CIMMYT activities in Central Asia and Caucasus

Alexey Morgounov

Head, International Winter Wheat Improvement Program

CIMMYT-Turkey

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CIMMYT

- CIMMYT is international non-profit non-government research organization with headquarters in Mexico and offices in 18 countries globally
- CIMMYT main goal is improvement of wheat and maize production through new varieties and technologies globally with emphasis on less developed countries

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Cooperation matrix

Country	Wheat area	Winter Wheat	Spring Wheat	Cons. Agric.	Training	Research
Armenia	0.1	+				
Azerbaijan	0.7	+			+	+
Georgia	0.1	+				
Kazakhstan	12.0	+	+	+	+	+
Kyrgyzstan	0.5	+				
Tajikistan	0.4	+				
Turkmenistan	0.7	+				
Uzbekistan	1.2	+			+	
Russia	42.0	+	+		+	+

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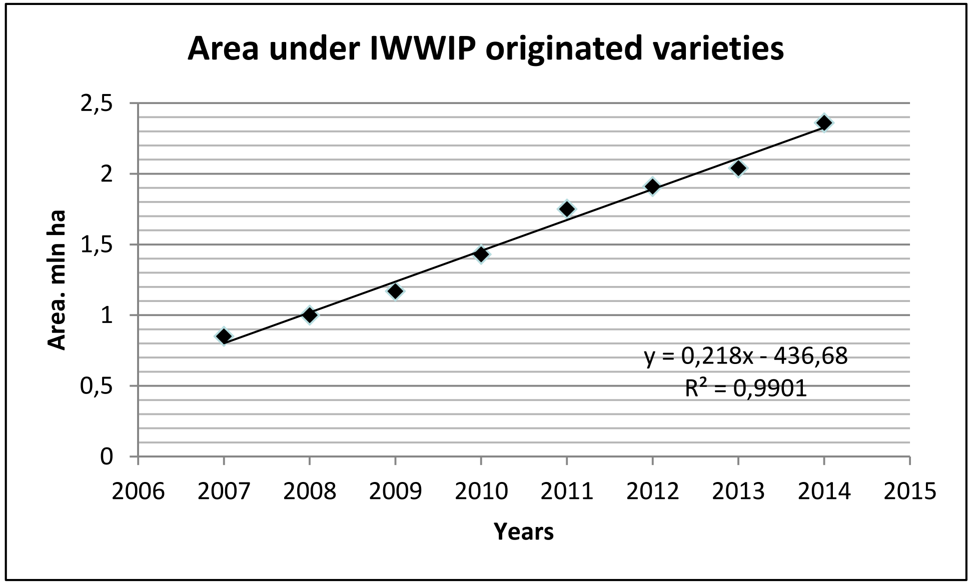
International Winter Wheat Improvement Program

- Well-integrated program in Turkey with linkages to all countries in the region
- Key connection to ICARDA-Uzbekistan for germplasm development and training (Dr. Ram Sharma)
- Huge impact in wheat breeding, research and production through:
  - Diversification of genetic basis of germplasm
  - Release and utilization of new superior varieties
  - Integration in international research community
  - Training of new generation of wheat breeders

www.iwwip.org

Winter/facultative varieties originated from IWWIW and released in the region

Country	Varieties released
Afghanistan	5
Armenia	4
Azerbaijan	2
Georgia	4
Iran	6
Kazakhstan	2
Kyrgyzstan	6
Tajikistan	3
Turkey	27
Turkmenistan	1
Uzbekistan	1



