

WINTER WHEAT GENETIC RESOURCES FOR END-USE QUALITY: MODERN GERMPLASM, LANDRACES AND PRIMARY SYNTHETICS

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International Winter Wheat Improvement Program

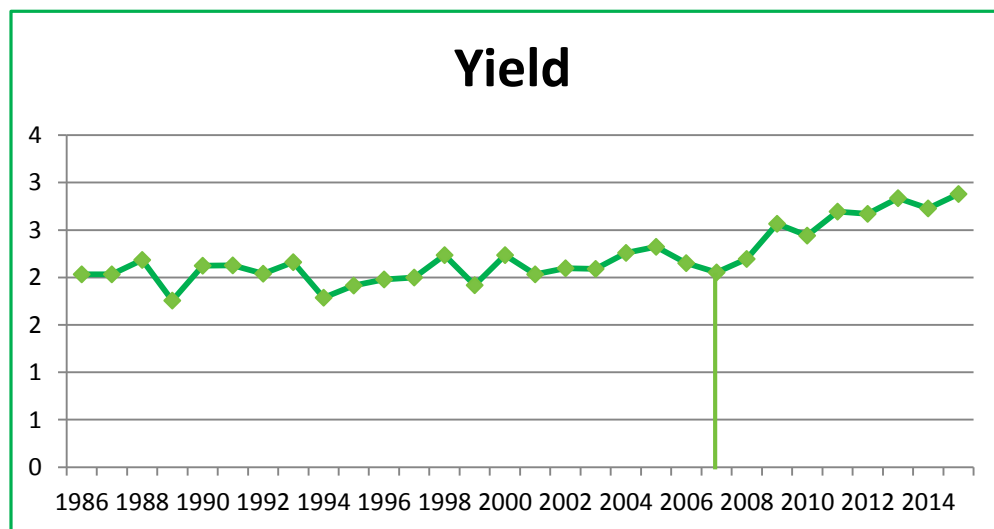
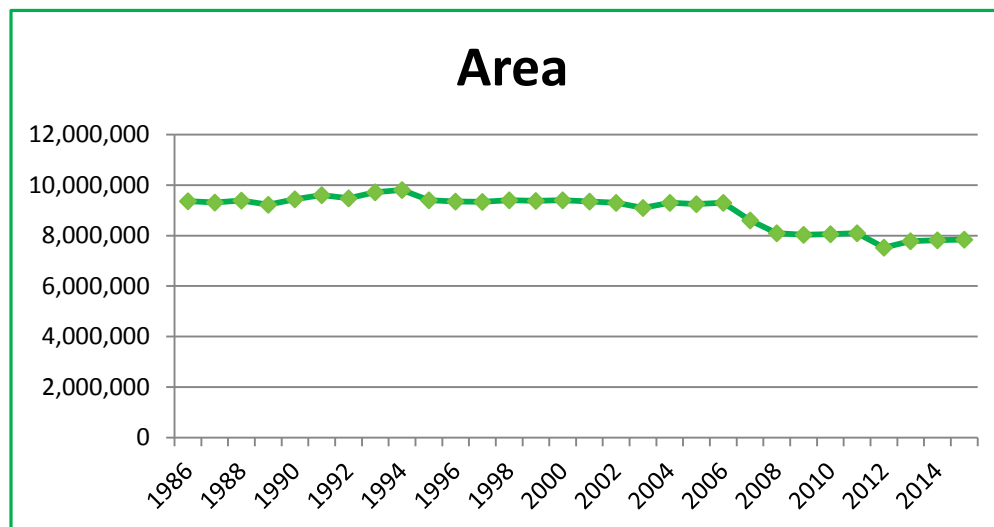
Objectives:

- Development of winter wheat germplasm for Central and West Asia
- Facilitation of global winter wheat germplasm exchange
- Maintenance of wheat genetic diversity including on-farm
- Research on priority topics

www.iwwip.org

Turkey wheat production: 1985-2015

Year	Area, ha	Yield (kg/Ha)	Production
1986	9.355.932	2.034	19.032.000
1987	9.310.681	2.033	18.932.000
1988	9.387.855	2.186	20.523.008
1989	9.227.000	1.758	16.221.000
1990	9.432.309	2.123	20.022.000
1991	9.597.539	2.127	20.418.496
1992	9.473.387	2.039	19.318.000
1993	9.716.377	2.163	21.016.000
1994	9.800.000	1.787	17.514.000
1995	9.400.000	1.916	18.015.000
1996	9.350.000	1.980	18.515.000
1997	9.340.000	1.998	18.663.400
1998	9.400.000	2.235	21.011.000
1999	9.380.000	1.920	18.008.800
2000	9.400.000	2.235	21.008.600
2001	9.350.000	2.033	19.007.000
2002	9.300.000	2.098	19.508.000
2003	9.100.000	2.089	19.008.200
2004	9.300.000	2.258	21.000.000
2005	9.250.000	2.324	21.500.000
2006	9.300.000	2.152	20.010.000
2007	8.600.000	2.055	17.673.000
2008	8.097.700	2.195	17.782.000
2009	8.026.000	2.566	20.600.000
2010	8.053.670	2.441	19.660.000
2011	8.096.000	2.693	21.800.000
2012	7.529.600	2.670	20.100.000
2013	7.772.600	2.837	22.050.000
2014	7.820.750	2.729	19.000.000
2015	7.846.481	2.880	22.600.000



