1. Assess and compare productivity of foreign spring soft wheat accessions from China with local varieties under local conditions
2. Assess and compare productivity of foreign winter wheat accessions from Pakistan with local varieties under local conditions
3. Assess and compare vernalized winter accessions from Pakistan with local facultative varieties during spring sowing under local conditions

Methodology

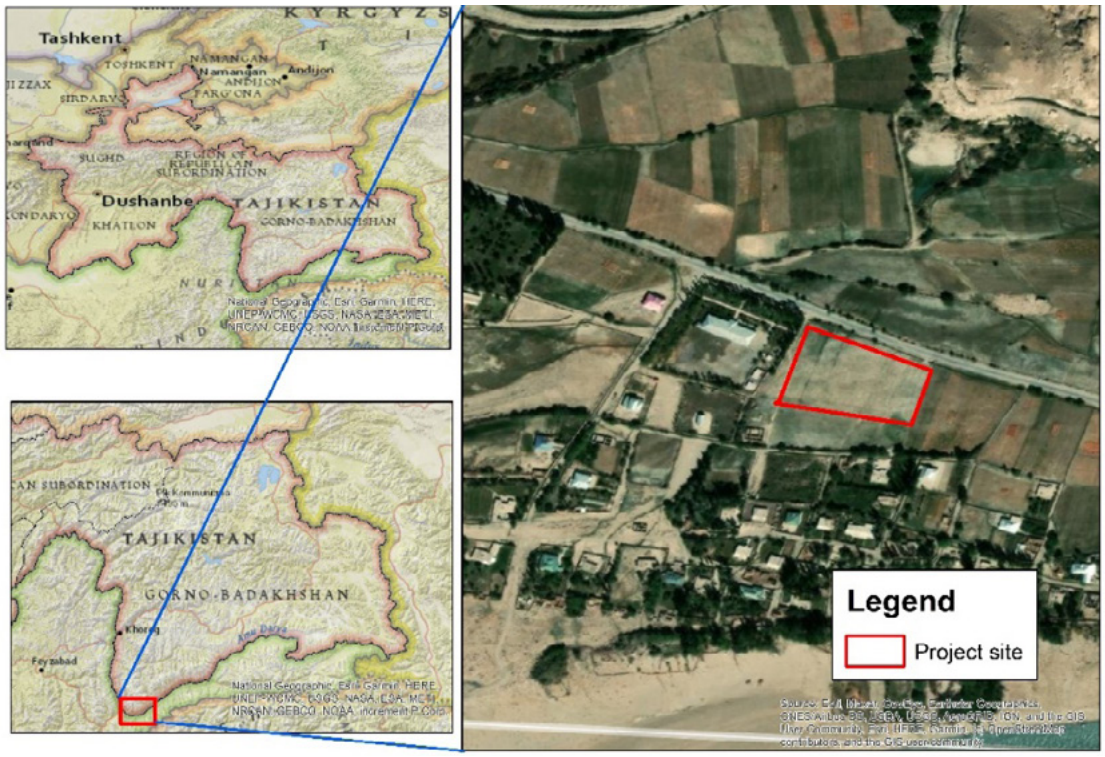
The research experiment was carried out at the Iskashim experimental station in Ishkashim, GBAO, Tajikistan. For the first objective 7 breeding accessions (CRBW1, CRBW2, CRBW3, CRBW4, CRBW5, CRBW6, and CRBW7) were kindly provided by University of Chengdu[1], China. For the second and third objectives 10 breeding accessions (Trjata, No. 63, No. 76 skd, No. 75 , No. 78 skd, No. 105, No. 141, No. 142, No. 144 and No. 147) were kindly provided by Pakistan. As a control local variety (s) from Badakhshan were used in all three objectives. Local varieties were included because they have gone through an evolutionary process under the local conditions and adopted to a high altitude (2000-3250 m above seas level). Until now none of the tested foreign varieties have not outperformed local varieties by total dry biomass and yield. Local wheat varieties have traits such as grain uniformity, high weight of 1000 grain, frost resistance and adoptability in high altitudes. Also, local varieties have high ratio of straw to grain yield (1.5-2.0), which is important factor for local farmers. The straw of the wheat is usually uses as a feeding stock for livestock during wintertime. If straw to grain yield is lower than the above-mentioned parameters local farmers do not wish to cultivate such variety. However, local varieties also have disadvantages such as lodging, susceptible to diseases and have low baking quality. It has been established that local varieties have low baking quality, and these varieties belong to fodder wheat (K. M. Bulatova, K. Abdulamonov et al., 2001).

It should be noted that local winter varieties Joydori and Bludon and 10 accessions from Pakistan were planted in the fall of 2019 (in the second decade of October) in the Ishkashim experimental station. Both local varieties and 10 accessions reached tillering stage but got destroyed by the frost. However, in March 2019 part of accession and local varieties seeds were put in the freezer for 86 days at subzero temperature to vernalize and to plant them in the springtime. Therefore, some of the accessions were dropped from the trial due to the lack of extra seeds and 3 accessions No. 75, No. 144 and No. 63 and local varieties Joydori and Bludon were saved and used for both objectives.

The soil at the experimental station were sandy-clay loam. The soil underlain by pebbles, which has good water permeability and high fertility (Kuteminsky V.N., 1960; Kann I.Ya., 1961). Field experiment for all tree objectives in 2019 and 2020 were planted in the second decade of April and the first decade of May (Table 1). Fertilizers such as nitrogen-phosphorous (ammophos) 200kg/ha and urea (carbamide) 100 kg/ha were applied before plowing (Fig 2). The furrows were cut with a row spacing of 50 cm. For sowing furrows were 1 m long and 60 cm of path left between the strips.

1 The University of Central Asia's Mountain Societies Research Institute (MSRI) had visited Chengdu several year ago and met with the Professor of Agronomy from the University of Chengdu. During this visit, MSRI and the University of Chengdu decided to partner on spring wheat testing and trialing in the Pamirs. As part of this, the Professor of Agronomy agreed to provide seven different varieties of spring wheat to MSRI.

Figure 4. Project site, Ishkashim experimental station



Each sample was sown by hand in to two lines, and each line had 100 pieces of seeds. The space between plants were 2 cm and between rows were 17 cm. The total area of each plot was 0.5 m^2. The experiment was replicated three times and each replication was randomized separately.

Figure 5. Field preparation and application of fertilizers in 2019

Figure 6. Field preparation by tractor in 2019

Data collection

Phenological observation such as germination, tillering, stem elongation, heading, different stage of ripeness (milk, dough, and full ripening) was collected. The duration of interphase periods of germination to heading and heading to ripeness were recorded. Some plants were infected with yellow rust during the stage of earing and flowering. During harvest, 10 plants were taken from each accession/variety and plant height, general and productive tillering, length of the main spike, number of spikelets of the main spike, number, and weight of grain of main spike, number of grains per spikelet, grain weight of main spike, number of grains per spikelet, grain weight of one plant and weight of 1000 grains were analyzed. Analysis of variance statistical test was performed based on B. A. Dospekhova (1985) methods. Quantitative analysis was performed based on the International Classifier of the CMEA of the genus *Hordeum* L (1983). To complete the statistical analysis reference tables were used (see Appendices) and the values of the *t* criterion at 5% significance level was used (see Appendices). More explanation of statistical analysis and examples attached (see Appendices).

Table 1. Schedule of field work, method, location, and dates from 2019 to 2021

Name of work	Method	Location	Dates
Seed preparation	Manually	Ishkashim experimental station	First decade of April
Randomization of experimental variants according to a table of random numbers		In the city of Khorog, Pamir Biological Institute	Second decade of April
Plowing, field preparation and application of fertilizers	Tractors MTZ-82M and DT-28	Ishkashim experimental station	Third decade of April - first decade of May
Preparation of pegs, stakeout of experimental field, sowing	Manually	Ishkashim experimental station	
Registration of the field journal	Manually	Ishkashim experimental station	During the season
Phenological observations. Data collection on emergence	Manually	Ishkashim experimental station	Second decade of May to first decade of September
Data collection on tillering phase, heading, and different stages of ripening (milk, dough, and full ripening)	Manually	Ishkashim experimental station	Second decade of May
Monitoring diseases and assessing the resistance to lodging	Manually	Ishkashim experimental station	First decade of July to second decade of August
Harvesting	Manually	Ishkashim experimental station	Second decade of September
Air bag of harvested varieties and accessions	Manually	Ishkashim experimental station	Third decade of September
Analyzing for plant height, total and productive bushiness, length of the main spike, number of grains of the main spike and their average value per 10 plants.	Manually in the laboratory	Ishkashim experimental station	October
Cleaning wheat sheafs	Manually on the experimental field	Ishkashim experimental station	October
Calculation number of grain in the main spike, number and mass of grain of one plant, their average value per 10 plants.	Manually in the laboratory using electrical scale	Ishkashim experimental station	First half of November

Name of work	Method	Location	Dates
Recalculation of 1000 grains for each plant and calculation of its average value for each variant of the experiment. Determination of the average number of grains per spikelet	On an electronic typewriter in the laboratory	Ishkashim experimental station	Second decade of November
Statistical analysis	On electronic typewriters ISKRA-121	Khorog	First half of December
Preparation of the annual report		Khorog	Second half of December
Final report		Khorog	January- July

Results

Foreign spring soft wheat accessions from China

The mean of the plant height of control variety Safedaki Ishkashimy in three years ranged from 90.6 to 96.0 cm and was significantly higher compared to the accessions from China (Table 2). The plant height of accessions from China in three years ranged from 49.5 to 64 cm. Local variety Surkhkhush was not statistically different at (p<0.05) from control variety. Similarly, variety Pandaki in 2019 and 2021 was not statistically different at (p<0.05) from control, but in 2020 it was significantly higher (102 cm) compared to the control.

