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Genetic Potential of Winter Wheat Grain Quality in Central Asia

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ABSTRACT

The grain quality of winter wheat varies significantly by cultivars and growing region, not previously differentiated by end-use (baking, confectionery, etc.) in the national breeding programs. In these conditions it is advisable to determine the genetic potential and analyze the actual grain quality. Determining the genetic potential requires the cultivars classification by grain hardness and composition of the HMS and the LMS glutenin. The most of winter wheat cultivars from Kazakhstan, Kyrgyzstan and CIMMYT are classified as “hard” and “semi hard” (62-95% in different blocks), characterizing them as baking wheat in the respective regions. The “soft” grain samples were also detected in small amounts ranging from 2% (Tajikistan) to 11% (Kazakhstan). Varieties are ranked by the HMS-glutenin from 10 (max) to (min) 4 point Payne scale for quality and by the LMS-glutenin from 5 to 1. The genetic potential of breeding material was determined by composition of the glutenin subunits as high level (75-80%). Several cultivars classified as “soft” –Batyr, Komsomolskaya 103 (Kazakhstan) and new registered cultivars Konditerskaya. It is therefore important not only to identify potential quality, but also its implementation in the specific growing conditions of the region.

KEYWORDS
Winter wheat, glutenin composition, hardness index, grain quality. national breeding programs

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Introduction

Wheat is the third most-produced cereal after maize and rice in the world (Hochman et al., 2014). Due to winter wheat cultivars is possible to obtain two harvest per year in temperate climate zone (Sharma et al., 2013). The characteristic feature of winter wheat is its requirement of rather low temperature for vernalization. The usual duration of the process of vernalization in most winter wheat at low temperatures (0°–10°C) is 30–50 days, depending upon the variety (Li & Liu, 2010). Once this stage has been accomplished, the plant becomes capable of forming flowers in favourable conditions (Morgounov et al., 2005). Genetic studies comparing winter and spring wheat have identified three genes (VRN1, VRN2 and VRN3) in the vernalization response (Sharma et al., 2012). Spring wheat differs from winter wheat in that it does not require vernalization, and is thus able to ear when sown in spring. Winter and spring habit, as a Mendelian character transmitted by gametes, is a hereditary

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property in wheat (Shewry, Halford & Tatham, 1992). The conversion of winter forms to spring forms is a method for creating high-productivity spring wheat varieties. The winter wheat variety 'Mironovskaya 808', which was converted from the spring wheat 'Artemovka', had been cultivated over many millions of hectares (Khazratkulova et al., 2015).

Winter wheat is grown in the Central Asian region in the square to 1 million hectares - in Kazakhstan, 1.2 - in Uzbekistan, 350 thousand hectares - In Kyrgyzstan, 400th - in Tajikistan, and 300th - Turkmenistan, and is represented above 80 common and 10 wheat durum cultivars registered in the Central Asia region (Abugalieva & Peña-Bautista, 2010).

Literature review

Winter wheat breeding it is important the optimization of grain quality with the level productivity in irrigated and drought conditions (Sharma et al., 2009). Over the past 10 years, there is an active co-operation and germplasm exchange with International Centers CIMMYT, ICARDA. In this context, it is advisable to determine the genetic potential and analyze the real grain quality in retrospective and on the comparative of productivity. The CIMMYT wheat program annually distributes international yield trials targeted to wheat growing mega-environments predominant in many developing countries through its collaborative international wheat improvement network (Sharma et al., 2012). The ICARDA mandate countries would each possess dense meteorological networks, and each station in those networks would provide unbroken daily weather records over a recent 30 year period (Mauget & de Pauw, 2010). With such data records an agro-climate application similar to that described here could be based on observed weather data similar to the daily temperature and precipitation measurements (Mauget & de Pauw, 2010).

Factors that persuade wheat quality have been broadly classified into two groups: physical and chemical characteristics (Nakamura et al., 2012). Grain vitreousness, color, weight, shape and hardness are some essential physical characteristics, which influence wheat grain quality (Koga et al., 2016). Chemical characteristics include protein content, SDS-sedimentation value and glutenstrength, etc (Wan, 2002). The kernel texture is one of the most important characteristics for milling and baking quality of wheat (Figueroa et al., 2011). Wheat is classified into soft, medium soft, hard, medium hard and extra hard on the basis of kernel hardness (Kent & Evers, 1994). This categorization forms the fundamental basis for differentiating the world trade of wheat grain.

An important role play glutenin subunits in wheat cultivars (Koga et al., 2016). Two major classes of glutenin polypeptides have been identified in wheat endosperm, designated as HMW-GS and LMW-GS; both classes occur in flour as cross-linked proteins resulting from inter-polypeptide disulphide linkages (Shewry, Halford & Tatham, 1992). The genes coding for HMW-GS subunits are located on the long arms of chromosomes 1A, 1B and 1D at the Glu-A1, Glu-B1 and Glu-D1 loci respectively (Payne, Law & Mudd, 1980). The genes coding for LMW-GS occur on the short arms of group-1 chromosomes at the Glu-A3, Glu-B3 and Glu-D3 loci which are tightly linked to the Gli-1 locus (Payne, Holt & Law, 1981). The effects of the Glu-1 and Glu-3 alleles in a wider range of genotypes are needed before their use in predicting dough properties can be fully justified. A better understanding of the effect of individual alleles on quality parameters will provide clearer information for the breadmaking quality breeders (Luo et al., 2001).

Grain hardness is used as a grading factor to determine the type of wheat (Pasha, Anjum & Morris, 2010). It is a key determinant for classification of wheat and end product quality (Abecassis, Chaurand & Autran, 1997). Grain hardness is important for the flour industry because it has significant impacts on milling, baking and qualities of wheat (Uvere, Ngoddy & Nwankwo, 2014). It is influenced by various environmental, physical and chemical factors like kernel protein, vitreousness of grain, kernel size, water-soluble pentosans, moisture content and lipid content (Petersen et al., 2013).

The quality of winter wheat grain varies greatly by cultivars and region growing, not previously differentiated by end- use (bakery, confectionery, etc.) and not been a priority in the national breeding programs in Central Asian region. We believe that this study has provided information to change the attitude of national breeding programs in Central Asian region.

Aim of the study

The aim of this study was to examine hardness of winter wheat cultivars in Central Asia region and analyze glutenin contribution.

Research questions

The overarching research question of this study was as follows:

what cultivars of winter wheat is preferable in Central Asia countries according to grain quality and bakery requirements?

Method

The research object were: samples of common winter wheat and triticale crop years 2001-2013, including the full scheme ~ 300 samples: 158 - Kyrgyzstan, 28 - Uzbekistan, 70 - Tajikistan; 18- Turkmenistan, and more than 500 samples of breeding material: 160 - Kyrgyzstan, 119 - Uzbekistan, 49 - Tajikistan, 172 - Kazakhstan.