Turkey wheat trade



Source: FAOSTAT

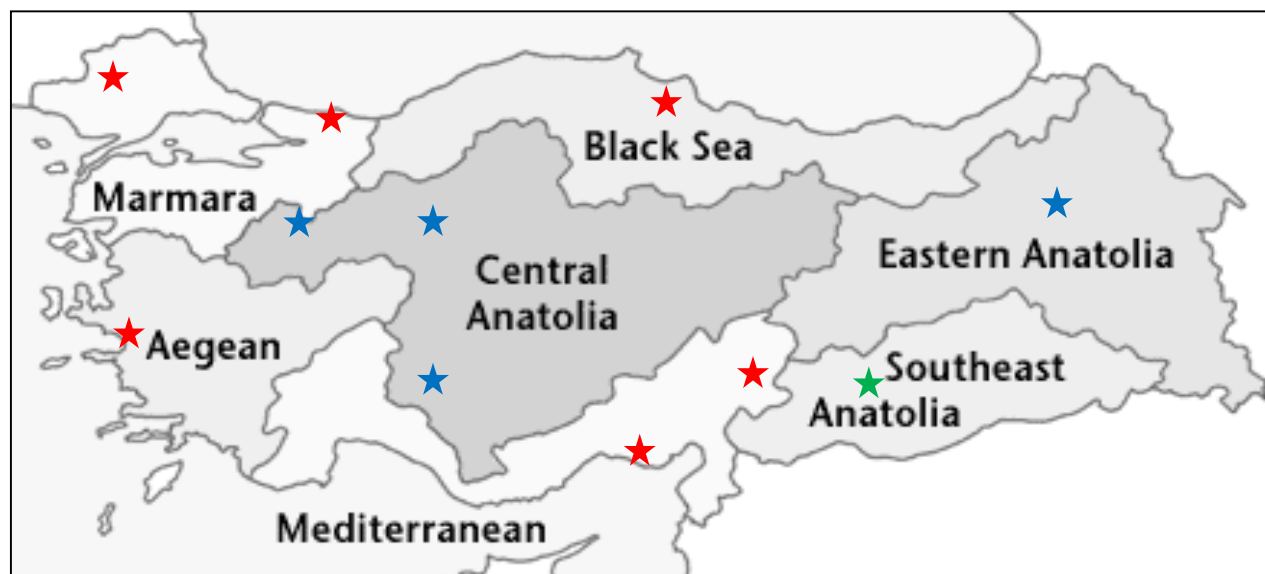
Turkey wheat production regions

Marmara – 60% winter wheat and 40% fall planted spring wheat, lowland <400 masl, high rainfall environment, 6% irrigated, 827.639 ha.

Aegean - fall planted spring wheat, high rainfall or irrigated, < 600 masl, 28% irrigated 669.520 ha.

Central Anatolia – winter wheat at 800-1200 masl, low rainfall, 19% irrigated, 2.749.582 ha.

Black Sea – fall planted spring wheat, mountain valleys < 1000 masl, high rainfall, 21% irrigated, 797.411 ha.

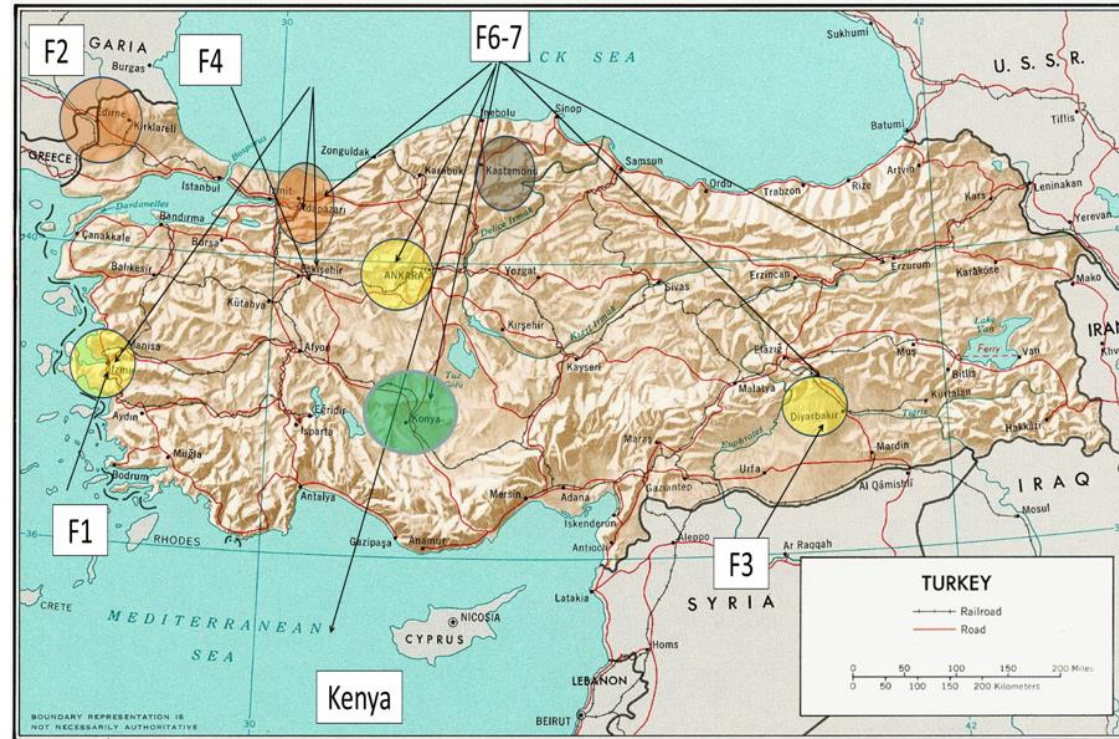


Eastern Anatolia – winter wheat > 1200 masl, low rainfall, cold winter, 34% irrigated, 714.271 ha.

Mediterranean – fall planted spring wheat, high rainfall or irrigated, < 600 masl, 38% irrigated 796.067 ha.

Southeast Anatolia – facultative and spring wheat primarily durum, < 800 masl; low rainfall, 36% irrigated, 1.266.261 ha.

IWWIP Breeding Program



- FAWWON: Facultative and Winter Wheat Observation Nursery – 80 sets distributed globally to 40+ countries
- IWWYT: International Winter Wheat Yield Trial – 30 sets distributed regionally

IWWIP Breeding Priority and Impact

- Broad adaptation
- Grain yield
- Drought and heat tolerance
- Rusts resistance
 - Stripe Rust
 - Leaf Rust
 - Stem rust
- Grain quality

Country	Varieties released
Afghanistan	5
Armenia	4
Azerbaijan	4
Georgia	6
Iran	7
Kazakhstan	2
Kyrgyzstan	9
Tajikistan	6
Turkey	32
Turkmenistan	3
Uzbekistan	2
Total	80