Table 2. Plant height analysis of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Plant height, cm					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	95.40	-	96.00	-	90.6	-
CRBW 1	52.63	-42.77*	55.07	-40.9*	51.5	-39.1*
Surkhkhush	98.50	3.10	98.37	2.4	87.7	-2.9
CRBW 7	54.03	-41.37*	52.37	-43.6*	49.5	-41.1*
CRBW 6	61.27	-34.13*	59.50	-36.5*	64.9	-25.7*
CRBW 4	54.90	-40.50*	54.83	-41.2*	56.0	-34.6*
Pandaki	98.27	2.87	102.97	7.0*	94.8	4.3
CRBW 5	51.73	-43.67*	52.47	-43.5*	54.9	-35.7*
CRBW 3	56.80	-38.60*	51.63	-44.4*	52.5	-38.1*
CRBW 2	54.83	-40.57*	51.17	-44.8*	54.7	-35.9*
LSD 0.05		7.29		3.57		5.88

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of the general tillering of control variety Safedaki Ishkashimy in three years ranged from 3.5-3.7 pcs. and was significantly higher than accessions from China, except CRBW1 in 2021 which was not significantly different from control (Table 3). The general tillering of accessions from China in three years ranged from 2.2 to 3.3 pcs. Local varieties were not significantly different from control, except Surkhkhush in 2020 which was significantly higher compared to control.

Table 3. General tillering analysis of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	General tillering, pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	3.67	-	3.63	-	3.57	-
CRBW 1	2.50	-1.17*	2.77	-0.9*	3.30	-0.3
Surkhkhush	4.17	0.50	4.53	0.9*	3.30	-0.3
CRBW 7	2.67	-1.00*	2.60	-1.0*	2.77	-0.8*
CRBW 6	2.37	-1.30*	2.53	-1.1*	2.77	-0.8*
CRBW 4	2.27	-1.40*	2.63	-1.0*	2.87	-0.7*
Pandaki	3.87	0.20	3.97	0.3	3.37	-0.2
CRBW 5	2.17	-1.50*	2.40	-1.2*	2.73	-0.8*
CRBW 3	2.70	-0.97*	2.77	-0.9*	2.93	-0.6*
CRBW 2	2.40	-1.27*	2.87	-0.8*	2.80	-0.8*
LSD 0.05		0.65		0.42		0.50

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of the productive tillering analysis of control variety in three years ranged from 3.3 to 3.5 pcs. and similarly, to general tillering it was significantly higher compared to all accession from China (Table 4). Productive tillering of accessions from China in three years ranged from 2.0 to 2.8 pcs. Also, similarly to general tillering local varieties were not significantly different from control, except Surkhkhusa in 2020 which was significantly higher compared to the control.

Table 4. Productive tillering of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Productive tillering, pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	3.50	-	3.40	-	3.33	-
CRBW 1	2.40	-1.10*	2.57	-0.8*	3.23	-0.1
Surkhkhush	3.57	0.07	3.80	0.4*	3.00	-0.3
CRBW 7	2.43	-1.07*	2.57	-0.8*	2.63	-0.7*
CRBW 6	2.20	-1.30*	2.43	-1.0*	2.77	-0.6*
CRBW 4	2.23	-1.27*	2.60	-0.8*	2.73	-0.6*
Pandaki	3.43	-0.07	3.60	0.2	3.33	0.0
CRBW 5	2.00	-1.50*	2.13	-1.3*	2.67	-0.7*
CRBW 3	2.50	-1.00*	2.60	-0.8*	2.87	-0.5*
CRBW 2	2.33	-1.17*	2.67	-0.7*	2.77	-0.6*
LSD 0.05		0.65		0.29		0.42

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of the length of the main spike of control variety in three years ranged from 8.2 to 9.0 cm and was significantly higher than accessions from China. The length of the main spike of accessions from

China in three years ranged between 5.5 to 7.5 cm. Local varieties were not significantly different from control, except Surkhkush in 2021 (7.40 cm) and Pandaki in 2020 (7.7 cm) were significantly lower compared to the control.

Table 5. The length of the main spike of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Length of the main spike, cm					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	9.0	-	8.6	-	8.23	-
CRBW 1	6.03	-2.97*	5.9	-2.7*	5.83	-2.4*
Surkhkhush	9.07	0.07	8.8	0.2	7.40	-0.8*
CRBW 7	6.2	-2.80*	5.8	-2.8*	5.60	-2.6*
CRBW 6	6.6	-2.40*	6.4	-2.2*	6.47	-1.8*
CRBW 4	6.67	-2.33*	6.1	-2.5*	6.03	-2.2*
Pandaki	8.9	-0.10	7.7	-0.9*	7.93	-0.3
CRBW 5	5.93	-3.07*	5.7	-2.9*	5.97	-2.3*
CRBW 3	6.7	-2.83*	6.0	-2.6*	5.47	-2.8*
CRBW 2	7.53	-1.47*	6.2	-2.4*	6.67	-1.6*
LSD 0.05		0.69		0.42		0.42

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of number of spikelets in the main spike of control variety in three years ranged from 14.1 to 16.87 pcs. and was significantly higher than accessions from China, except CRBW7, CRBW6 CRBW5 and CRBW2 in 2020 (Table 6). The mean of number of spikelets in the main spike of Chinese accessions in three years ranged from 11.2 to 15.1 pcs. Local varieties also had significantly lower values compared to the control, except Surkhkush in 2020 (14.3 pcs.) and Pandaki in 2019 (17.1 pcs.) and 2020 (13.6 pcs.).

Table 6. Number of spikelets in the main spike of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Number of spikelets in the main spike, pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	16.87	-	14.6	-	14.07	-
CRBW 1	12.53	-4.33*	13.1	-1.4*	11.33	-2.7*
Surkhkhush	15.20	-1.67*	14.3	-0.3	11.73	-2.3*
CRBW 7	13.77	-3.10*	13.3	-1.3	11.20	-2.9*
CRBW 6	13.57	-3.30*	14.9	0.3	12.00	-2.1*
CRBW 4	14.30	-2.57*	12.8	-1.7*	12.47	-1.6*
Pandaki	17.10	0.23	16.0	1.4*	13.60	-0.5
CRBW 5	13.20	-3.67*	13.3	-1.2	11.93	-2.1*
CRBW 3	14.73	-2.13*	13.6	-0.9	12.53	-1.5*
CRBW 2	15.07	-1.80*	13.6	-1.0	12.53	-1.5*
LSD 0.05		1.58		1.45		1.37

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of number of grains per spikelet of control variety in three years ranged from 2.8 to 2.9 pcs. (Table 7). The mean of number of grains per spikelet of Chinese accessions in three years ranged from 2.2 to 3.20 pcs. The accessions from China CRBW7, CRBW6, CRBW4, CRBW5 and CRBW2 had significantly higher grains per spikelet compared to the control in 2019. Values in other years were not significantly higher compared to the control. Local varieties in 2019 had similar values compared to the control and in other two years both varieties had significantly lower number of grains per spikelet compared to the control.