Utilization of IWWIP germplasm in Europe and USA primarily as parents

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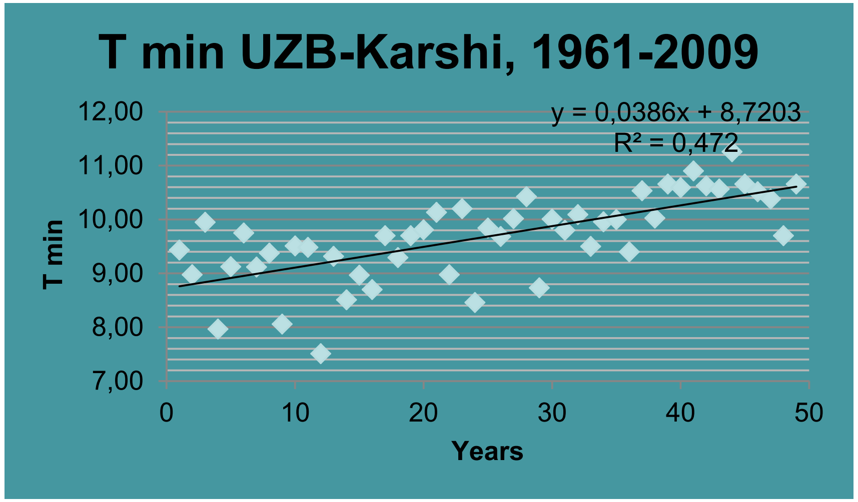
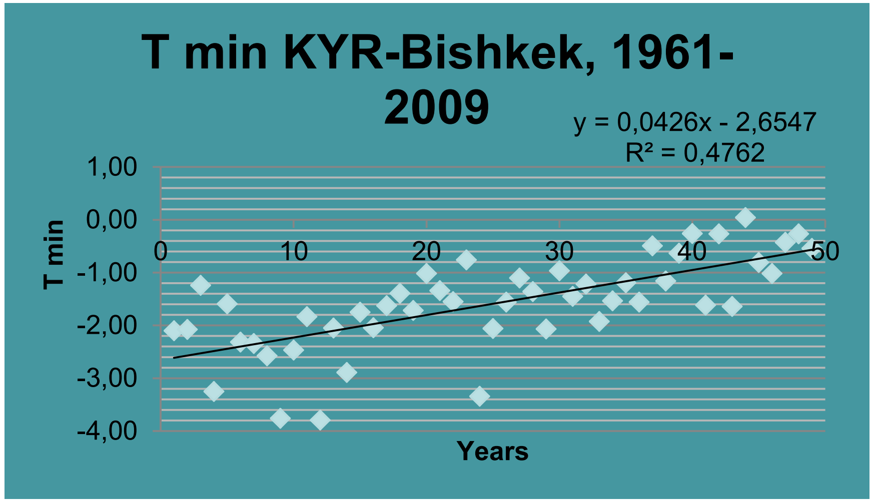
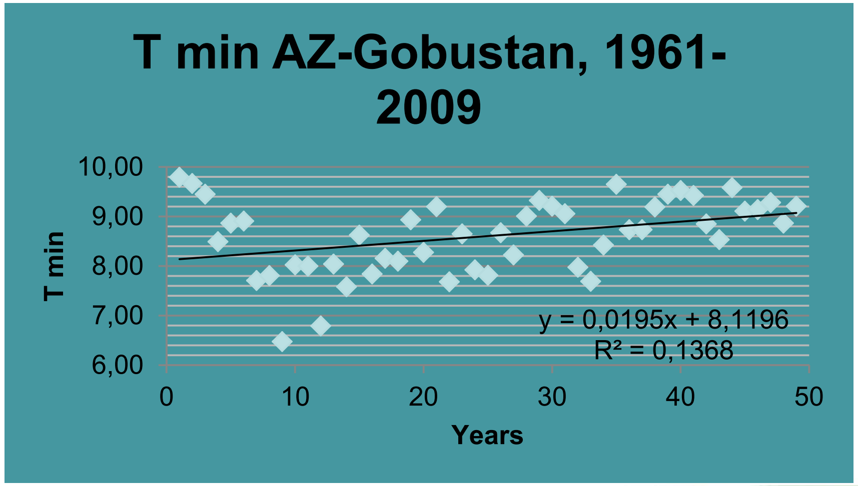
Climate change study







Morgounov, A.; Haun, S.; Lang, L.; Martynov, S.; Sonder, K. (2013) Climate change at winter wheat breeding sites in central Asia, eastern Europe, and USA, and implications for breeding. ***Euphytica*** 194(2):277-292.

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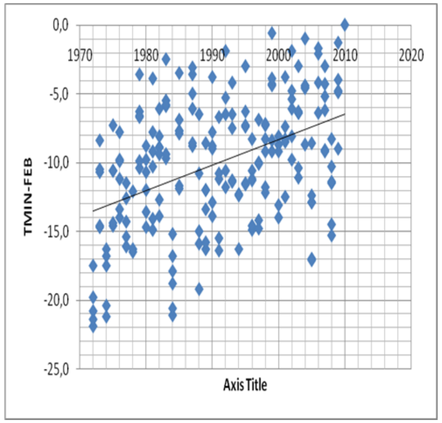
Climate change study: S. Kazakhstan