Grain quality variation in Turkey

Historical set of 15 WW irrigated varieties x 3 sites x 2 years

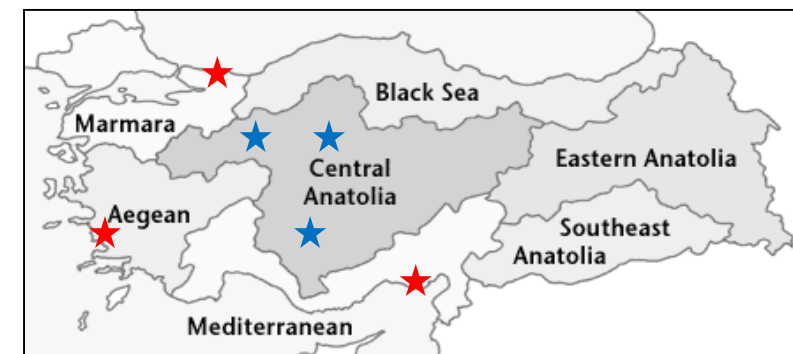
Trait	Ankara		Eskisehir		Konya	
	2009	2010	2009	2010	2009	2010
Yield. t/ha	2.29	4.11	4.02	6.69	4.16	5.18
TW	75.3	74.2	80.5	77.0	74.0	77.5
TKW, gr	33.1	36.5	41.5	36.7	30.4	43.0
PC, %	12.8	11.6	9.7	10.9	10.4	11.1
Mini-SDS	2.29	4.11	4.02	6.69	4.16	5.18

Historical set of 22 WW dryland varieties x 3 sites x 2 years

Trait	Ankara		Eskisehir		Konya	
	2009	2010	2009	2010	2009	2010
Yield. t/ha	1.11	2.67	3.09	4.56	4.06	4.64
TW	74.2	77.9	77.0	77	78.9	76.7
TKW, gr	32.1	35.7	33.0	35.4	35.0	34.4
PC, %	12.9	12.3	14.2	8.4	14.3	10.2
Mini-SDS	13.2	14.3	12.2	11.3	13.6	14.3

Historical set of 35 SW varieties x 3 sites x 3 years

Trait	Adana			Adapazari			Izmir		
	2009	2011	2012	2009	2011	2012	2009	2011	2012
Yield. t/ha	5.93	6.91	6.30	3.99	5.10	6.44	5.22	5.73	6.59
TW	78.5	78.0	78.4	10.5	76.9	77.2	75.9	79.2	80.7
TKW, gr	41.0	36.6	35.2	-	33.2	36.9	37.1	33.0	38.7
PC, %	12.8	11.2	13.1	13.1	14.1	15.1	14.2	12.0	14.6
Zeleny sed	5.93	6.91	6.30	3.99	5.10	6.44	5.22	5.73	6.59



Grain quality breeding

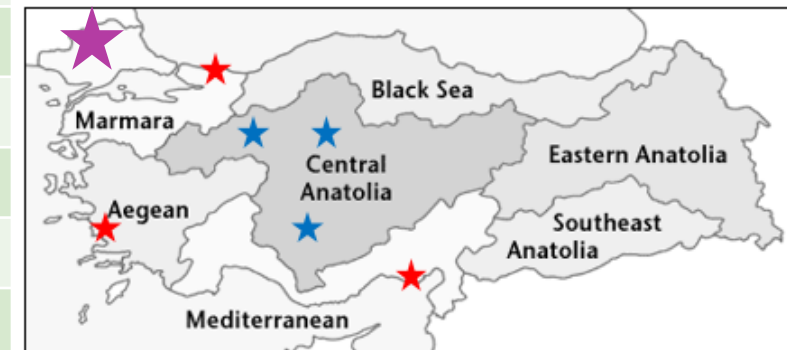
- High priority trait for IWWIP
- In Turkey farmers want varieties which produce higher value grain.
- Variety of wheat products.
- Gluten strength is a prime objective.
- Old variety Bezostya-1 is un-contested quality check.
- High consideration for crossing program and selection.
- Carlos visit in 2016 was very important in establishing connection between groups in Turkey and Mexico.
- Evaluation system:
 - Crossing Block – glutenins (Mexico)
 - Preliminary Yield Trial (F5) – 300 gr (Eskisehir)
 - FAWWON Candidates – 1 kg (Konya)
 - IWWYT candidates – 1 kg (Ankara)

Pedigrees of superior and poor quality lines from 16AYT-Irrigated

Nursery	Entry	Pedigree	SDS	Stability time
16AYT-IRR	9011	MT0419/DESTIN//BONITO-36	46	17.3
16AYT-IRR	9030	T88/2180//T811//KRISTADORA/3/SHARK/F4105W2.1	68	17.5
16AYT-IRR	9050	B1551-WH/KS94U326/3/F10S-1//STOZHER/KARL/4/F10S-1//STOZHER/KARL	62	17.7
16AYT-IRR	9080	HATCHER/KS03HW12-1//NUDAKOTA	52	17.9
16AYT-IRR	9085	TAM200/3/F60314.76/MRL//CNO79/4/84.40022/5/VORONA//MILAN/SHA7/3/MV17	71	17
16AYT-IRR	9109	ST.ERYHTR894-07/3/KIRITATI//HUW234+LR34/PRINIA	45	17.8
16AYT-IRR	9112	NEMURA/CRDN//78014.40/4/PASTOR/3/BJY/COC//PRL/BOW/5/GONDVANA	63	15.9
16AYT-IRR	9114	TAM200/KAUZ/7/91-142A61/3/F35.70/MO73//1D13.1/MLT/6/PI/MZ//CNO67/3/LFN/4/ANT/5/ATTILA	51	15.8
16AYT-IRR	9144	TX90V7912/ABILENE//SAULESKU#44/TR810200/3/BONITO-36	85	17.9
16AYT-IRR	9006	ID800994W/VEE//F900K/3/PONY/OPATA/4/C-75-5/5/DORADE-5	19	17.5
16AYT-IRR	9021	AU/3/MINN//HK/38MA/4/YMH/ERA/5/PMF//CNO/GLL/6/KAUZ//ALTAR84/AOS/7/N566/OK94P597	35	4.9
16AYT-IRR	9031	VORONA//PRL/VEE#6/3/KAUZ/3/*2/YACO//KAUZ//PANTHEON/BLUEGIL-2	38	6.3
16AYT-IRR	9052	DORADE-5/3/SHI#4414/CROWS"//GKSAGVARI/CA8055	35	3.9
16AYT-IRR	9061	ORKINOS-7/4/CRR/TIA.2//FDL490/3/IRNERIA/MUKKABHIB.	34	6.8
16AYT-IRR	9094	ID800994W/VEE//F900K/3/PONY/OPATA/4/BUCUR/5/SHI#4414/CROWS"//GKSAGVARI/CA8055	43	0.4
16AYT-IRR	9110	FRTL/NEMURA//VORB/3/DORADE-5	31	0.1

Grain yield and quality of germplasm originating from different countries tested in Edirne, Turkey, 2016