Table 7. The number of grains per spikelet of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	The number of grains per spikelet, pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a],	2.27	-	2.83	-	2.96	-
CRBW 1	2.47	0.20	2.17	-0.67*	2.60	-0.36*
Surkhkhush	2.23	-0.03	2.30	-0.53*	2.57	-0.39*
CRBW 7	2.87	0.60*	2.47	-0.37*	3.20	0.23
CRBW 6	2.63	0.37*	2.60	-0.23	2.98	0.02
CRBW 4	3.10	0.83*	2.77	-0.07	3.20	0.23
Pandaki	2.00	-0.27	1.60	-1.23*	2.59	-0.38*
CRBW 5	2.57	0.30*	2.13	-0.70*	2.82	-0.14
CRBW 3	2.60	0.33*	2.83	0.00	3.07	0.10
CRBW 2	2.73	0.47*	2.43	-0.40*	2.55	-0.41*
LSD 0.05		0.29		0.29		0.36

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean number of grains in the main spike for control in three years ranged between 38.1 to 41.7 pcs (Table 8). The accession CRBW1 had significantly lower number of grains in the main spike compared to the control. The accessions CRBW7, CRBW6 and CRBW5 were not significantly different from the control in 2019 but they were significantly lower in 2020 and 2021, respectively. CRBW3 and CRBW2 had significantly lower values in 2020 and 2021 but were not significantly different in 2019 compared to the control. CRBW4 had significantly higher number of grains in the main spike (44.3 pcs.) in 2019, but in 2020 had significantly lower and in 2021 was not significantly different from the control. Local varieties in 2019 had similar values compared to the control and in other two years both varieties had significantly lower number of grains in the main spike compared to the control.

Table 8. The number of grains in the main spike of spring soft wheat varieties including control, local and accessions from China

Wheat varieties/ accessions	Number of grains in the main spike, pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	38.17	-	40.8	-	41.67	-
CRBW 1	30.87	-7.30*	28.0	-12.8*	29.43	-12.2*
Surkhkhush	33.90	-4.27	32.8	-8.1*	30.13	-11.5*
CRBW 7	39.60	1.43	36.1	-4.7*	35.83	-5.8*
CRBW 6	35.90	-2.27	36.2	-4.6*	35.63	-6.0*
CRBW 4	44.27	6.10*	35.5	-5.3*	39.70	-2.0
Pandaki	34.37	-3.80	25.5	-15.4*	35.17	-6.5*
CRBW 5	33.77	-4.40	28.4	-12.5*	33.73	-7.9*
CRBW 3	38.13	-0.03	39.2	-1.6*	38.60	-3.1
CRBW 2	41.20	3.03	33.1	-7.8*	32.03	-9.6*
LSD 0.05		6.22		3.99		5.52

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean weight of grain in the main spike of control variety in three years ranged from 1.2 to 1.3 (Table 9). The accessions from China were not significantly different in all three years, except CRBW1 in 2021 was significantly lower (1.1 g) and CRBW7 (1.5 g) and CRBW3 (1.5 g) in 2020 were significantly higher compared to the control. Local varieties in 2019 had similar values compared to the control and Surkhkhush and Pandaki in 2020 had significantly lower weight of grain in the main spike compared to the control.

Table 9. Weight of grain in the main spike of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Weight of grain in the main spike, g					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	1.33	-	1.25	-	1.32	-
CRBW 1	1.27	-0.06	1.31	0.07	1.16	-0.2*
Surkhkhush	1.18	-0.15	1.06	-0.19	1.05	-0.3*
CRBW 7	1.48	0.15	1.55	0.31*	1.41	0.1
CRBW 6	1.23	-0.10	1.29	0.04	1.20	-0.1
CRBW 4	1.81	0.48	1.46	0.22*	1.40	0.1
Pandaki	1.24	-0.09	0.52	-0.72*	1.55	0.2
CRBW 5	1.46	0.13	1.29	0.04	1.27	-0.1
CRBW 3	1.51	0.18	1.55	0.31*	1.31	0.0
CRBW 2	1.72	0.39	1.32	0.08	1.31	0.0
LSD 0.05	Fф= 2.16<Fт=2.46			0.19		0.29

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean weight of 1000 grains in control variety in three years ranged from 29.8 to 34.7 g (Table 10). In 2019 accessions CRBW1 (40.6g), CRBW4 (40.3 g), CRBW5 (43.0) and CRBW2 (40.1 g) had significantly higher weight compared to the control. Accessions CRBW7, CRBW6, CRBW3 and two local varieties were not significantly different from control.

Table 10. Weight of 1000 grains of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Weight of 1000 grains, g					
	2019		2020		2021	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Safedaki Ishkashimy[a]	34.65	-	29.8	-	31.7	-
CRBW 1	40.59	5.94*	47.5	17.7*	39.3	7.6*
Surkhkhush	34.32	-0.33	30.7	0.9	34.8	3.2
CRBW 7	36.93	2.28	44.1	14.3*	39.4	7.7*
CRBW 6	34.35	-0.30	35.4	5.5*	33.7	2.1
CRBW 4	40.38	5.73*	41.2	11.3*	35.3	3.6
Pandaki	35.03	0.38	20.0	-9.8*	44.1	12.5*
CRBW 5	42.97	8.32*	45.9	16.1*	37.6	6.0*
CRBW 3	37.58	2.93	39.3	9.4*	33.9	2.2
CRBW 2	40.88	6.23*	38.9	9.0*	41.0	9.3*
LSD 0.05		5.57		3.57		5.21

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of germination to heading analysis in three years for control variety ranged from 53 to 61 days (Table 11). The mean for germination to heading for Chinese accession in three years ranged from 50 to 59 days. In 2019 and in 2020 all accession had significantly lower values (days) compared to the control. However in 2021, 2 accessions had significantly higher values 58 and 59 days, respectively, and the rest of the accession were not statistically different from the control. Local variety Surkhkhush in 2019 had significantly higher value compared to the control and in 2020 and in 2021 was not significantly different from the control. Pandaki in all three years had significantly higher values (65, 72 and 66 days, respectively) compared to the control.

Table 11. Germination to heading period (days) of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Germination-heading, days					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	58	-	61	-	53	-
CRBW 1	51	-7*	51	-10*	58	5*
Surkhkhush	64	6*	61	0	53	0
CRBW 7	51	-7*	50	-11*	54	1
CRBW 6	53	-5*	53	-8*	59	6*
CRBW 4	51	-7*	51	-10*	53	0
Pandaki	65	7*	72	11*	66	13*
CRBW 5	52	-6*	51	-10*	54	1
CRBW 3	51	-7*	50	-11*	53	0
CRBW 2	52	-6*	52	-9*	53	0
LSD 0.05		2.86		1.32		2.0

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean heading to ripening period in three years for control variety ranged from 47-55 days (Table

12). The mean heading to ripening in all accessions in 2019 and 2021 were not significantly different from control, except CRBW6 in 2019 had significantly higher values (52 days) compared to the control. All accession in 2020 significantly higher values (ranged from 59-62 days) than control. Local varieties were significantly lower in 2019 and 2020 but had significantly higher values in 2021.

Table 12. Heading-ripening period (days) of varieties of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Heading-ripening, days					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimya	47	-	55	-	50	-
CRBW 1	49	2	61	6*	49	-1
Surkhkhush	42	-5*	52	-2*	57	7*
CRBW 7	49	2	62	7*	50	0
CRBW 6	52	5*	59	4*	52	2
CRBW 4	49	2	60	5*	51	1
Pandaki	45	-2	60	5*	53	3*
CRBW 5	48	1	61	6*	50	0
CRBW 3	49	2	62	7*	51	1
CRBW 2	49	2	60	5*	51	1
LSD 0.05		4.96		1.16		2.5

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean germination to ripening period for three years for control variety ranged from 104-113 days (Table 13). The mean germination to ripening in all accessions in 2019 and 2021 were significantly lower compared to the control. In 2020 all accessions were not significantly different from control. The variety Surkhkhush in all three years was not significantly different from control. Whereas local variety Pandaki had significantly higher values in 2019 and 2020 (109 and 119 days, respectively), and in 2021 was not significantly different from the control.

Table 13. Germination-ripening period (days) of spring soft wheat varieties including control, local varieties, and accessions from China

Wheat varieties/ accessions	Germination-ripening, days					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Safedaki Ishkashimy[a]	104	-	113	-	111	-
CRBW 1	100	-4*	112	-1	103	-8*
Surkhkhush	106	2	114	1	115	4
CRBW 7	100	-4*	112	-1	104	-7*
CRBW 6	104	0	112	-1	109	-2
CRBW 4	99	-5*	111	-2*	106	-5*
Pandaki	109	5*	119	6*	113	2
CRBW 5	100	-4*	112	-1	104	-7*
CRBW 3	100	-4*	112	-1	104	-7*
CRBW 2	101	-3*	112	-1	104	-7*
LSD 0.05		3.32		1.13		5.3

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

Conclusion

Assess and compare productivity of foreign spring soft wheat accessions from China with local varieties under local conditions.
Grain productivity in local wheat varieties formed based on characteristics such as productive tillering, spike length, number of spikelets and the number of grains in the main spike. Whereas it was observed that grain productivity in accessions from China were based mainly on weight of 1000 grains and a longer heading to ripening period. In overall heading stage in 2019 and in 2020 in 5 accessions were 5 to 11 days earlier compared to the control. In comparison, local variety Pandaki had 8 to 13 days later heading to ripening period compared to the control. The heading to maturity period in 5 accessions in 2020 were 2 to 7 days longer but other years were not significantly different from the control. The germination to heading period for 5 accessions 2 to 7 days were shorter than local variety Surkhkush.