The grain hardness index (GHI), weight of 1000 grains, grain size and grain moisture analyzed by SKCS 4100 Perten Instruments. The GHI and protein content were also determined NIR spectroscopic (Pacific Scientific 4250) using a previously developed by us calibration equations (Abugalieva et al., 1998). Grain nature, vitreouesness, gluten content and quality were determined according to the state Standard (Кайгородцев, 2014). The physical properties of the dough and flour were evaluated by alveograph (Bettge, Rubenthaler & Pomeranz, 1989), farinograph (Migliori & Correra, 2013). Extraction of glutenin and its separation was analyse carried out at the CIMMYT Laboratory (J.Pena). Cluster analysis was conducted using the algorithm of minimum DX $(1\text{-R})^2$ as described (Abugalieva et al., 1998).

Data, Analysis, and Results

Kazakhstan

In Kazakhstan, systematic research on grain hardness initiated as part of wheat cultivars genofund investigation on the State Trial Variety materials, than were developed in the breeding process (Abugalieva & Peña-Bautista, 2010), including creation and registration of varieties of confectionery soft type (table1).

Hardness special studies of Central Asia wheat as have not been conducted. The initial screening of the material allowed to note the presence of “soft” wheat genotypes: Guldor-MIS and Jamin (Kyrgyzstan); Kinasi, Alex (Tajikistan); Maxcat, Caragum, Same, Gunea, GNH / SAD, Dostlik (Turkmenistan) and 211, 219, 222 and 224 (Uzbekistan), generally from 3% to 14% of soft grain and from 2% to 11% of the semi soft grain (figure 1).

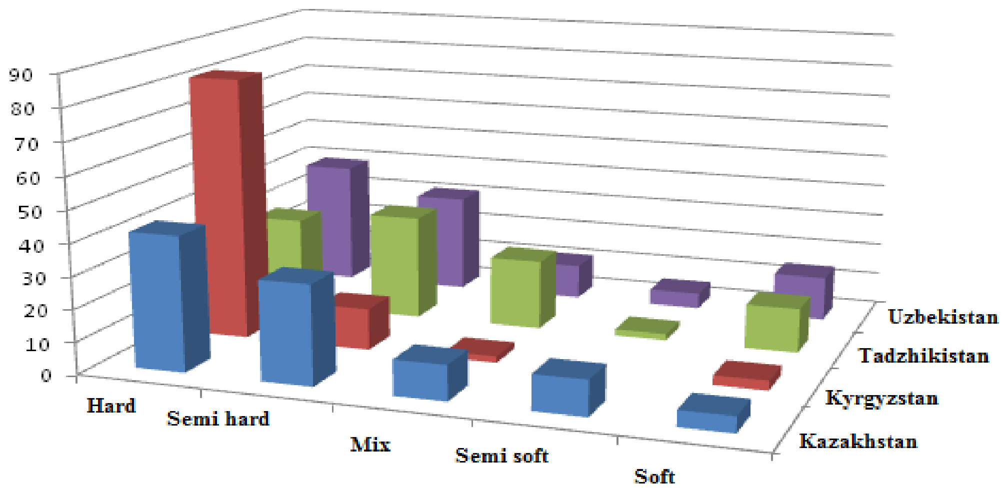


Figure 1. Distribution of winter common wheat on the hardness class in the country of Central Asia

Table 1. Classification of Central Asia winter common wheat grain varieties on hardness (SKCS 4100, Perten Instrument)

Hardness Class	*Winter wheat cultivars in CA country:*				
	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmeniya	Uzbekistan
Hard 100-66 un. SKCS 4100	**Almaly,** Arap, Altynmasak, Bat-zhan, Basar, Zhalyn, **Krasnovodopad-skaya 210**, OPAKS 26, OPAKS 50, OPAKS 55, OPAKS 56, **Pamyat 47, Pirotriks 50,** Ratan, Erithrospermum 97, Erithrospermum 2000, OPAKS-1, Krasnaya zvezda, Ramin, Alem, Grekum, KP 32093,	Adir, Asil, Bermet, Bez-ostaya 1 Dostuk, Intensivnaya, Kairak, Kyzyldan, Kiyal, Krasnovodopad-skaya 210 Lutescens 42, Lutescens 480, 505,559, 627, 628, 629, 632, **Milyanonus 223,** Skiflyanka, Tilek, Frunzenskaya	Chillyahi, Sul-tan, 95, Karly-gash, Jager, Fonchi, Echo, Kinasi, Bat'ko, Navruz, Atilla, Zander, Somoni, Krasnodarskaya 99, Bocro 4, Superwheat-139, Superwheat-140		213, 214, 217, 223, Fravo, Noreen Bayavut, Sandaziz, Guran, Olmos Denov-1, Enbosh, Shavrat, Rabat, Saihun

	Mironovskaya 35, Tungish, Mambo, MK-3816, Bonpen, Guadalupe, Kuibyshevka, Sultan 2, Arai, Jenis, Efremovskaya10	60, Ferrugineum 60, Erithrospermum 13, 80, 176, 302, 518, 670, 760, Erithrospermum 1948, 9933, 9945-1, 9755, Erithrospermum 77, 194, 302, 342, 432, 434, 503, 507, 518, 528, 570, 574, 10086, 10099, Polovchanka, Cholpon			
Semihard 65-53 un. SKCS 4100	Bayandy,**Bezostaya 1, Bogarnaya 56,** Derbes, Kokbiday, Komsomolskaya 1, **Mironovskaya 808,** Maryam, Naz, Ok-tyabrina 70, OPAKS 55, **Odesskaya 120, Steklovidnaya 24,** Sultan, Erithrosper-mum 350, Yuzhnaya 12, Jyubileinaya 60, Reke, Aksai, Kom-somolskaya 56, 2899, Egemen, 2783, 15723, 15123, Efre-movskaya 11, Levo-berezhnaya 2,3	Lutescens 46, Erithrospermum 517, Zagadka, Aichurek, Zubkov, Azibrosh, Gneiss, Swindle	Tasik, Norman, Atay, President, Delta, Kauz, Krasotka, Zhetisu, Krasnovodopadskaya 90, Zimorodok, KupavaJager, Masha, Soyuz, Umanka, Vita, Chakbol	Turkmenbasy, Garalsyr, Bitarap, Libap	208; 209; 210; 212; 215; Tabhar, Guldu, Denov-2, Tamara, Sanzar-8, Bodur
Mix 52-48	**Karlygash, Sapaly,** Erithrospermum 260, Erin, Lutescens 72, Ershovskaya 10 Levoberezhnaya1, Ershovskaya 11, Gu-bernija	Merim-MIs	Knyazhna, Russa, Lyra, Kroshka, San-zar 12, Karly-gash, Normon, Avangard, Delta, Kuk-bulak, Attila, Normoni		220; 225; 226; 227
Semisoft 47-36	**Zhetisu,** Koksu, **Kazakhstanskaya 10,** Progress Rausin, Taza, Levoberezh-naya 3	Saratovskaya46, Saratovskayaostistaya, Victoria 95	JUP /4/ CLLF /3/		218; 221