Country	Number of lines	Yield, t/ha	Test Weight	1000K W, gr	Protein, %	Zeleni Sed., ml	Mixograph, %Tq*min
Hungary	6	6726	78.2	34.3	13.0	32.8	131.1
Iran-Dryland	43	4704	78.0	31.8	13.3	33.5	130.8
Iran-Irrigated	23	5029	78.0	29.1	13.9	31.4	111.9
Mexico (S x W)	70	6137	70.3	37.2	12.6	32.8	91.8
Romania	5	7240	78.1	41.1	13.5	49.4	163.3
Russia	5	6406	77.4	36.9	13.4	42.0	143.4
Tajikistan	15	6360	77.9	42.1	13.0	40.8	136.0
IWWIP-Morocco	16	4802	78.4	34.4	13.2	30.3	110.9
US-Colorado	12	6050	77.7	38.3	13.1	32.7	93.1
US-Kansas	48	7471	78.8	37.0	13.1	38.8	144.0



Wheat landraces collection in Turkey

Year	Number of provinces	Number of collections*
2009	3	134
2010	9	192
2011	6	43
2012	33	772
2013	9	159
2014	4	75
Total	62	1375

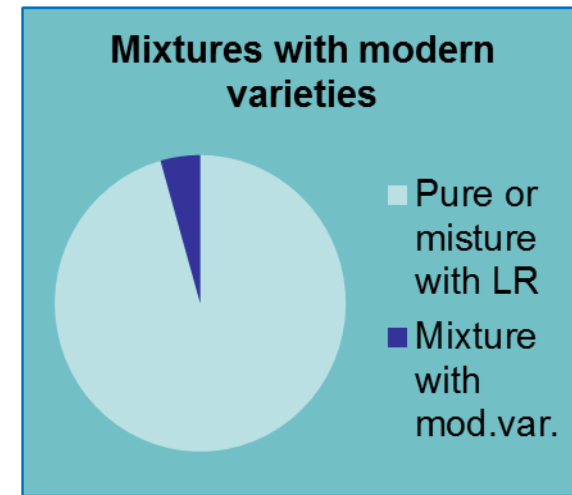
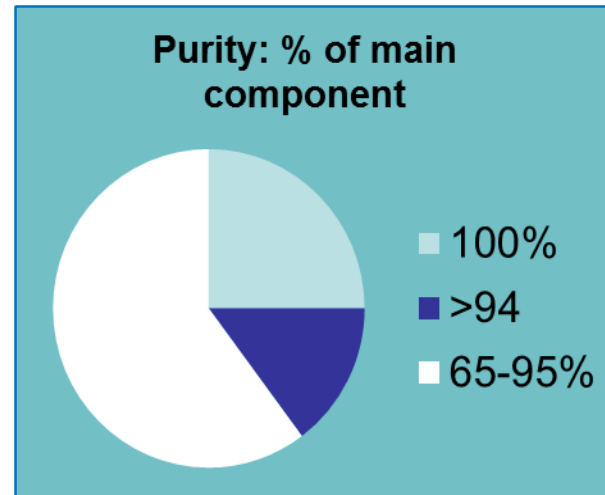
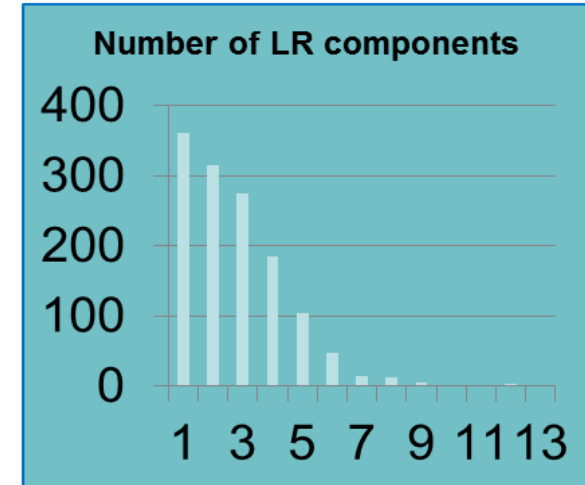
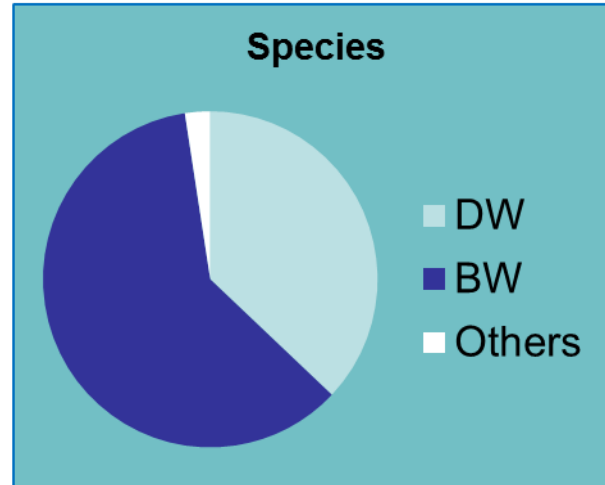
* Collection of at least 100 spikes representing the landrace.

- Communication to provinces and counties agriculture agencies to find out the possibility of landraces being grown
- Confirmation through the phone calls
- Identification of the villages with the landraces
- Communication to the village seniors and setting up appointments
- Visit-survey-collection



Diversity of wheat landraces currently cultivated in Turkey

- Based on botanical description and composition of individual landraces
- Species:
 - Durum Wheat (DW)
 - Bread Wheat (BW)
 - Bread Wheat – Club Wheat (BC)
 - Club Wheat (CW)
- Pure vs. mixture of individual landrace
 - 100% the same BV
 - $\geq 95\%$
 - $\geq 65\%$ of the major LR component
 - Number of components within individual LR
- Mixtures with modern varieties



Wheat landraces of Turkey: regions

- Wheat landraces in Turkey are grown all over the country primarily by small family farms in mountainous remote villages using traditional technologies
- Majority of the farmers had access to MV and 30% grow both but maintain the landraces because of tradition, adaptation and suitability for home consumption
- Highest diversity of the landraces in the Black Sea region, Central and East Anatolia
- Durum wheat dominates in the South and S. East