Therefore, the best samples in terms of productivity trait included characteristics such as number of grains per spike, grain weight of the main spike and weight of 1000 grain showed 5 accessions (CRBW1, CRBW7, CRBW4, CRBW5, CRBW3 and CRBW2) showed. These findings are imported for the Mountains Badakhshan to use these accessions in hybridization and as a breeding material with local varieties. Moreover, the accessions from China also had resistance to lodging, resistance to pest and diseases and good baking qualities. The disadvantage of these accessions based on the study and the local region is that they have shorter stem which has lower straw to grain yield ratio and therefore it is not suggested to introduce these accessions as it is, but introduce and use it in the breeding and hybridization process with local varieties that has better straw to grain trait.

Results

Assess and compare vernalized winter accessions from Pakistan with local facultative varieties during spring sowing under local conditions.
Due to the frost issue in the Fall of 2019 the objectives #2 were not performed at all and only objective #3 was tested.
The mean of the plant height of control variety in three years ranged between 85.9 to 105.6 cm (Table 14). The accessions from Pakistan mean of the plant height ranged from 74.4 to 95 cm, and they were significantly lower compared to the control, except accession №63 in 2019. The local variety Bludon in 2019 was not significantly different from the control, but in 2020 it had significantly higher height (104.4 cm) and in 2021 it had significantly lower height (94.0 cm) compared to the control.

Table 14. Plant height of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Plant height, cm					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	85.90	-	96.33	-	105.57	-
№75	78.07	-7.83*	76.13	-20*	82.33	-23.23*
№144	77.60	-8.30*	74.37	-22*	77.10	-28.47*
№63	86.57	0.67	88.83	-7*	95.00	-10.57*
Bludon	83.13	-2.77	104.43	8*	93.97	-11.60*
LSD 0.05		6.7		6.84		6.70

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of the general tillering in three years of control variety ranged from 3.2 t0 3.4 pcs. (Table 15). All accessions in three years had significantly lower values (2.0 to 2.9 pcs.) except №144 in 2020 was not significantly different from the control, and №75 in 2021 had significantly higher general tillering values (3.5 pcs.) compared to the control. Bludon was significantly lower in 2019 and 2021 (2.2 and 2.6 pcs.) but was not significantly different (3.8 pcs.) in 2020 compared to the control.

Table 15. General tillering of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	General tillering, pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	3.40	-	3.17	-	3.37	-
№75	2.07	-1.33*	2.53	-0.63*	3.53	0.17*
№144	2.03	-1.37*	3.17	0.00	2.87	-0.50*
№63	2.13	-1.27*	2.03	-1.13*	2.50	-0.87*
Bludon	2.23	-1.17*	3.27	0.10	2.60	-0.77*
LSD 0.05		0.51		0.55		0.17

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

Table 16. Productive bushiness of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Productive tillering					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	3.30	-	3.00	-	3.27	-
№75	2.03	-1.27*	2.50	-0.50*	3.40	0.13*
№144	1.83	-1.47*	2.97	-0.03	2.83	-0.43*
№63	2.03	-1.27*	1.97	-1.03*	2.50	-0.77*
Bludon	2.17	-1.13*	2.93	-0.07	2.53	-0.73*
LSD 0.05		0.46		0.60		0.02

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of the productive tillering in three years for control variety ranged from 3.0 to 3.3 pcs. (Table 16). All accessions and local variety in three years had significantly lower values ranged from 2.0 to 2.9 pcs, except №75 in 2021 had significantly higher productive tillering (3.4 pcs.).

The mean of the length of the main spike in three years for control variety ranged from 8.1 to 8.5 cm (Table 17). All accessions and Bludon in three years were not significantly different from the control, except accessions №75 in 2020 and 2021 (6.6, 6.7 cm, respectively) and №144 (7.0. cm) in 2020 had significantly lower values.

Table 17. Length of the main spike of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Length of the main spike, cm					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	8.53	-	8.40	-	8.07	-
№75	7.50	-1.03	6.57	-1.83*	6.70	-1.37*
№144	8.23	-0.30	7.07	-1.33*	7.80	-0.27
№63	7.60	-0.93	7.93	-0.47	8.37	0.30
Bludon	8.50	-0.03	8.30	-0.10	8.17	0.10
LSD 0.05	Fф= 3.43<Fт=3.84			0.76		0.95

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of number of spikelets in the main spike for control variety in three years ranged from 13.8 to 15.8 pcs. (Table 18). All accessions and Bludon in three years were not significantly different from the control, except accession №63 in 2021 had significantly higher values (15.7 pcs.) compared to the control.

Table 18. The number of spikelet's in the main spike of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Number of spikelets in the main spike pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	15.80	-	14.87	-	13.87	-
№75	16.27	0.47	14.10	-0.77	13.60	-0.27
№144	16.17	0.37	14.47	-0.40	14.53	0.67
№63	15.33	-0.47	15.70	0.83	15.67	1.80*
Bludon	15.67	-0.13	15.20	0.33	13.33	-0.53
LSD 0.05	Fф=0.47<Fт=3.84		Fф =1.70<Fт=3.84			1.18

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean number of grains per spikelet in three years for control variety ranged from 2.4 to 2.8 pcs. (Table19). Accessions №75 and №63 in three years were not significantly different from the control. Accession №144 in 2019 (2.7 pcs.) and 2021 (3.2 pcs.) had significantly higher grains per spikelet compared to the control, however in 2020 it was not significantly different from the control. Bludon in 2019 and 2021 was not significantly different from the control, but in 2020 had significantly lower values compared to the control.

Table 19. The number of grains per spikelet of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Number of grains per spikelet, pcs.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	2.27	-	2.43	-	2.72	-
№75	2.33	0.07	2.63	0.20	2.80	0.08
№144	2.70	0.43*	2.53	0.10	3.17	0.45*
№63	2.17	-0.10	2.60	0.17	2.87	0.15
Bludon	2.43	0.17	2.17	-0.27*	2.84	0.12
LSD 0.05		0.23		0.23		0.25

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean number of grain from the main spike in three years in control variety ranged from 35.9 to 37.7 pcs. (Table 2020). Accession №75 and Bludon in three years were not significanty different from the control. Accessions №144 and №63 had significantly higher grains per spikelet in three years, except in 2019 (№144) and 2020 (№63) were not significantly different from the control.

Table 20. The number of grains from the main spike winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Number of grains from the main spike, pcs.					
	2019		2020		2021	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Joydori, St.	35.93	-	35.87	-	37.63	-
№75	37.83	1.90	34.53	-1.33	38.03	0.40
№144	44.30	8.37*	37.17	1.30	46.10	8.47*
№63	33.30	-2.63	40.70	4.83*	45.00	7.37*
Bludon	38.07	2.13	32.83	-3.03	37.77	0.13
LSD 0.05		5.38		3.47		4.11

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of grain weight of the main spike in three years for control variety ranged from 1.3 to 1.8 g (Table 21). All accession in three years were not significantly different from the control, except №144 in 2021 and №63 had significantly lower values compared to the control. Bludon variety in three years had significantly lower values compared to the control.

Table 21. Grain weight of the main spike winter varieties including control, local and varieties from Pakistan

Wheat varieties/ accessions	Grain weight of the main spike, g.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	1.47	-	1.26	-	1.81	-
№75	1.35	-0.12	1.20	-0.06	1.53	-0.29
№144	1.37	-0.10	1.28	0.02	1.46	-0.36*
№63	1.19	-0.28*	1.43	0.18	2.03	0.22
Bludon	1.11	-0.35*	0.71	-0.55*	1.68	-0.13
LSD		0.23		0.23		0.32

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of the weight of 1000 grains in three years in control variety ranged from 34.9 to 48.1 g (Table 22). Accessions №75 and №144 in 2019 and 2020 were not significantly different from the control, but in 2021 they had significantly lower values (40.1 and 33.3, respectively). Accession №144 in 2019 and 2021 had significantly lower values compared to the control and in 2020 was not significantly different from control. Bludon all three years had significantly lower weight of 1000 grains compared to the control.