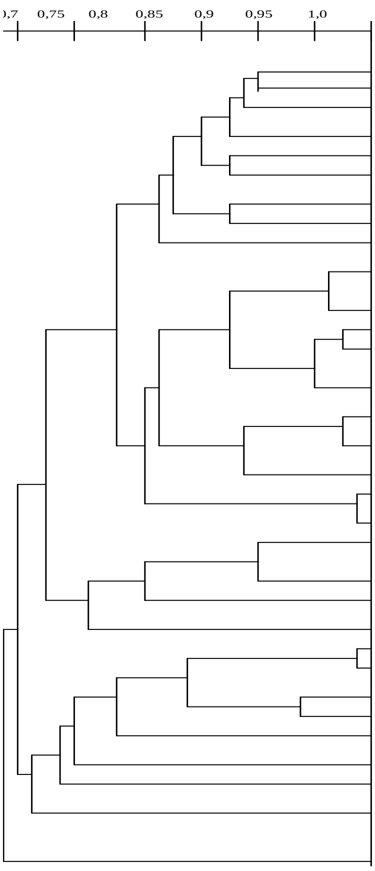
Soft <35	Batyr, Komsomolskaya 103, Komsomolskaya 75, Akdan, Konditerskaya	Guldor-MIS, Jamin	Kinasi, Sultan, Alex, 7C/CNO //CAF/3/ YMH /4/VD; TAM 200/KAUZ	Maxcat, GNU/SADC aragum Same, Gunea	Dostlik; 211; 222

Kyrgyzstan

The Kyrgyzstan Republic produces common wheat in area about 350th hectares. In the production was registered the 31 cultivars of winter wheat. This rather extensive list contains a variety of Russian, Ukrainian, Kazakhstan and Kyrgyzstan breeding. For this material have been found 23 types of HMW-glutenin and 4 LMW- types (1, 2, 4 and 5) in combination LMW-glutenin was 33 variations. Composition of HMW analyzed on flour for certain samples, the mixed type: 1/2 * (1A - 30%); 7+9/7+8, 6+8/7+8, 13+16/7+9, 6 + 8 (18)/7+ 9 (1B - 21.1%); 5+10/2+12 (1D - 6,2%). The greatest diversity was recorded in subunits controlled by locus Glu 1B - 11 allelic variants. Among the 33 varieties of common wheat approved for use on the territory of the Kyrgyz Republic analyzed 23 cultivars (Abugalieva & Peña-Bautista, 2010). Their variety is limited by six formulas: 1D only subunits 5 +10; 1B – 7+9,7+8 and 7 and the mixture of 7+9/7+8; on 1A chromosome by - N, 1, 2 *. A similar pattern noted earlier in the USSR cultivars characterization in trials E.D.Nettevich et al. (2001). The cluster analysis of HMW+LMW-glutenin and quality of grain, flour, bread varieties have posibility to differentiate samples into 4 groups in the breeding process (Figure 2).

The second cluster genotypes combined with high genetic potential composition HMW+LMW subunits except SBVD/13 genotypes and AKL/81-130 (1B subunit-“7” and LMS-2) in the first case, in synchronism with lowering of the quality by integrated evaluation unit to 3.17 relative to the ideal.

The genotypes of cluster I (average mean SD = 2,00) also confirm the genetic prediction by HMW glutenin composition, including grain quality reduction by "N" allele on chromosome 1A, to addition LMW glutenin subunits (LMW-1 and LMW-2). The first two clusters are mainly represented by samples of local selection and are characterized by high-quality alleles. Clusters 3 and 4 are mainly composed of genotypes with a predominance poor quality 2+12 subunit (1D), “null” allele at 1A, and diversity at 1B including subunits with reducing the quality effect (7, 6+8, 20). Accordingly, the cumulative score as a deviation from the ideal of the most, high for these groups of genotypes with high productive potential (2,18-2,37 average in the cluster), and reflects the deterioration of the grain quality.



Kyrgyzstan

№	1A	1B	1D	LMM	Payne	HMW+LMW	SD, integration assessment the deviation from the ideal		
1	1	7+9	5+10	4+	9	13	0,75-3,58	1,63	
2	1	7+9	5+10	1+	9	10		2,54	
3	1	7+9	5+10	5+	9	14	1,75-2,38	1,82	I SD = 2,0
4	1	7+9	5+10	2+	9	11	2,15-3,05	2,50	
5	0	7+9	5+10	2+	7	9	2,38-2,52	2,45	
6	1/2*	7+9	5+10	4+	9	13		1,27	
7	1	7+8	5+10	5+	10	15		1,64	
8	1	7+8	5+10	4+	10	14		0,92	
9	1	20			4			3,22	
10	2*	7+9/ 7+8	5+10	4	9-10	13-14	0,53-0,85	0,69	
11	2*	7+9	5+10	4	9	13	1,32-2,44	1,83	
12	2*	7+8	5+10	4	10	14	1,11-1,76	1,36	II SD = 1,6
13	2*	7+8	5+10	5	10	15		1,19	
14	2*	6+8/ 7+8	5+10	4	8-10	12-14		1,97	
15	2*	7+9	5+10	5	9	14	1,17-2,25	1,66	
16	2*	7+9/ 7+8	5+10	5	9-10	14-15	0,93-1,08	1,01	
17	2*	7+8	5+10	5	10	15	0,57-1,53	1,19	
18	2*	7	5+10	4	8	12		3,17	
19	2*	7+9	5+10	2	9	11		1,83	
20	2*	17+18	5+10	5	10	15		1,89	
21	2*	17+18	5+10/ 2+12	5	9-10	14-15		1,80	III SD = 2,4
22	0	17+18	5+10	2	8	10		3,48	
23	0	13+16	5+10	5	8	13		2,30	
24	1	7+8	2+12	4	8	12		3,08	
25	1	7	2+12	4	6	10		2,23	
26	2*	7+9	2+12	4	7	11	1,36-2,08	1,72	IV SD = 2,2
27	0	6+8	2+12	4	4	8		2,81	
28	2*	7+9	3+12	4	7	11		1,92	
29	0	20	5+10	5	6	11		2,27	
30	1	17+18	2+12	4	8	12		2,13	
31	2*	13+16/ 7+9	2+12	5	7-8	12-13		1,25	
32	2*	6+ (8-18) 7+9	5+10/ 2+12	1	6-9	7-10		2,04	