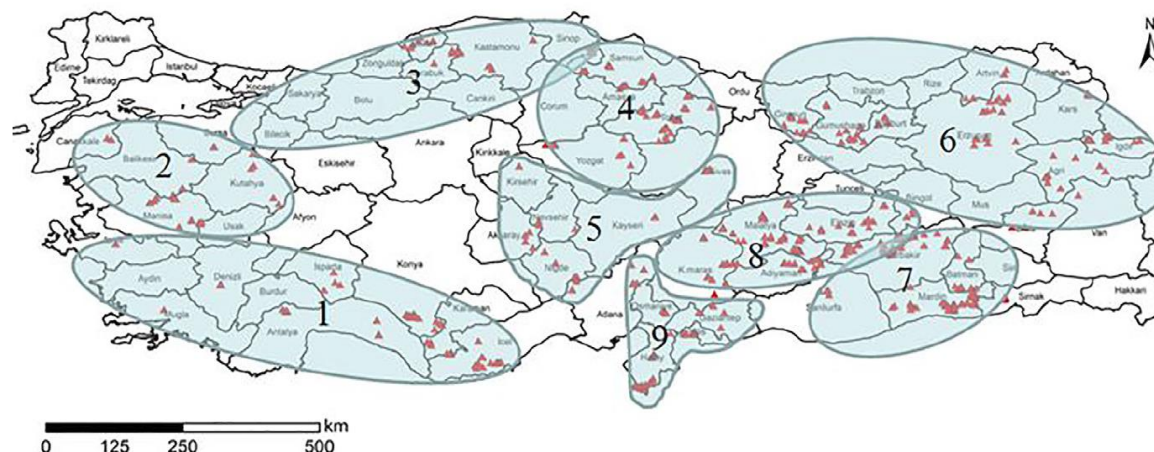


Fig. 1. Main regions of wheat landrace cultivation in Turkey based on surveys and collections in 2009 to 2014. 1, southern coastal; 2, Aegean; 3, western Black Sea; 4, central Black Sea; 5, central Anatolia; 6, northeastern Anatolia; 7, southeastern Anatolia; 8, central-eastern Anatolia; 9, eastern Mediterranean. ▲ = approximate collection sites.

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Wheat landraces of East Anatolia

Province	DW	BW	BW-BC	BW-C	T.m/T.d/T.t	Mixture	Total
Agri		4		1		4	8
Bingol		1	1				2
Bitlis		3	1			1	5
Elazig	1	1	1		1		4
Erzurum		5	1	1			7
Igdir	1	5	2				8
Malatya	2	3	1		1	1	8
Van						1	1
Total	4	21	7	2	2	7	43
Total, %	9.3	48.8	16.3	4.6	4.6	16.3	100

Average altitude: 1292 masl

Average number of landrace components: 2.4



Farmers description	
Average farm size, ha	8.0
Average farmer age	52.7
Number of people per household	6.9
% of farmers graduating primary school only or none	90.5
% of wheat planted by hand	60.0
% of farmers growing both MV and landraces	8.8
% of farmers who never change the seed	42.8
% of farmers using wheat for bread	70.3
% of farmers satisfied with grain yield	81.0
% of farmers satisfied with grain quality	99.0

Wheat landraces changes from 1930

Species	Number of botanical varieties	
	2010s	1930s
<i>Tr. monococcum</i>	2	4
<i>Tr. dicoccum</i>	2	2
<i>Tr. turgidum sp. turgidum</i>	6	49
<i>Tr. turgidum sp. durum</i>	23	82
<i>Tr. polonicum</i>	1	12
<i>Tr. pericicum</i>	0	2
<i>Tr. aestivum sp. aestivum</i>	45	159
<i>Tr. aestivum sp. compactum</i>	16	80
Total	95	388

Landrace	2012			1930		
	DW	BW	CW	DW	BW	CW
Ak Bugday	22.7	54.9	20.7	42.0	43.5	14.5
Asurelik Bugday	0.7	93.2	0.4	3.0	94.9	2.1
Goderedi	3.4	82.6	0.5	-	-	-
Kamci	0.9	81.8	6.6	-	-	-
Karakilcik	62.9	29.1	6.9	66.0	28.1	5.9
Kirik	0	98.5	1.1	3.6	87.7	8.7
Kirmizi Bugday	16.8	65.7	16.7	45.6	47.7	6.8
Koca Bugday	50.7	37.5	9.3	92.9	5.1	2.0
Sari Bugday	61.0	15.5	20.7	81.9	11.4	6.7
Topbas	5.3	37.9	55.5	0.6	33.1	66.3
Zerun	0.9	97.9	0.1	0.2	96.4	3.4
Total	22.0	58.9	14.6	37.3	49.8	12.9

Drivers of genetic diversity

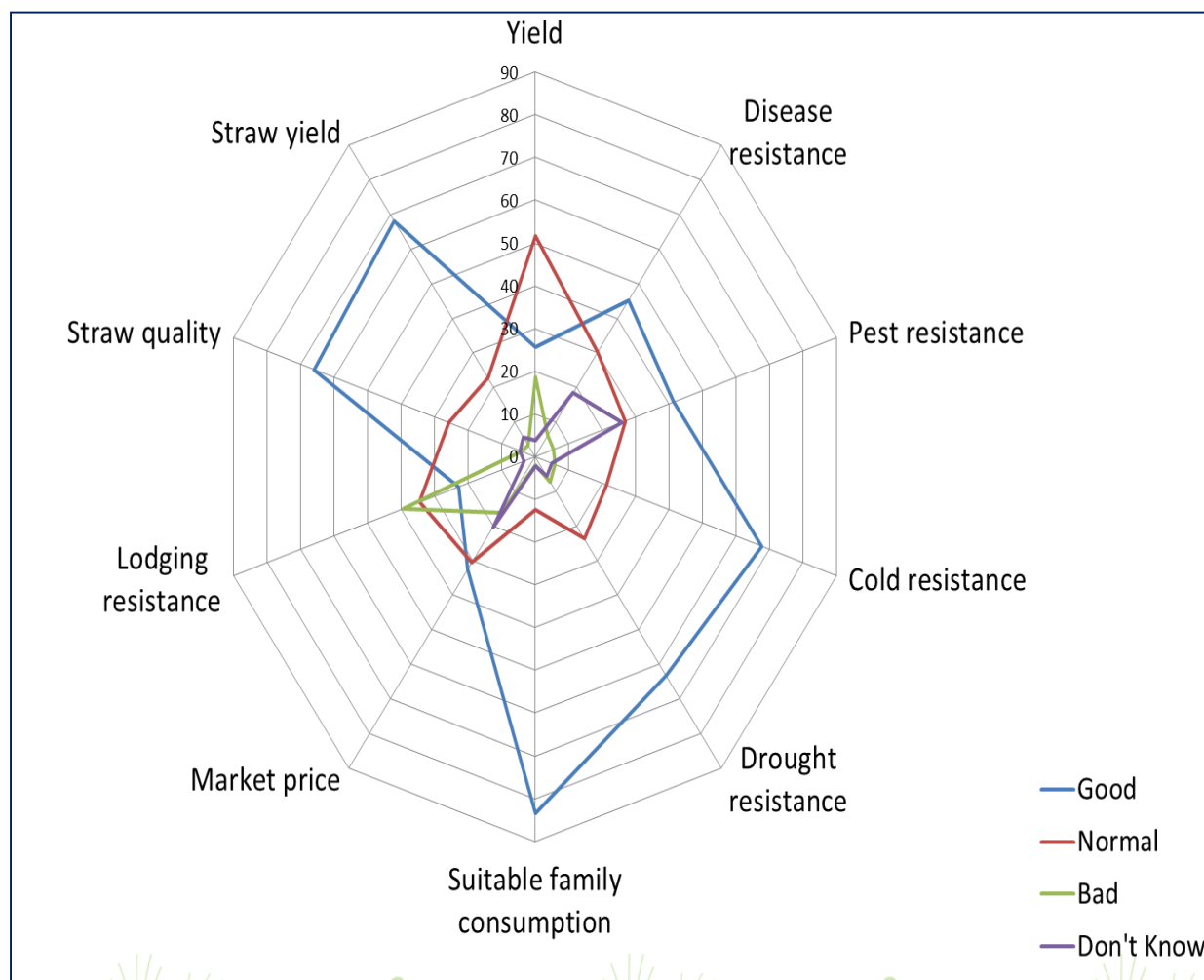
- Diversity of individual landraces represented by different components