Table 22. Weight of 1000 grains of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Weight of 1000 grains, g.					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	35.9	-	34.87	-	48.10	-
№75	38.8	2.91	34.26	-0.61	40.11	-7.99*
№144	35.4	-0.55	34.40	-0.47	33.34	-14.76*
№63	30.5	-5.39*	34.84	-0.03	45.19	-2.90*
Bludon	28.2	-7.76*	20.96	-13.91*	44.17	-3.93*
LSD 0.05		5.08		4.16		2.26

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean germination to heading period in three years for control variety ranged from 61 to 71 days (Table 23). All accessions in 2019 and 2021 had significantly lower germination to heading days. In 2020 accession was not significantly different from the control. Bludon in 2019 and 2021 was not significantly different from the control, but in 2020 had significantly higher values (68 days) compared to the control.

Table 23. Germination to heading period (days) of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Germination-heading, days					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	71	-	61	-	64	-
№75	63	-8*	59	-2	54	-10*
№144	64	-7*	62	1	59	-5*
№63	63	-8*	63	2	60	-4*
Bludon	70	-1	68	7*	62	-2
LSD		3.93		4.39		4.16

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean heading to ripening period in three years for control variety ranged from 34 to 51 days (Table 24). All accessions in 2019 were not significantly different from the control. All accessions in 2020 and 2021 had significantly higher days compared to the control, except accession №63 in 2021. Bludon in three years was not significantly different from the control.

Table 24. Heading to ripening period (days) of winter varieties including control local, and accessions from Pakistan

Wheat varieties/ accessions	Heading-ripening, days					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	34	-	42	-	51	-
№75	35	1	52	10*	60	9*
№144	36	2	50	8*	55	4*
№63	36	2	49	7*	54	3
Bludon	34	0	44	2	53	2
LSD	Fф =0,42<Fт=3,84			2.77		4.16

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

The mean of germination to ripening in three years in control variety ranged from 103 to 115 days (Table 25). All accession in 2019 had significantly lower values (ranged from 98 to 104 days) compared to the control. In 2020 all accessions and Bludon had significantly higher values (ranged from 111 to 112 days) compared to the control. In 2021 all accession and Bludon were not significantly different from the control.

Table 25. Germination-ripening period (days) of winter varieties including control, local and accessions from Pakistan

Wheat varieties/ accessions	Germination-ripening, days					
	2019		2020		2021	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Joydori[a]	105	-	103	-	115	-
№75	98	-7*	111	8*	114	-1
№144	100	-5*	112	9*	113	-2
№63	99	-6*	112	9*	114	-1
Bludon	104	-1	112	9*	115	-1
LSD 0.05		2.82		4.83	Fф=1,87<Fт=3,84	

a–Control variety
*–Numbers that have "–" symbol before the number means significantly lower compared to control variety
* Numbers that are positive means significantly higher compared to the control variety

Overall, in three-year study winter accessions from Pakistan No. 75, No. 144, No. 63 and local variety Bludon had significantly lower values in plant height, general and productive tillering, length of the main spike compared to the control with some exception. The number of spikelets in the main spike and grains per spikelet values were similar and were not significantly different from the control with one exception (No. 144). The germination to heading period for all accessions were 4-10 days shorter compared to the control variety. Bludon had longer period compared to the control. The heading to ripening period was 4-10 days longer in all accessions, and Bludon had shorter period compared to the control. The germination to ripening period for all accessions were 5-7 days earlier compared to the control. Bludon variety in 2020 was 8-9 days later but in 2021 performed similarly as control.

Accession No. 144 showed significantly higher number of grains per spike compared to the control. Moreover, accession No. 144 and No. 63 had higher number of grains in the main spike compared to the control. Accessions from Pakistan have smaller grain size and highly resistant to lodging and pest and diseases and have good baking qualities (this was not tested but based on the accession characteristics). Accessions also showed relatively long phase of heading to ripening especially during the accumulation of grain filling phase. These traits are important and missing in local varieties, therefore they are a good breeding material and can be included in hybridization process with local varieties.

Conclusion

Varieties from China

Analysis of the productivity elements showed that in the local wheat varieties (Safedaki Ishkashimy, Surkhkhush, Pandaki), the grain yield is formed mainly due to the characteristics of productive tillering, spike length, number of spikelets and the number of grains in the main spike. For wheat accessions from China, CRBW 7, 4, and 3 grain yield is formed mainly due to the number of grains per spikelet and grain weight of the spike, while in CRBW 1, 7, 4, 5, 2 at an altitude of 2600 above sea level, grain yield is formed mainly due to the weight of 1000 grains and longer period of heading - maturation, when the accumulation of the mass of the grain of the ear proceeds. All accessions (except for CRBW 6) ripen 4-7 days earlier than the standard (local) variety. The positive features of the foreign varieties are their high resistance to lodging, various diseases (9 points) and good baking quality. But considering their

low performance they could not be recommended for introduction into the production. On the other hand, high resistance quality makes them a good source material for hybridization with local varieties.

The disadvantage of the foreign varieties is their short height, which leads to a low ratio of straw to grain yield which is only 1.1-1.4 (straw/yield) to against 1.6-1.7 for local wheat varieties. Cereal straw serves as the main fodder for cattle in wintertime. Therefore, considering the contribution of a livestock to livelihood of local farmers it can be concluded that these varieties are not attractive for local farmers. Crops with low straw yield are not cultivated by the local farmers. Therefore, they cannot be recommended for implementation in production.

Varieties from Northern Pakistan

In autumn 2019, in the Ishkashim experimental station (h = 2600 m above sea level), 12 samples of winter wheat from the Northern Pakistan were sown, and local variety Bludon (from the Takhor province, of the Islamic Republic of Afghanistan) as a crop to compare with, was included. The winter variety Joydori (from Afghan part of Badakhshan of the Islamic Republic of Afghanistan) was used as a standard.

All varieties grew well and reached the tillering stage, but they could not stand the usual snowless winter frosts and completely died.

Next year part of the seeds from each variety were subjected to vernalization and sown during spring. Among them, only varieties Bludon, Joydory and samples No. 75, No. 144 and No. 75, went through all phases of development and fully matured.

Samples No. 75, No. 144 and No. 63 from the North of Pakistan in terms of plant height, total and productive tillering and length of the main ear, weight of 1000 grains and the ratio of straw to grain yield were significantly lower to the standard Joydori variety. No significant differences were found between them in terms of other indicators of productivity.

However, these accessions compared to the standard are more resistant to lodging, diseases and have good baking qualities, and can serve as the source material for involvement in the hybridization process with local varieties to improve the quality of the local varieties.

Depending on the growing season, the studied wheat samples ripen earlier (by 6-7 days, 2019) or later (by 8-9 days, 2020) or at the same time with the standard variety (in 2021).

Considering the low yield of these foreign varieties and their low ratio of straw and yield, they could not be recommended to local farmers to be used in production. As mentioned above the straw and yield ratio play a significant role in a selection prosses for local farmers, and local farmers will never select those with low ratio even if they have good traits to diseases and lodging. Introduction of the new varieties is an important part of science because it may provide a new perspective for further direction.

In this study it was revealed that the local wheat varieties show better results compared to foreign varieties. On the other hand, foreign varieties are more resistant to diseases and lodging, the main reasons affecting the wheat yield. Therefore, hybridization can help to improve the crop genotype and establish commercially important traits in crops, for example, disease resistance. Hybridized crops will contain the trait from both parents, thus they are assumed to have favorable traits. It will help to improve the traits of local wheat varieties and as a result provide better opportunity for local farmers.

Recommendations

- Test the winter wheat varieties in other districts of GBAO where snow cover exists including in Rushan, which has different climatic condition s from Ishkashim and where farmers are already cultivating winter wheat The winter varieties from Pakistan did not perform well in Ishkashim, because there was no snow, an d they were affected by frost in December.

- Start to hybridize the local with the foreign varieties to create a new variety that is more resilient to diseases and lodging and has h igh perform ance traits The varieties from China, especially CRBW1, CRBW4, CRBW6, and CRBW7, showed good results and are suggested for hybridization.

- Establish demonstration plots of the best performing and recommended wheat varieties with progressive farmers. The best perform ing local varieties were Safedaki Ishkashimy, Surkh kh ush, and Pandaki, which can be further disseminated to other areas of GBAO. To date, the wheat varieties produced by PBI have only been available to local farmers in Ishkashim Identifying how to deliver the wheat to other areas of GBAO will, therefore, be crucial.

- Establish and support wheat seed producer groups in each district, build their capacities and equip with tools and equipment. Once the seeds are produced by the wheat seed producer groups, then the seeds can be marketed, and linkages can be made between the seed producers and the farmers.