Figure 2. The dendrogramme of Kyrgyzstan MIS breeding samples similarity-difference on genetic potential (HMW+LMW glutenin) and the quality of the grain, and the integrated assessment (SD) –deviation from the ideal

1 - Frunzenskaya 60, Intensivnaya, Tilek, Kiyal, Erithr. 670, Erithr.176, Ferrugenium 26, Erithr.9755, Frunzenskaya 60, Erithr.13, Erithr.760; 2 – Lutescens 46; 3 – Kyzyldan, NS-55-58/VEE, Intensivnaya, Erithr. 670; 4 – SBVD/14, JUP 14/CLIF, Lutescens 46; 5 – Bermet, SBVD/17; 6 – Lutescens 505; 7 – Melyanopus 223; 8 – Erithr. 9933; 9 – Lutescens 42; 10 – Erithr.760, Bermet; 11 – Erithr.80, Bezostaya1, Erithr.518, Г-10S-1, 70б???; 12 – Erithr. 1948, Erithr.302, Kyzyldan; 13 – Adyr; 14 – Erithr.9933; 15 – Skifyanka, Tlek,Erithr. 9945/1, 1D13.1/MLT//KAUZ, Erithr. 80, 43 б???; 16 – F 474 S 10.1, Erithr.760; 17 – Dostyk, KS 82142/SERJ, Krasnovodopadskaya 210, Adyr, Bezostaya 1; 18 – SBVD/13; 19 – AKN/81-130//…; 20 – SBVD/8; 21 – CA 8055/6RK; 22 – ANK 8/96; 23 – JUP 14/CLIF; 24 – Erithr.517; 25 – SBVD/; 26 – SBVD/18, 32б ???; 27 – DUBR 86.1/CHAM 6; 28 – 451, 29 – SBVD/7; 30 – A6RI/BJJ//VEE; 31 – HYS(CNDR//VEE//5); 32 –Dagdas

In general, the removal of the ideal (rank 1 - 67) on the phenotypic expression of quality deterioration in the quality of synchronization on genetic potential based on the scale Payne from 9-10 to 7. At the same time, at a lower genetic index samples N4S 7 (CNDK / / VEE115) and D.32 (rainfed) empirically characterized as sufficiently high quality, and samples with high genetic indicator (9 score) formed low quality values. Apparently, the grain quality is determined not only by the presence of specific subunits, but their content, the relationship between the HMW/LMW glutenin balance and gliadin/ glutenin proteins, including taking pedigree pressure.

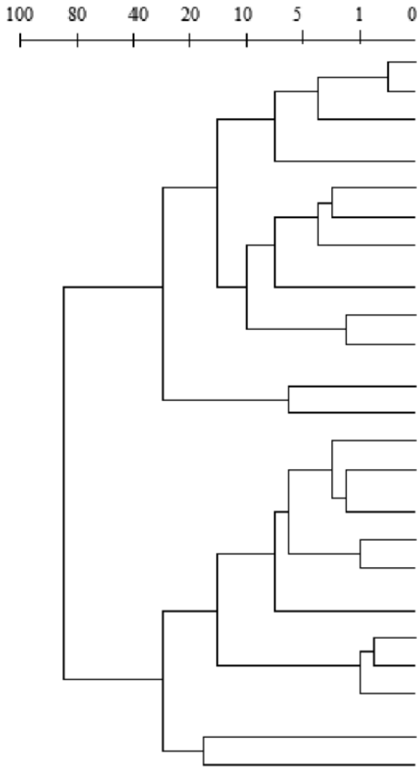
Classification of samples at the same time on the genetic potential and the phenotypic expression of its prominently displayed as part of the cluster analysis (Figure 2) . Thus, the remoteness Erythrospermum 9933 and 32 samples in their clusters as explained at the level of genetic markers : specificity loci B1 and D1, respectively, and at the level of empirically assessed quality (1,97 SD) and 1 36 (SD). Simultaneous monitoring on genetic markers and the actual quality varieties are very important for registered and perspective cultivars. For example, under one title varieties cultivated varieties with differed formulas HMW glutenin have been found to Bermet cultivar – subunit 0 and 2* (A1); 7+9 и 7+9/7+8 (B1); Bezostaya 1 – 7+9 and 7+8 (B1); Kyzyldan – 1 and 2* (A1); 7+9 and 7+8 (B1); Erithrospermum 760 - 1 and 2* (A1); 7+9/7+8 and 7+8 (B1); Erithrospermum 9933 - 7+9 and 6+8 (B1).

Uzbekistan

The Uzbekistan's registered list contains a variety of local Uzbek, Krasnodar (Russia), Kazakhstan breeding. In the 2000 began actively testing and introduction of the winter wheat varieties with different origins and initial priority aim in the country - an increase of grain production. The issue of quality has remained in the shadows, but always present. Optimize it with productivity complicated variety of soil and climatic zones and different levels of testing: research, farmer, variety-testing, etc. The issue of gluten quality remains open for a Krasnodar breeding varieties as Kroshka, Knyazhna, Polovchanka, Umanka, Kupava, thanks to which was solved the grain productivity problem. The Kazakhstan's varieties were tried such as rainfed or semi-intensive agrotype, which were characterized by the best quality, but inferior in yield.

According to the GHI the samples on irrigated is softness and three genotypes belonging to the soft class according to particle size: 219/2-201 (60 PSI); 222/5 5-01 (56), 244/7 7-01 (55) and in rainfed condition (without irrigation) genotype 211/4 0123 (58) was "soft".

Analysis of the HMW glutenin subunits allowed estimating the genetic potential of the studied samples grain quality. First of all, among the samples grown in rainfed two genotypes are characterized by the absence of subunits controlled by chromosome 1D, what is typical for durum wheat (Tr.durum). For these two samples marked by the highest hardness (16 and 21 units) and the dough elasticity = 2,35-3,20 P/L. In all for the whole set is characterized by a sufficiently high baking capacity to the scale Payne 8-9 points, excluding the genotypes 211/4-0123 with "N" allele1A, respectively, and quality grade of 7 points for the genotype 224/7 7-01 - at 1B (6+8) and 1D (2 +12) (figure 3). Much mostly of the genotypes predicted with poor quality on the composition of low molecular weight glutenin subunits and the presence of wheat-rye translocation (table 2). In general, the best prediction of rainfed in quality aggregate (grain hardness, LMW, HMW, 1B/1R) had 2 genotype 214/7-0126 and 215/8-0127 confirming the gluten quality I-th best group, the strength of flour (W=347 and 222 u.a. respectively), good pharinograph parameters and the highest Zeleny sedimentation (9 ml) and acetic acid sedimentation (42-37 ml). For the samples from the irrigated condition the highest predictive quality the are for genotype presumably 226/9-9-01 (LMW + HMW = 13 points, hard, 1B/1B) confirmed by technological properties of flour for bread making: gluten elastic with the power of flour W=255 u.a., the mixing value by pharinograph 42 e.f. with the initial level of sedimentation 38-40 ml.