- Individual farm wheat diversity represented by combination of different landraces or varieties grown on the same farm



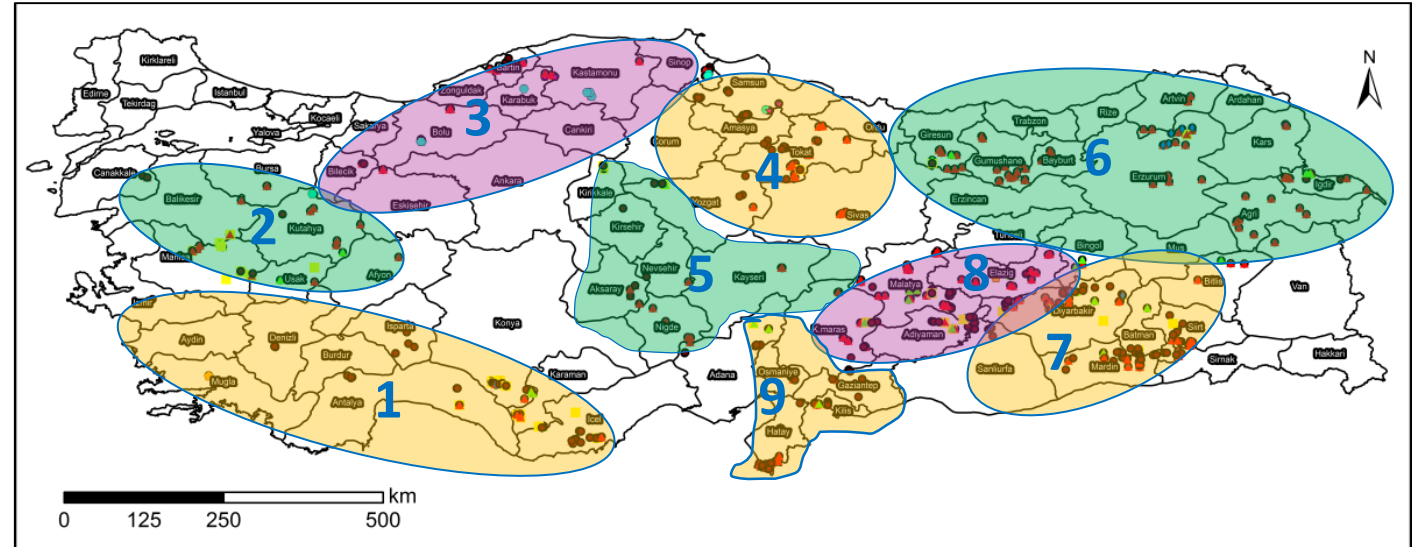
Characteristics	Degree of landrace diversity evaluated at survey for durum wheat farmers			Degree of landrace diversity evaluated at survey for bread wheat farmers		
	1	2	3	1	2	3
Number of farmers	121	162	118	147	200	163
Wheat area, ha	2.25	2.60	2.54	1.87	2.18	2.73
Altitude, masl	1034	833	891	1412	1159	961
Farmer's age, years	54.0	52.9	55.4	54.6	52.3	54.5
% of farmers without education	22.3	32.7	33.8	16.3	23.0	30.0
% of farmers growing only landraces	74.3	57.0	72.0	83.6	72.0	78.5
% of farmers who tried modern varieties	28.9	43.2	28.8	23.8	32.0	24.5
% of farmers who tried modern varieties and continued growing them	24.8	29.0	24.6	17.0	23.0	20.9
% of homogeneous landraces	45.4	33.9	27.1	36.0	23.0	7.4
Number of components per landrace	2.02	2.55	2.98	2.30	2.65	3.96
% of landraces mixed with modern varieties	2.4	4.9	7.6	2.7	6.0	14.7
% of farmers planting by hand	19.8	8.6	22.9	21.8	15.0	16.5
% of farmers harvesting by hand	51.2	34.5	18.6	48.3	40.5	35.0
% of farmers never changing the seed	52.1	18.5	33.0	44.2	33.5	45.4
% of farmer satisfied with grain yield	32.2	22.8	22.0	10.2	26.0	27.0
% of farmer satisfied with disease resistance	55.4	58.6	61.0	37.4	48.5	47.8
% of farmer satisfied with pest resistance	58.7	58.0	64.4	37.4	43.5	49.1
% of farmer satisfied with cold tolerance	73.5	74.1	89.0	60.5	69.5	81.5
% of farmer satisfied with drought tolerance	76.0	71.6	85.6	53.1	65.0	76.7
% of farmer satisfied with grain quality	96.6	79.0	88.1	93.9	76.5	77.9