- Conserve local wheat seeds through continued suppor t to PBI. PBI already has a seed bank that includes certified wheat varieties from Tajik and Afghan Badakhshan and t heir main goals are enrichment of the seed bank and conservation of the local seeds.

- Establish and support agriculture input supply shops through the engagement of local entrepreneurs, in the center of each district in GBAO E nsure the supply of the best performing wheat variety seeds chemical fertilizers and other inputs on a regular basis through linking the local entrepreneurs with national suppliers.

Appendices

Examples: One-way analysis of variance with annual crops

Example 1. Conducting a dispersion analysis of the experimental data on the basis of the Mass of 1000 grains - will determine the least significant difference (LSD) and group wheat varieties in relation to the standard.

Table 1. Mass of 1000 grains (g) of varieties of spring soft wheat, Ishkashim, 2019

	"Options(samples)"	Reps, X			Sums V	Average
		I	II	III		
1	Safedaki Ishkashimy	36.4	33.92	33.66	103.95	34.65
2	CRBW 1.	37.5	37.09	47.21	121.76	40.59
3	Surkhkhush	32.3	34.56	36.14	102.96	34.32
4	CRBW 7.	36.5	38.56	35.77	110.79	36.93
5	CRBW 6.	33.6	30.84	38.63	103.06	34.35
6	CRBW 4.	43.0	38.6	39.57	121.15	40.38
7	Pandaki	38.5	37.55	29.08	105.09	35.03
8	CRBW 5.	43.5	40.09	45.3	128.91	42.97
9	CRBW 3.	36.1	37.31	39.38	112.74	37.58
10	CRBW 2.	40.8	41.95	39.88	122.64	40.88
	Sums P	**378**	**370.5**	**384,.**	**1133.05=Sums X**	**37.77=X**

Solution 1. In the table. 1 sum and averages are calculated. The correctness of the calculations is checked by the equality of the sum P = the sum V = the sum X1 = 1133.05

2. To calculate the sum of squares, it is advisable to convert the original dates according to the ratio X1 \u003d X-A, taking the number 37.77 as the conditional average A (it can be close to X, i.e. 38). The converted dates are recorded in Table 2. The correctness of the calculations is checked by the equality of the sum P = the sum V = the sum X1 = 10.35

Table 2. Converted dates

Options		X1=X-37,77			Sums V
		I	II	III	
1	Safedaki Ishkashimy	-1.40	-3.85	-4.11	-9.36
2	CRBW 1.	-0.31	-0.68	9.44	8.46
3	Surkhkhush	-5.51	-3.21	-1.63	-10.35
4	CRBW 7.	-1.31	0.79	-2.00	-2.51
5	CRBW 6.	-4.18	-6.93	0.86	-10.25
6	CRBW 4.	5.21	0.83	1.80	7.85
7	Pandaki	0.69	-0.22	-8.69	-8.22
8	CRBW 5.	5.75	2.32	7.53	15.61
9	CRBW 3.	-1.72	-0.46	1.61	-0.56
10	CRBW 2.	3.04	4.18	2.11	9.34
	Sums P	**5.79**	**-4.00**	**8.57**	**10.35=Sums X1**

The calculation of the sum of squared deviations is carried out in the following sequence:
Total number of observations = N = in=10 x 3=30
Correction factor C= (X1 sums)2 : N=(10.35)2 : 30 =3.6
Sum of squared deviations Cy=Sum X1-C=(0.312+0.682+….+2.112) – 3.6=474.87
Cp=P2 sums : i-C=(5.792+4.02+8.572) :10 – 3.6=8.72
Cv= V2 sums : n-C =(8.462+10.352+2.512+……..+9.342) : 3 – 3.6 = 275.54
Cz \u003d Cy - Cp - Cv \u003d 474.87-8.72-275.54 \u003d 190.61
Now you can fill in Table 3 of the analysis of variance

Table 3. Analysis of variance

Dispersion	Sum of squares	Degrees of freedom	Medium square	FΦ	F0.5
General (Cy)	474.87	29	_	_	
Reps (Cp)	8.72	2	_	_	
Options (CV)	275.54	9	30.62	2.89	2.46
Remainder (errors) (Cz)	190.61	18	10.59	_	

The value of the criteria F 0.5 is found according to Table 2 of the appendices for 9 degrees of freedom of the variance of the variants (numerator) and for the 18-dispersion of the error (denominator). It is shown that there is a significant difference between the variants of the experiment and the null hypothesis (H0) is rejected, i.e. (FF =2.89 >F0.5=2.46).

3. To assess the significance of frequent differences and grouping options (varieties), the error of the experiment, the error of the difference between the means and LSD 0.05 are calculated in absolute and relative values:
Sx=√S2/n=√10,59/3=1,87 г.
Sd=√2S2/n=√(2*10,59)/3=2,65 г.
HCP 0,5=t0,5Sd=2,10 x 2,65=5,57
HCP 0,5 =t0.5sd/x 100=5,57/37,77*100 = 14,7 %

Table 4. Weight of 1000 grains (g) of spring wheat varieties

Wheat sample varieties	Average weight of 1000 grains, g.	Deviation from St, g		Group g
		g	%	
Safedaki Ishkashimy	34.6	-	-	St.
CRBW 1.	40.6	6.0*	17.3*	I
Surkhkhush	34.3	-0.3	-0.9	II
CRBW 7.	36.9	2.3	6.6	II
CRBW 6.	34.3	-0.3	-0.9	II
CRBW 4.	40.4	5.7*	16.8*	I
Pandaki	35.0	0.4	1.1	II
CRBW 5.	43.0	8.4*	24.3*	I
CRBW 3.	37.6	3.0	8.7	II
CRBW 2.	40.9	6.3*	18.2*	I
LSD 0.05		**5.57**	**14.7**	**-**

Значение критерия t на 5, 1 и 0.1 %-ном уровне значимости

Число степеней свободы	Уровен значимости		
	0.05	0.01	0.001
1	12.71	63.66	
2	4.3	9.93	31.6
3	3.18	5.84	12.94
4	2.78	4.6	8.61
5	2.57	4.03	6.86
6	2.45	3.71	5.96
7	2.37	3.5	5.41
8	2.31	3.36	5.04
9	2.26	3.25	4.78
10	2.23	3.17	4.59
11	2.2	3.11	4.44
12	2.18	3.06	4.32
13	2.16	3.01	4.22
14	2.15	2.98	4.14
15	2.13	2.95	4.07
16	2.12	2.92	4.02
17	2.11	2.9	3.97
18	2.1	2.88	3.92
19	2.09	2.79	3.73
20	2.09	2.85	3.85
21	2.08	2.83	3.82
22	2.07	2.82	3.79
23	2.07	2.81	3.77
24	2.06	2.8	3.75
25	2.06	2.79	3.73
26	2.06	2.78	3.71
27	2.05	2.77	3.69
28	2.05	2.76	3.67
29	2.05	2.76	3.66
30	2.04	2.75	3.65
50	2.01	2.68	3.39
100	1.98	2.63	3.39
∞	1.96	2.58	3.29

Значение критерия F на 5 %-ном уровне значимости (вероятность 95%)