Genotype	1A	1B	1D	LMW	SD	1B/1R	Hard
219/2 2-01	+	+	+	—	17	—	—
222/5 5-01	+	+	+	—	20	—	—
211/4 0123	—	+	+	—	18	—	—
224/7 7-01	+	—	—	+	23	+	—
218/1 1-01	+	+	+	—	21	—	+
221/4 4-01	+	+	+	—	19	—	+
223/6 6-01	+	+	—	+	22	+	+
227/10 10-01	+	+	+	+	14	+	+
220/3 3-01	+	+	+	—	16	—	+
225/8 8-01	+	+	+	—	15	—	+
208/1 012	+	+	+	+	12	+	+
212/5 0124	+	+	+	—	10	—	+
204/1 Bezostaya 1	+	+	+	+	5	+	+
214/7 0126	+	+	+	—	1	—	—
226/9 9-01	+	+	+	—	8	—	+
209/20121	+	+	+	—	11	—	+
215/8 0127	+	+	+	+	6	+	+
210/3 0122	+	+	+	—	2	—	+
206/3 Zhetisu	+	+	+	+	9	+	+
207/4 Progress	+	+	+	—	13	+	—
205/2 Steklovidnaya24	+	+	+	+	4	+	+
213/6 0125	—	—	—	+	3	+	—
217/10 0129	—	+	—	—	7	+	—

Figure 3. Dendrogramme of the similarities-differences of winter wheat genotypes on grain quality (Andijan)

Tajikistan

In the system of a local introduction breeding Tajikistan conducted researches on grain quality for the selected samples by yield. From all of the first set studied in Tajikistan two varieties referred as semi soft: Geme and Sultan, the sample Shamg/110 131/MLT - as the "mixture" and wheat-rye translocation had samples Sharora, Kauz, Norman and Chamg/110. On the composition of HMW glutenin subunits we can predict the decreasing of grain quality by "N" alleles 1A chromosome for genotypes Geme and Norman, by the presence of subunits "2+12" (chromosome 1D) for genotypes Sharora, Norman, Zander, Chamg/110, Somani and the low rank at low-molecular weight glutenin subunits predicted for genotypes Sharora, Kauz and Chamg/110 (table 3).

Accordingly, the forecast genotypes Norman, Geme, Chang/110, Somani, Sharora, Atilla characterized by low power of flour (W= from 105 a.a.to 163,5 u. alveograph), whereas samples Bezostaya 1 and Steklovidnaya 24 in this experiment in the same conditions were assessed as strong wheat (W = 419 and

438 u. alveograph, respectively). In terms of reduced quality of dilution test in addition to these cultivars of Zander-12 (1B7 and 1D 2 +12), Caus (HMW = 1), Attila (1B7*) with the magnitude of dilution from 190 u.f. (Chamg/110 ...) to 100 u.f. Kauz and Attila (table 4).

Table 3. The genetic potential of grain quality of winter wheat in Tajikistan (Vahsh RIA), 2001

Cultivars	*HMW glutenin subunit:*			LMW glutenin subunit:		Rank HMW	Rank LMW	Rank HMW+LMW	Wheat/ Rye Translocation	Class on grain hardness
	1A	1B	1D							
Navruz	2*	7+9	5+10	в	a/c	9	4	13	1B/1B	hard
Sharora	2*	7+9	2+12	j	a	7	1	8	1B/1R	Semi hard
Karlygash	2*/1	7+9	5+10	b	a	9	4	13	1B/1B	hard
Dzhager	1	17+18	5+10	i	a	10	4	14	1B/1B	hard
Kauz	2*	7+9	5+10	j	a	9	1	10	1B/1R	hard
Sultan	2*	7*	5+10	b	c	8	3	11	1B/1B	Soft
Atilla	2*	7*	5+10	h	a	8	4	12	1B/1B	hard
Tasikar	1	17+18	5+10	h	c	10	3	13	1B/1B	Semi hard
Norman	0/1	17+18/ 7+9	5+10/ 2+12	g	a	8/7	4	12/11	1B/1R	Semi hard
Zand-12	1	7*	2+12	b	c	6	4	10	1B/1B	hard
East Eur2	2	7+8	5+10	f	a	10	4	14	1B/1B	Semi hard
Zhem	0	7*	5+10	g	a	6	4	10	1B/1B	Semi soft
Shamg/110	2*	7+8/7+9	2+12	j	a	7	1	8	1B/1R	Mix
PTZNISKA	2*	7+8/7+9	5+10	b/g	a	9	4	13	1B/1B	Semi hard
PTZNISKA	2*	7+9	5+10	b	a	9	4	13	1B/1B	Semi hard
Somani	2*/1	7+8	2+12	i	c	8	4	12	1B/1B	Semi hard

Table 4. Winter wheat grain quality characterization in Tajikistan (Vakhshs)

Name	DDS, ml	Hardness (PSI)	Natureg/l	Vitreousness,%	Protein, % (USA st)	*Gluten*		*Alveograph*		*Pharinograph*		
						%	GDI	P/L	W	Water absorb.	Tilling	Mixing evaluation
Navruz	9	26	783	83	12,6	29,4	70	2,30	275	61,2	50	54
Sharora	9,5	36	778	76	13,2	31,4	90	1,29	163	59,4	160	51
Karlygash	10	27	747	81	14,6	32,6	70	2,62	301	58,0	0	68
Jager	8	34	780	70	13,1	29,2	65	1,10	379	56,6	20	60
Kauz	7,5	30	789	67	12,7	29,4	85	1,21	209	58,2	100	65
Atilla	8	25	792	69	11,6	29,6	85	0,44	163	53,8	100	61
Sultan	8	55	742	8	12,3	25,4	70	0,61	196	51,4	80	46
Tasikar	8	34	828	82	12,7	29,4	80	1,25	235	60,6	90	52
Norman	6,5	36	783	65	13,4	34,6	100	0,78	105	60,4	180	41
Zander-12	9	25	755	87	14,0	37,0	95	0,68	262	61,0	140	46
2 Vost-Europ 21	10,5	34	782	76	13,5	30,2	70	0,48	190	58,6	60	56
Geme	11	53	712	42	13,5	33,4	95	0,87	111	53,6	110	46