Perception of wheat landraces by farmers



Utilization of wheat landraces in Turkey

1. Southern Coastal: 60% DW (Koca Bugday and Sari Bugday), BW –Goderedi.
2. Aegean: 77% BW (Ak Bugday) with high diversity.
3. Western Black Sea: follows Koroglu mountain range, equal share of DW and BW. *T. monococcum* common ;
4. Central Black Sea: 57% DW (Sari Bugday and Uyevik Bugday), BW (Cam Bugday), *Tr. dicoccum*
5. Central Anatolia: 87% BW (Kamci, Zerun, Albostan)
6. North-Eastern Anatolia: 98% BW (Kirik), Club Wheat (Topbas) is common.
7. South-Eastern Anatolia: 61% DW (Sorgul, Kirmizi Bigday); BW (Asurelik)
8. Central-Eastern Anatolia: 52% BW (Asurelik), DW (Siverek)
9. East Mediterranean: 68% DW (Karakilcik, Havrani), BW (Kel Bugday)



Region	Durum wheat landrace growers - % of the grain used for:			Bread wheat landrace growers - % of the grain used for:		
	Bread	Bulgur	Both	Bread	Bulgur	Both
1. Southern Coastal	9.5	55.5	35.2	60.0	5.0	31.7
2. Aegean	-	-	-	83.0	3.8	13.2
3. Western Black Sea	5.1	74.4	5.1	45.2	33.3	4.8
4. Central Black Sea	4.2	27.8	61.1	39.5	10.5	26.3
5. Central Anatolia	-	-	-	75.4	5.3	19.3
6. North-East Anatolia	-	-	-	64.6	0.5	28.7
7. South-East Anatolia	2.4	14.3	83.3	41.6	8.4	50.0
8. Central-East Anatolia	0	11.8	88.2	64.3	5.1	26.5
9. East Mediterranean	9.7	87.1	3.2	67.7	19.3	3.0



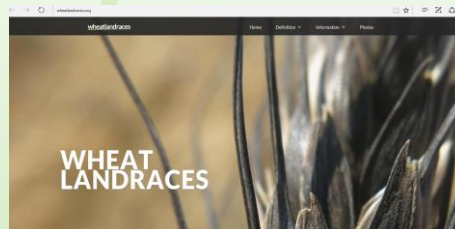
Grain yield and quality of wheat landraces from Turkey

Landrace	Province	Species	No. of lines	Yield-1, kg/ha	Yield-2, kg/ha	TW	1000K W, gr	Protein , %	SDS, ml	Mix., %TQ*MIN.
Gerek	-	Bread wheat	-	3290	2847	74.8	30.3	15.4	20.4	66.4
Karahan	-	Bread wheat	-	3955	3676	82.0	45.4	12.7	15.3	78.4
Akbugday	Aksaray Karaman	Bread wheat	15	3151	2604	78.5	34.6	14.1	22.0	63.6
		Club	7	3115	2534	78.2	33.2	14.7	23.8	73.1
		Durum	3	2428	2097	77.6	43.1	15.4	14.5	60.0
Kamci	Nigde	Bread wheat	16	2756	2456	76.1	33.1	16.1	21.7	73.3
		Club	5	3030	2500	76.9	31.2	14.9	19.3	61.5
		Durum	3	2327	2409	76.2	40.8	16.4	16.0	84.1
Sahman	Aksaray	Bread wheat	7	2746	2709	75.4	30.8	17.8	21.5	75.3
		Club	3	3350	3216	75.7	30.8	16.3	21.8	78.6
		Durum	6	3042	2676	76.5	38.7	17.5	15.1	74.1
Albostan	Nevsehir	Bread wheat	11	2851	2094	78.6	34.7	15.0	22.7	62.8
Goderedi	Konya	Bread wheat	5	2759	2195	75.6	33.6	15.6	21.3	57.6



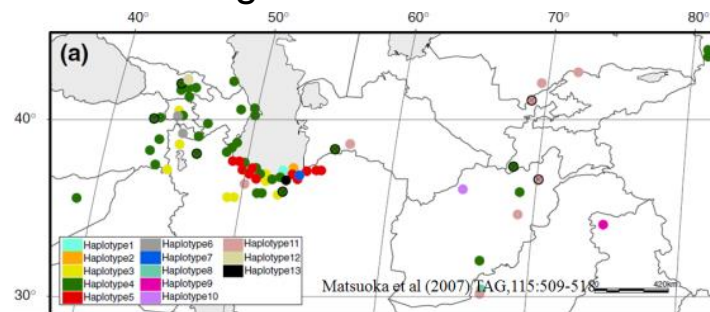
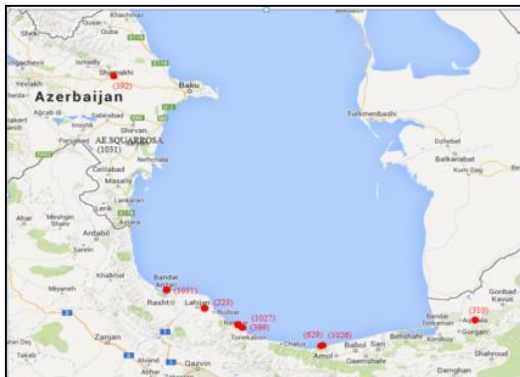
Improving food security by enhancing wheat production and its resilience to climate change through maintaining the diversity of currently grown landraces (2016-2019)

1. Participatory selection of drought and heat tolerant wheat landraces
2. Development of germplasm combining drought and heat tolerance with disease resistance
3. Promotion of selected drought and heat tolerant landraces in the targeted regions
4. Training of farmers, extension services and local administration, policy-makers, NGOs and researchers on sustainable cultivation of wheat landraces



Primary hexaploid synthetics

- **Winter synthetics:**
- Durum wheat varieties from Ukraine and Romania crossed to collection of *Aegilops taushii* from the Caspian Sea Basin.
- 300+ primary diverse synthetics originating from 10 crosses being tested in 2015-17 for several traits across the region.
- **Japanese synthetics:**
- Developed by crossing durum wheat variety Langdon with *Aegilops taushii* selections based on genetic diversity analysis covering the entire natural distribution range of the species (Kyoto Univ.)
- 29 primary synthetics originating from 29 crosses being tested in 2015-17 for several traits across the region.