Степени свободы для меньшей дисперсии (знаминателя)	Степени свободы для большей дисперсии (числителя)													
	1	2	3	4	5	6	7	8	9	10	12	24	50	100
1	161	200	216	225	230	234	237	239	241	242	244	249	252	253
2	18.51	19	19.16	19.25	19.3	19.33	19.36	19.37	19.38	19.39	19.41	19.45	19.47	19.49
3	10.13	9.55	9.28	9.12	9.01	8.94	8.88	8.84	8.81	8.78	8.74	8.64	8.58	8.56
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6	5.96	5.91	5.77	5.7	5.66
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.78	4.74	4.68	4.53	4.44	4.4
6	5.99	5.14	4.76	4.53	4.39	4.27	4.21	4.15	4.1	4.06	4	3.84	3.75	3.71
7	5.99	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.63	3.57	3.41	3.32	3.28
8	5.32	4.46	4.07	3.84	3.69	3.58	3.5	3.44	3.39	3.34	3.28	3.12	3.03	2.98
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.13	3.07	2.9	2.8	2.76
10	4.96	4.1	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.97	2.91	2.74	2.64	2.59
11	4.84	3.98	3.59	3.36	3.2	3.09	3.01	2.95	2.9	2.86	2.79	2.61	2.5	2.45
12	4.75	3.88	3.49	3.26	3.11	3	2.92	2.85	2.8	2.79	2.69	2.5	2.4	2.35
13	4.64	3.8	3.41	3.18	3.02	2.92	2.84	2.77	2.72	2.67	2.6	2.42	2.32	2.26
14	4.6	3.74	3.34	3.11	2.96	2.85	2.77	2.7	2.65	2.6	2.53	2.35	2.24	2.19
15	4.54	3.6	3.29	3.06	2.9	2.79	2.7	2.64	2.59	2.55	2.48	2.29	2.18	2.12
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.24	2.13	2.07
17	4.45	3.59	3.2	2.96	2.81	2.7	2.62	2.55	2.5	2.45	2.38	2.19	2.08	2.02
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.15	2.04	1.98
19	4.38	3.52	3.13	2.9	2.74	2.63	2.55	2.48	2.43	2.38	2.31	2.11	2	1.94
20	4.35	3.49	3.1	2.87	2.71	2.6	2.52	2.45	2.4	2.35	2.28	2.08	1.96	1.9
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.05	1.93	1.87
22	4.3	3.44	3.05	2.82	2.66	2.55	2.47	2.4	2.35	2.3	2.23	2.03	1.91	1.84
23	4.28	3.42	3.03	2.8	2.64	2.53	2.45	2.38	2.32	2.28	2.2	2	1.88	1.82
24	4.26	3.4	30.1	2.78	2.62	2.51	2.43	2.36	2.3	2.26	2.18	1.98	1.86	1.8
25	4.24	3.38	2.99	2.76	2.6	2.49	2.41	2.34	2.25	2.24	2.16	1.96	1.84	1.77
26	4.22	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.16	1.96	1.84	1.77
28	4.2	3.34	2.95	2.71	2.56	2.44	2.36	2.29	2.24	2.19	2.12	1.91	1.78	1.72
30	4.17	3.32	2.92	2.69	2.53	2.42	2.34	2.27	2.21	2.12	2.09	1.89	1.76	1.69
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.07	2	1.89	1.76	1.69
50	4.03	3.18	2.79	2.56	2.4	2.29	2.2	2.13	2.07	2.02	1.95	1.74	1.6	1.52
100	9.94	3.09	2.7	2.46	2.3	2.19	2.1	2.03	1.97	1.92	1.85	1.63	1.48	1.39

These are additional tables that contains mean, standard deviation and values that are separated by letters which means that same letter is not significantly different at p=0.05.

Three-year data of spring soft wheat varieties including control, local and accessions from China.

Wheat varieties/ accessions	**Plant height, cm**					
	2019		**2020**		**2019**	
	Mean		Mean		Mean	
Safedaki Ishkashimy	95.4	a*	96	b	90.6	ab
CRBW 1	52.6	c	59.6	c	51.5	de
Surkhkhush	98.5	a	98.4	ab	87.7	b
CRBW 7	54.0	bc	55.1	cd	49.5	e
CRBW 6	61.3	b	52.4	d	64.9	c
CRBW 4	54.9	bc	54.8	d	56.0	d
Pandaki	98.3	a	102.7	a	94.8	a
CRBW 5	51.7	c	52.4	d	54.9	de
CRBW 3	56.8	bc	51.7	d	52.5	de
CRBW 2	54.8	bc	51.2	d	54.7	de
LSD 0.05		**7.3**		**3.6**		**5.9**

Wheat varieties/ accessions	**General tillering, pcs.**					
	2019		**2020**		**2019**	
	Mean		Mean		Mean	
Safedaki Ishkashimy	3.7	a*	3.6	b	3.6	a
CRBW 1	2.5	b	2.8	c	3.6	a
Surkhkhush	4.2	a	4.5	a	3.3	abc
CRBW 7	2.7	b	2.6	c	3.3	abc
CRBW 6	2.4	b	2.5	c	2.8	cd
CRBW 4	2.3	b	2.6	c	2.9	bcd
Pandaki	3.9	a	3.9	ab	3.4	ab
CRBW 5	2.2	b	2.4	c	2.7	d
CRBW 3	2.7	b	2.8	c	2.9	bcd
CRBW 2	2.4	b	2.9	c	2.8	d
LSD 0.05		**0.7**		**0.7**		**0.5**

Wheat varieties/ accessions	**Productive tillering, pcs.**					
	2019		**2020**		**2019**	
	Mean		Mean		Mean	
Safedaki Ishkashimy	3.5	a*	3.4	a	3.3	a
CRBW 1	2.4	b	2.6	b	3.3	a
Surkhkhush	3.6	a	3.8	a	3.2	ab
CRBW 7	2.4	b	2.6	b	3.0	abc
CRBW 6	2.2	b	2.4	b	2.7	c
CRBW 4	2.3	b	2.6	b	2.7	c
Pandaki	3.4	a	3.6	a	3.3	a
CRBW 5	2.0	b	2.1	b	2.7	c
CRBW 3	2.5	b	2.6	b	2.9	bc
CRBW 2	2.3	b	2.7	b	2.8	c
LSD 0.05		**0.7**		**0.5**		**0.4**

Wheat varieties/ accessions	Length of the main spike, cm					
	2019		2020		2021	
	Mean		Mean		Mean	
Safedaki Ishkashimy	9.1	a*	8.6	a	8.2	a
CRBW 1	6.0	cd	5.9	c	5.9	de
Surkhkhush	9.0	a	8.8	a	7.4	a
CRBW 7	6.2	cd	5.8	c	5.6	de
CRBW 6	6.6	cd	6.4	c	6.5	cd
CRBW 4	6.7	c	6.1	c	6.0	cde
Pandaki	8.9	a	7.7	b	7.9	a
CRBW 5	5.9	d	5.7	c	5.9	cde
CRBW 3	6.2	cd	6.0	c	5.5	de
CRBW 2	7.5	b	6.2	c	6.7	bc
LSD 0.05		**0.7**		**0.4**		**0.4**

Wheat varieties/ accessions	Number of spikelets in the main spike pcs.					
	2019		2020		2021	
	Mean		Mean		Mean	
Safedaki Ishkashimy	16.9	a	14.9	ab	14.0	a
CRBW 1	12.5	e	14.6	ab	11.3	c
Surkhkhush	15.2	b	13.1	b	11.7	c
CRBW 7	13.8	bcde	14.3	ab	11.2	c
CRBW 6	13.6	cde	13.3	b	12.0	c
CRBW 4	14.3	bcd	12.9	b	12.5	bc
Pandaki	17.1	a	16.0	a	13.6	ab
CRBW 5	13.2	de	13.3	b	11.9	c
CRBW 3	14.7	bcd	13.7	ab	12.5	bc
CRBW 2	15.1	bc	13.6	ab	12.5	bc
LSD 0.05		**1.6**		**1.5**		**1.4**

Wheat varieties/ accessions	Number of grains per spikelet, pcs.					
	2019		2020		2021	
	Mean		Mean		Mean	
Safedaki Ishkashimy	38.2	abc*	36.2	ab	35.6	bcde
CRBW 1	30.9	d	40.8	a	41.7	a
Surkhkhush	33.9	cd	28.0	cd	29.4	f
CRBW 7	39.6	abc	32.8	bc	30.1	ef
CRBW 6	35.9	bcd	36.1	ab	35.8	bcd
CRBW 4	44.3	a	35.5	ab	39.7	ab
Pandaki	34.7	cd	25.5	d	35.2	bcd
CRBW 5	33.8	cd	28.4	cd	33.7	cdef
CRBW 3	38.1	abc	39.2	ab	38.6	abc
CRBW 2	41.2	ab	33.1	bc	32.0	def
LSD 0.05		**6.2**		**3.9**		**5.5**

Wheat varieties/ accessions	Weight of grains per main spike					
	2019		2020		2021	
	Mean		Mean		Mean	
Safedaki Ishkashimy	1.3	bc*	1.3	ab		
CRBW 1	1.3	c	1.2	ab	1.3	ab
Surkhkhush	1.1	c	1.3	ab	1.2	bc
CRBW 7	1.5	abc	1.1	b	1.0	c
CRBW 6	1.2	c	1.6	a	1.4	ab
CRBW 4	1.8	a	1.5	a	1.4	ab

Pandaki	1.2	c	0.5	c	1.5	a
CRBW 5	1.5	abc	1.3	ab	1.3	bc
CRBW 3	1.5	abc	1.6	a	1.3	abc
CRBW 2	1.7	ab	1.3	ab	1.3	abc
LSD 0.05	**0.4**			**0.2**		**0.3**