Chamg/110…	8,5	42	807	55	14,3	36,8	85	0,51	111	58,2	190	47
PTZ NISKA	10	36	787	75	13,4	32,2	75	1,56	373	58,2	30	59
PTZ NIZKA	9	29	786	77	13,7	33,8	85	0,90	262	58,2	50	60
Somani	6,5	32	801	81	12,6	27,4	95	1,21	144	58,0	140	41

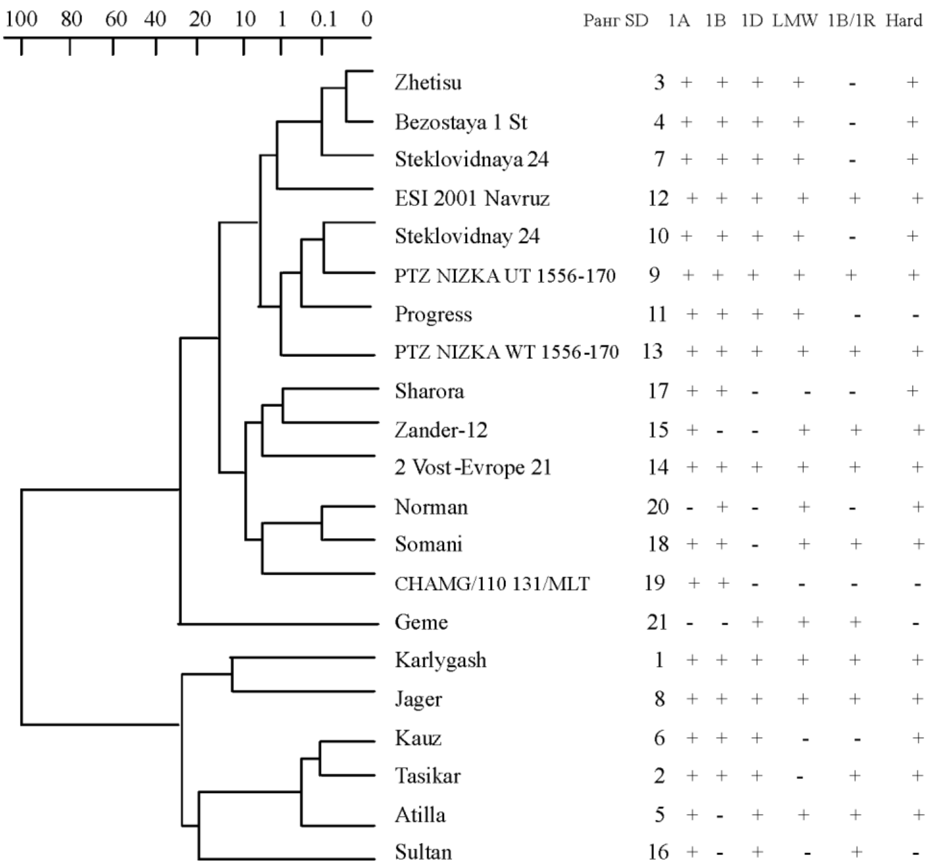


Figure 4. Similarity-difference dendrogramme of winter wheat varieties by grain quality and flour (2001, Vahsh RIA, Tajikistan)

Accordingly, the flour mixing value from the grain of these accessions was reduced to 47-41 u.f. (Chamg/110, Geme, Zander-12, Sultan, Norman, Somani). In general, the similarities and differences between winter wheat varieties on grain and flour quality is shown in figure 4 (Vahsh). Genotypes clustering on the content of HMW + LMW-glutenin does not coincide with the classification of the grain and flour quality, which means about insufficient explanation of quality level only on glutenin subunits content (chromosome 1 and 6). Grain hardness (5A and 5D), wheat-rye translocation (1B/1R) and protein levels of course also genetically determine the grain quality.

Turkmenistan

Turkmenistan is known in the ancient traditions with cultivation and domestication of common wheat cultivars in the 19-20 centuries: Ak-Bugdai, Kyzyl-Bugdai, Kelek, Kyzyl-ja, Karagach, Ak and Kyzyl- Jaidari. Breeding work of modern Turkmenistan associated with both traditional gene pool and wide involvement, testing and selection of material CIMMYT-ICARDA-Turkey (Babadzanov, 2003).

A systematic breeding in the Institute of Agriculture since 1991 has led to 1) the restoration of varieties Ak-Bugdai, 2) selection of international nurseries for yield and the development of advanced varieties: Guncha, Garagum, Bitarap (Hajiev, 2003).

In the framework of international cooperation with CIMMYT breeding work on quality of grain held in conjunction with the Turkmen breeders at CIMMYT and the Laboratory of Biochemistry and Laboratory of grain quality Kazakh Research Institute of Agriculture and crop production.

Samples of competitive nurseries variety trials were characterized by high background screening criteria: nature mass 779-819 g/l and the gluten content 27,2-35,6%. Problematic are indicators of the gluten quality in generally 110-120 units of GDI (II-III group), the flour strength 98-137 u.alveograph (filler class), very high dilution of the dough(160-250) opposite 0-30 on requirements for strong wheat.

Table 5. Characteristic of winter wheat on the grain quality (Turkmenistan)

Name						Gluten		Alveograph		Pharinograph		Bread	
	SDS, ml	Hardness, PSI	Nature, g/l	Vitreousness	Protein, %	%	GDM	P/L	W	thinning	Val value	V, ml	Bal
228/1Turkmenbasy	8,5	31	814	76	14,0	30,4	115	0,79	131	210	46	740	3,36
229/2 Garalsyz 10	8,5	25	804	85	13,7	65,2	115	0,69	111	230	42	550	2,14
230/3 Garagum	9,0	59	779	20	12,8	30,4	110	0,6	137	150	40	750	3,24
231/4 Bitarap	7,5	32	819	74	13,7	31,6	115	0,53	137	210	56	700	3,14
232/5 Gunca	7,5	54	807	31	11,8	27,2	90	0,73	203	160	43	850	3,70
233/6 Libap	8,5	29	809	87	14,1	35,6	120	0,75	98	250	36	500	1,86
234/1 Manati	4,5	53	792	43	11,7	26,0	110	1,05	16	290	20	–	–
235/2 GNU/ASAD	4,0	57	799	40	10,2	18,8	110	1,88	16	280	19	–	–
236/3 Samur St	5,0	56	732	52	11,0	18,0	70	0,65	85	190	29	430	1,74

Overall, the varieties similarities and differences of a grain quality indicators range is shown in the dendrogramme (Figure 5), with indicating proximity to the ideal of 1 to 9 according to the rank integral evaluation (SD). The cultivars Turkmenbashi, Garalsyz, Bitarap and Libap characterized as genotypes of hard class had high vitreousness (> 74%) and high protein (13,7-14,1%). However, gluten is mostly poor quality - the third group.