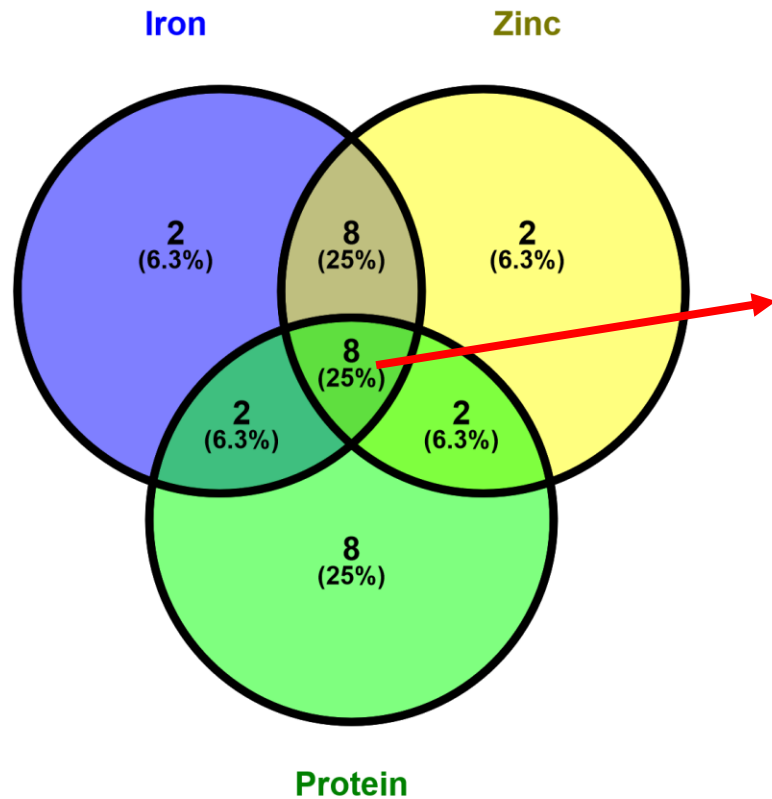
► AABBD Synthetic derivatives



T. durum AABB *T. tauschii* DD *Hexaploid Synthetic* AABBD



Primary hexaploid synthetics with high protein, Iron, and Zinc under drought stressed condition in Konya (2016 and 2017)



Entry	Synthetics	Zinc (mg Kg ⁻¹)	Iron (mg Kg ⁻¹)	Protein %	TKW, gr	Yield (g m ⁻²)
Check	Gerek (Check)	21	46	13.3	31.1	301
Check	Karahan (Check)	20	38	14.1	33.5	300
117	LANGDON/KU-2079	34	53	16.0	36.9	260
119	LAGDON/KU-2093	30	56	15.7	34.9	213
114	LANGDON/KU-2097	31	51	15.5	37.6	214
109	LANGDON/KU-2074	29	51	15.4	35.0	151
118	LANGDON/KU-20-9	33	54	15.3	35.6	206
102	PANDUR/AE.SQ.409	34	49	15.1	40.1	182
90	PANDUR/AE.SQ.223_90	32	50	15.0	41.7	275
76	PANDUR/AE.SQ.223_76	28	48	15.0	41.1	326

Primary hexaploid synthetics: frequency of *Glu-A1* and *Glu-B1* subunits

Cross	No. of lines	<i>Glu-A1</i>				<i>Glu-B1</i>					
		0	1	2*	2''	6+8	7	7+8	7+9	17+18	13+20y
<i>AISBERG</i> /AE.SQUARROSA(369)	15	2		12	1					12	3
<i>AISBERG</i> /AE.SQUARROSA(511)	12	10		2				4			8
LEUC 84693/AE.SQUARROSA(409)	14	10		4		4		8			
<i>PANDUR</i> /AE.SQUARROSA(223)	39	21		15	3			20	11	8	
<i>PANDUR</i> /AE.SQUARROSA(409)	26	8		15	3			13	13		
<i>UKR-OD 1530.94</i> /AE.SQUARROSA(1027)	46	30	1	3	12			45			1
<i>UKR-OD 1530.94</i> /AE.SQUARROSA(310)	7	4		3				3	4		
<i>UKR-OD 1530.94</i> /AE.SQUARROSA(392)	13	8		1	4			5	1	7	
<i>UKR-OD 1530.94</i> /AE.SQUARROSA(458)	9	5	3	1				5	4		
<i>UKR-OD 1530.94</i> /AE.SQUARROSA(629)	31	9	7	12	2		1	21	9		
UKR-OD 761.93/AE.SQUARROSA(392)	26	18		8					5	12	9
UKR-OD 952.92/AE.SQUARROSA(1031)	19	2	11	5	1		3	7	1	8	0
LANGDON/AE.SQUARROSA (various)	15	15				15					



Primary hexaploid synthetics: frequency of Glu-D1 subunits

Cross	No. of line s	Glu-D1																						
		1.5 + T2	1.5* + T2	1.5 + 12	1.5 + 12. 2	1.5 + 10	2 + T2	2 + 12	2 + 12. 2	2.1 + 12	2.1 + 12. 1	2 + 10	2.1 + 10	2.1 + T2	3 + 12	3 + T2	3* + 10	3* + 12	3* + 12 .1	4* + 12	4 + 10	5 + 10	5 + 12	5 + 12 .2
AISB./AE.SQ.(369)	15	1																				14		
AISB./AE.SQ.(511)	12							12																
L.84693/AE.SQ.(409)	14	4	1	1	1			6	1															
PAN./AE.SQ.(223)	39	9					2	3		6		1			3			2				13		
PAN./AE.SQ.(409)	26	1						2		5												19		
U-O1530.94/AE.SQ(1027)	46					1		2		25	4				2							9		
U-O1530.94/AE.SQ.(310)	7			2									2									1	2	
U-O1530.94/AE.SQ.(392)	13			2				3					7		1									
U-O1530.94/AE.SQ.(458)	9							2											1	1		1	3	1
U-O1530.94/AE.SQ.(629)	31							4		9		1										17		
U-O.761.93/AE.SQ.(392)	26						3	5				2	4									11		
U-O.952.92/AE.SQ.(1031)	19	1		1				1				1	5					3				7		
LANG./AE.SQ.(various)	15			3				1		3			1	1	1	1	1				1	1		

Primary hexaploid synthetics: perspectives

- GWAS is underway for agronomic traits, disease, pest resistance and mineral content
- Substantial diversity for *Glu-D1* - range of new subunits with unknown effect on grain quality.
- Substantial diversity and new subunits for Low-Molecular Glutenins (not presented)
- All material with new subunits planted in Konya (Turkey) on 5 m² plots to have grain for quality analysis in 2018
- Looking for cooperators interested in identification and characterization of new *Glu* subunits
- Germplasm described in the paper at Plant Genetic Resources is freely available upon request

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High-yielding winter synthetic hexaploid wheats resistant to multiple diseases and pests

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Thank you for your interest!

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