Wheat varieties/ accessions	**Weigh of 1000 grain, g**					
	2019		**2020**		**2021**	
	Mean		**Mean**		**Mean**	
Safedaki Ishkashimy	34.65	d*	29.8	e	15.3	c
CRBW 1	40.9	abc	47.5	a	26.4	a
Surkhkhush	34.3	d	30.7	e	16.2	c
CRBW 7	36.9	bcd	44.1	abc	17.9	bc
CRBW 6	34.4	d	35.4	de	13.7	c
CRBW 4	40.4	abc	41.2	abcd	18.0	bc
Pandaki	35.0	cd	20.0	f	23.9	ab
CRBW 5	42.9	a	45.9	ab	15.7	c
CRBW 3	37.9	abcd	39.3	bcd	15.9	c
CRBW 2	40.1	ab	38.9	cd	16.8	c
LSD 0.05		**5.6**		**3.6**		**5.2**

Wheat varieties/ accessions	**Number of grains per spike**					
	2019		**2020**		**2021**	
	Mean		**Mean**		**Mean**	
Safedaki Ishkashimy	2.3	de*	2.8	a	2.9	ab
CRBW 1	2.5	cd	2.2	bc	2.9	ab
Surkhkhush	2.2	de	2.3	bc	2.6	c
CRBW 7	2.9	ab	2.5	b	2.6	c
CRBW 6	2.6	bc	2.6	b	3.2	a
CRBW 4	3.1	a	2.8	a	3.2	a
Pandaki	2.0	e	1.6	d	2.6	c
CRBW 5	2.6	c	2.1	bc	2.8	bc
CRBW 3	2.6	bc	2.8	a	3.1	ab
CRBW 2	2.7	bc	2.4	bc	2.6	c
LSD 0.05		**0.3**		**0.3**		**0.4**

Wheat varieties/ accessions	**Heading-ripening, days**					
	2019		**2020**		**2021**	
	Mean		**Mean**		**Mean**	
Safedaki Ishkashimy	57.7	b*	59.0	abcd	51.7	bc
CRBW 1	51.3	c	54.7	d	50.3	c
Surkhkhush	63.7	a	61.0	ab	49.3	c
CRBW 7	50.7	c	55.7	cd	57.0	a
CRBW 6	52.7	c	62.3	a	50.3	c
CRBW 4	50.7	c	60.3	abc	50.7	bc
Pandaki	65.3	a	57.3	bcd	53.0	b
CRBW 5	52.0	c	61.3	ab	50.3	c
CRBW 3	51.3	c	61.7	ab	51.0	bc
CRBW 2	52.0	c	59.7	bcd	51.7	bc
LSD 0.05		**2.7**		**1.3**		**2.5**

Wheat varieties/ accessions	Germination-ripening, days					
	2019		2020		2021	
	Mean		Mean		Mean	
Safedaki Ishkashimy	104.3	b*	112.0	b	108.7	bcd
CRBW 1	100.7	c	113.0	b	111.0	abc
Surkhkhush	105.7	b	112.0	b	102.7	e
CRBW 7	100.0	c	114.0	b	115.0	a
CRBW 6	104.3	b	112.0	b	103.7	de
CRBW 4	99.7	c	111.0	b	113.3	ab
Pandaki	109.0	a	122.0	a	113.3	ab
CRBW 5	100.3	c	112.0	b	104.3	de
CRBW 3	100.3	c	112.0	b	104.3	de
CRBW 2	101.0	c	112.0	b	104.3	de
LSD 0.05		**3.3**		**1.1**		**5.3**

Three-year data of winter wheat varieties including control, local and accessions from Pakistan.

Wheat varieties/ accessions	Plant height, cm					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	85.9	a*	96.3	b	105.6	a
№75	78.1	b	76.1	c	82.3	c
№144	77.6	b	74.4	c	77.1	c
№63	86.6	a	88.8	b	95.0	b
Bludon	83.1	ab	104.4	a	94.0	b
LSD 0.05		**6.7**		**7.9**		**6.7**

Wheat varieties/ accessions	General tillering, pcs.					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	3.4	a*	3.2	ab	3.4	a
№75	2.1	b	2.5	bc	3.5	a
№144	2.0	b	3.2	ab	2.9	b
№63	2.1	b	2.0	c	2.5	c
Bludon	2.2	b	3.3	a	2.6	bc
LSD 0.05		**0.5**		**0.6**		**0.3**

Wheat varieties/ accessions	Productive tillering, pcs.					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	3.3	a*	3.0	a	3.3	a
№75	2.0	a	2.5	ab	3.4	a
№144	1.8	a	3.0	a	2.9	b
№63	3.3	a	2.0	b	2.5	c
Bludon	2.2	a	3.0	a	2.5	c
LSD 0.05		**0.5**		**0.6**		**0.2**

Wheat varieties/ accessions	Length of the main spike, cm					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	8.5	a*	8.4	a	8.1	a
№75	7.5	b	6.6	c	6.7	b
№144	8.2	ab	7.1	bc	7.8	a
№63	7.6	b	8.0	ab	8.4	a
Bludon	8.5	a	8.3	a	8.2	a
LSD 0.05		**3.4**		**0.9**		**0.9**

Wheat varieties/ accessions	Number of spike in the main spikelet					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	15.8	a*	14.9	ab	13.9	bc
№75	16.3	a	14.1	b	13.6	bc
№144	16.2	a	14.5	ab	14.6	ab
№63	15.3	a	15.7	a	15.7	a
Bludon	15.7	a	15.2	ab	13.3	c
LSD 0.05		**1.8**		**1.6**		**1.2**

Wheat varieties/ accessions	Number of grains in the main spikelet					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	35.9	b*	35.9	bc	37.6	b
№75	37.9	b	34.5	bc	38.0	b
№144	44.3	a	37.2	ab	46.1	a
№63	33.3	b	40.7	a	45.0	a
Bludon	38.1	b	32.9	c	37.8	b
LSD 0.05		**5.4**		**4.2**		**4.1**

Wheat varieties/ accessions	Weight of the main spike, g					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	1.3	a	1.3	a	1.8	ab
№75	1.1	a	1.2	a	1.5	bc
№144	1.1	a	1.3	a	1.5	c
№63	1.2	a	1.4	a	2.0	a
Bludon	1.1	a	0.7	b	1.7	bc
LSD 0.05		**0.2**		**0.2**		**0.3**

Wheat varieties/ accessions	Weight of 1000 grain, g					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	38.8	a*	34.9	a	48.1	a
№75	35.9	a	34.3	a	40.1	c
№144	30.5	bc	34.4	a	33.3	d
№63	35.9	ab	34.8	a	45.2	b
Bludon	28.8	c	21.0	b	44.2	b
LSD 0.05		**5.1**		**4.9**		**2.3**

Wheat varieties/ accessions	Weight of grain, g					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	20.7	a*	16.1	ab	27.4	a
№75	9.3	b	10.7	bc	25.7	ab
№144	7.5	b	18.2	a	21.0	bc
№63	8.1	b	9.1	c	22.7	abc
Bludon	8.4	b	10.8	bc	18.2	c
LSD 0.05		**6.7**	**6.6**			**5.9**

Wheat varieties/ accessions	Number of grains per spikelet, pcs.					
	2019			2020	2021	
	Mean		Mean		Mean	
Joydori	2.3	bc*	2.4	ab	2.7	b
№75	2.3	bc	2.6	a	2.8	b
№144	2.7	a	2.5	a	3.2	a
№63	2.2	c	2.6	a	2.9	b
Bludon	2.4	b	2.2	b	2.9	b
LSD 0.05		**0.2**		**0.2**		**0.3**

Wheat varieties/ accessions	Germination-heading, days					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	71.0	a*	61.0	b	64.3	a
№75	63.0	c	59.3	c	54.0	c
№144	64.0	c	62.0	b	58.7	b
№63	63.3	c	62.7	b	60.0	b
Bludon	69.7	b	68.0	a	61.7	ab
LSD 0.05		**4.0**		**4.4**		**4.2**

Wheat varieties/ accessions	Heading-ripening, days					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	105.0	a*	103.0	b	115.3	a
№75	97.7	b	111.0	a	113.7	a
№144	100.0	b	112.0	a	113.3	a
№63	99.3	b	112.0	a	114.0	a
Bludon	104.0	a	112.3	a	114.7	a
LSD 0.05		**2.8**		**5.6**		**3.8**

Wheat varieties/ accessions	Germination-ripening, days					
	2019		2020		2021	
	Mean		Mean		Mean	
Joydori	34.0	a*	42.0	b	51.0	b
№75	34.7	a	51.7	a	59.7	a
№144	36.0	a	50.0	a	54.7	b
№63	36.0	a	49.3	a	54.0	b
Bludon	34.3	a	44.3	b	53.0	b
LSD 0.05		**4.8**		**3.2**		**4.2**

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University of Central Asia
125/1 Toktogul Street, Bishkek 720001, Kyrgyz Republic
Tel.: +996 (312) 910 822, E-mail: msri@ucentralasia.org
www.msri.ucentralasia.org