In general, the situation of grain quality similar in the region. The own sample Guncha cultivars was allocated with relatively satisfactory flour strength (203 u.a.) and bakery value 3,70 points, the volume of bread 850 ml. According to the valorimetr assessment and nature cultivar Bitarap (figure 5).

According to the formula, HMW-glutenin samples must be high quality (8-10 points by Payne). Bitarap and Turkmenistan predictive quality is reduced by:

1) LMW glutenin subunits (up to 1 point, Pena);

2) with the presence of wheat-rye translocation (table 5).

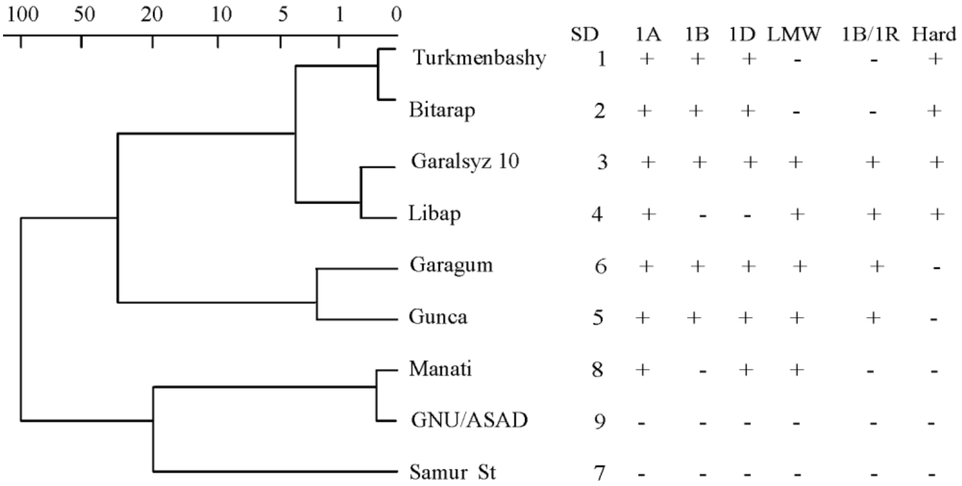


Figure 5. Dendrogramme of similarity-difference varieties of winter wheat on the technological quality of grain and flour (Turkmenistan)

Discussion and Conclusion

On the HMW-glutenin content the high quality genotypes part is very high: from 55% (Turkmenistan and Kyrgyzstan) to 79% (Kazakhstan) – genotypes with the value of 10 and 9 points (figure 6). On the content of LMW glutelin we attend high quality of winter wheat from 31% in Uzbekistan to 87% in Kyrgyzstan (figure 7) genotypes with 5+4 points (Pena).

The presence of wheat-rye translocation it is found from 0% (Kazakhstan) to 59% (Uzbekistan) genotypes, usually in material, introducing from CIMMYT as high productive germplasm.

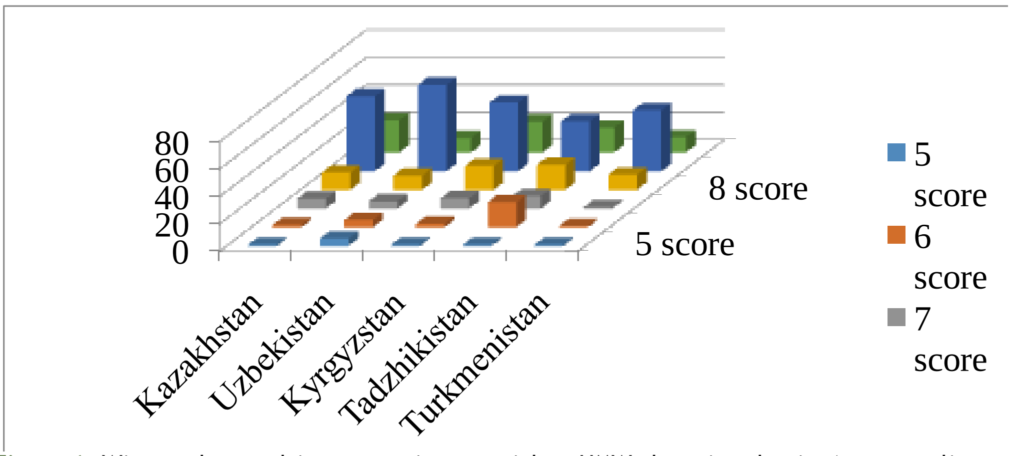


Figure 6. Winter wheat cultivars genetic potential on HMW glutenin subunits (rang, quality, score)

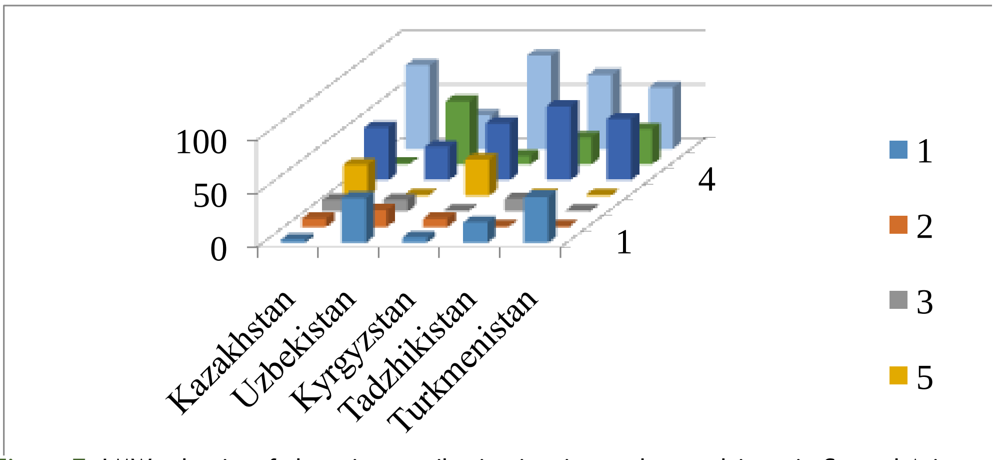


Figure 7. LMW subunits of glutenin contribution in winter wheat cultivars in Central Asia

The selecting level of high quality genotypes on the technological parameters is lower from 12 to 47% (Kazakhstan) in depends on breeding process nursery, from 10% to 30% in Uzbekistan, 10-37% (Kyrgyzstan) and from 10% to 40% (Tadzhikistan) (table 6). Combination of HMW+LMW glutenin content the presence of wheat-rye translocation, determining of hardness class and homogenous in joint allows prediction the technological quality in optimization with yield.

Table 6. Efficiency of quality breeding on markers and technological properties (%, good quality)

Quality Index		*KZ*	*UZ*	*KRZ*	*TZ*	*TU*
HMWS-glutenin	9-10 scale	79	74	73	55	55
LMW	5-4 scale	78	31	87	69	57
1B/1R- translocation	-	100	41	92	75	67
Hard/semihard		70	79	80	55	
Class (technological)	1 - strong	23-27	10	10	12-18	
Class, rainfed	2 - ценная	47	30	20-37	40	

This study concludes, that winter common wheat of Central Asia mostly belongs to the class of "hard" and "middle hard" (figure 1). In Kazakhstan created new confectionary cultivars of technological types along with baking types. For the Central Asia winter wheat it is noted that cultivars are not homogeneous on hardenss index – the special breeding programs are necessary for the end using type identification.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Abecassis, J., Chaurand, M. & Autran, J. C. (1997). Structural basis of wheat hardness and technological consequences. *International Agrophysics*, *11(4),* 273–281.

Abugalieva, A. I., Dracheva, L. M., Fursov, O. V & Yessimbekova, M. A. (1998). Common wheat hardness in Kazakhstan: NIRs, varieties and grain quality breeding strategy. In *16th International Association for Cereal Science and Technology conference: Cereal Science–Its Contribution to Health and Well Being*, 9–12.

Abugalieva, A. & Peña-Bautista, R. J. (2010). *Grain quality of spring and winter wheat of Kazakhstan.* Direct access: Abugalieva, A. & Peña-Bautista, R. J. (2010). Grain quality of spring and winter wheat of Kazakhstan.

Bettge, A., Rubenthaler, G. L. & Pomeranz, Y. (1989). Alveograph algorithms to predict functional properties of wheat in bread and cookie baking. *Cereal Chem*, *66(2),* 81–86.

Figueroa, J. D., Peña, R. J., Maucher, T., Rayas-Duarte, P. & Khan, K. (2011). Kernel elastic properties and sedimentation: Influence of high and low molecular weight glutenin allelic composition. *Cereal Chemistry*, *88(1),* 41–44.

Hochman, G., Rajagopal, D., Timilsina, G. & Zilberman, D. (2014). Quantifying the causes of the global food commodity price crisis. *Biomass and Bioenergy*, *68*, 106–114.

Kent, N. L. & Evers, A. D. (1994). *Technology of Cereals.* London: Woodhead Publiching, 325 p.

Khazratkulova, S., Sharma, R. C., Amanov, A., Ziyadullaev, Z., Amanov, O., Alikulov, S., … Muzafarova, D. (2015). Genotype × environment interaction and stability of grain yield and selected quality traits in winter wheat in Central Asia. *Turkish Journal of Agriculture and Forestry*, *39(6),* 920–929.

Koga, S., Böcker, U., Uhlen, A. K., Hoel, B. & Moldestad, A. (2016). Investigating environmental factors that cause extreme gluten quality deficiency in winter wheat. *Acta Agriculturae Scandinavica Section B: Soil and Plant Science*, *66(3),* 237–246.

Li, X. & Liu, Y. (2010). The conversion of spring wheat into winter wheat and vice versa: False claim or Lamarckian inheritance? *Journal of Biosciences*, *35*(2), 321–325.

Luo, C., Griffin, W. B., Branlard, G. & McNeil, D. L. (2001). Comparison of low- and high molecular-weight wheat glutenin allele effects on flour quality. *Theoretical and Applied Genetics*, *102*(6-7), 1088–1098.

Mauget, S. & de Pauw, E. (2010). The ICARDA Agro-climate tool. *Meteorological Applications*, *17(1),* 105–116.

Migliori, M. & Correra, S. (2013). Modelling of dough formation process and structure evolution during farinograph test. *International Journal of Food Science and Technology*, *48(1),* 121–127.

Morgounov, A. I., Braun, H. J., Ketata, H. & Paroda, R. (2005). International cooperation for winter wheat improvement in Central Asia. *Turkish Journal of Agriculture and Forestry*, *29*(2), 137–142.

Nakamura, K., Taniguchi, Y., Taira, M. & Ito, H. (2012). Investigation of soft wheat flour quality factors associated with sponge cake sensory tenderness. *Cereal Chemistry*, *89*(2), 79–83.

Pasha, I., Anjum, F. M. & Morris, C. F. (2010). Grain Hardness: A Major Determinant of Wheat Quality. *Food Science and Technology International*, *16*(6), 511–522.

Payne, P. I., Holt, L. M. & Law, C. N. (1981). Structural and genetical studies on the high-molecular-weight subunits of wheat glutenin - Part 1: Allelic variation in subunits amongst varieties of wheat. *Theoretical and Applied Genetics*, *60*(4), 229–236.

Payne, P. I., Law, C. N. & Mudd, E. E. (1980). Control by homoeologous group 1 chromosomes of the high-molecular-weight subunits of glutenin, a major protein of wheat endosperm. *Theoretical and Applied Genetics*, *58(4),* 113–120.

Petersen, S. O., Schjonning, P., Olesen, J. E., Christensen, S. & Christensen, B. T. (2013). Sources of nitrogen for winter wheat in organic cropping systems. *Soil Science Society of America Journal*, *77(1),* 155–165.

Sharma, R. C., Crossa, J., Velu, G., Huerta-Espino, J., Vargas, M., Payne, T. S. & Singh, R. P. (2012). Genetic gains for grain yield in CIMMYT spring bread wheat across international environments. *Crop Science*, *52(4),* 1522–1533.

Sharma, R. C., Morgounov, A. I., Braun, H. J., Akin, B., Keser, M., Bedoshvili, D., van Ginkel, M. (2009). Identifying high yielding stable winter wheat genotypes for irrigated environments in Central and West Asia. *Euphytica*, *171(1),* 53–64.

Sharma, R. C., Rajaram, S., Alikulov, S., Ziyaev, Z., Hazratkulova, S., Khodarahami, Morgounov, A. I. (2013). Improved winter wheat genotypes for Central and West Asia. *Euphytica*, *190(1),* 19–31.

Shewry, P. R., Halford, N. G. & Tatham, A. S. (1992). High molecular weight subunits of wheat glutenin. *Journal of Cereal Science*, *15*(2), 105–120.

Uvere, P. O., Ngoddy, P. O. & Nwankwo, C. S. (2014). Hardness as a modification index for malting red and white sorghum (kaffir) grains. *Journal of the Science of Food and Agriculture*, *94(5),* 890–897.

Wan, Y. N. (2002). Kernel handling performance of an automatic grain quality inspection system. *Transactions of the American Society of Agricultural Engineers*, *45*(2), 369–377.