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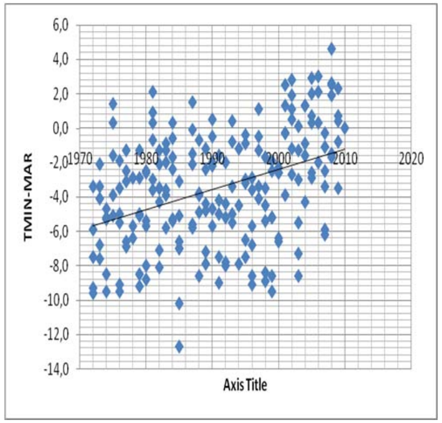

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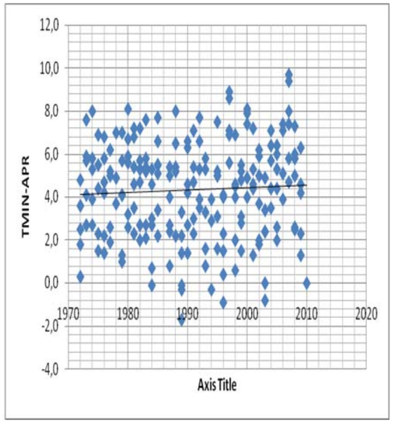

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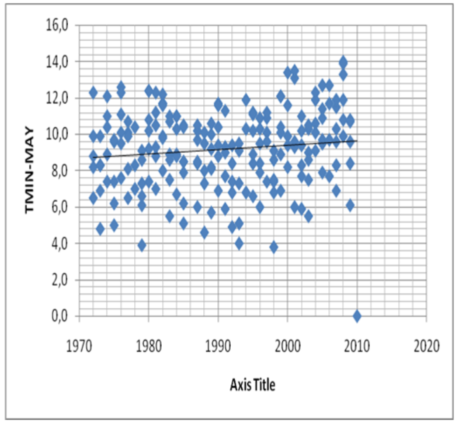
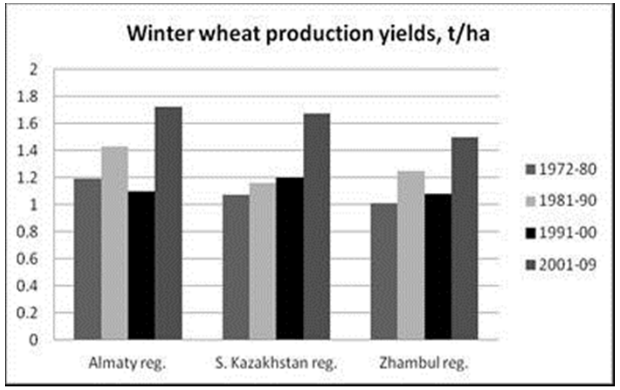


Май



Region	Site	Coefficients of correlation between average production grain yield in respective regions and:						
		Tmin	Tmax			Precipitation		
		Winter	Spring	May	June	Spring	June	Year
Almaty	Ili-1	0.52***	-0.17	-0.30*	-0.37*	0.59***	0.37*	0.49***
	Ili-2	0.53***	-0.15	-0.31*	-0.37*	0.61***	0.36*	0.54***
S.Kazakhstan	Sairam	0.64***	-0.12	-0.28	-0.31*	0.65***	0.28	0.48**
Zhambyl	Zhambyl	0.49***	-0.33*	-0.47*	-0.35*	0.58***	0.28	0.58***

Morgounov A.I., Abugalieva A., Martynov S. (2013) Effect of Climate Change and Variety on Long-term Variation of Grain Yield and Quality in Winter Wheat in Kazakhstan, ***Cereal Research Communications***
DOI: 10.1556/CRC.2013.0047

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Climate change associated traits in WW

Climate effect	Breeding trait
Warmer falls	Germination of wheat at increased temperatures
	Root development is warmer soil
	Coleoptile and first leaf reaction on temperature
Warmer winters	Growth habit: winter versus spring – *Vrn* Study
	Tolerance of spring types to late cold in March-April
	Facultative wheats: *Ppd* gene effect
Warmer springs	Reaction of genotypes to higher temperature at stem elongation - heading
	Higher competition with weeds
Warmer June	Grain fill at higher temperature: reaction of different genotypes
Moisture stress	Drought breeding
Diseases and pests	Higher priority

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Rust resistance and fungicide protection

- Due to *Ug99* threat, Borlaug Global Rust Initiative and increased funding rust research globally is now flourishing
- The advances in the genomic area also help us to understand better all the complexity of rust-wheat interaction
- Our previous understandings are now challenged:
- Minor resistance genes – non-specific and durable
- Interaction between resistant genes to different rusts can have different directions
- Important genes are now sequenced: *Lr34*

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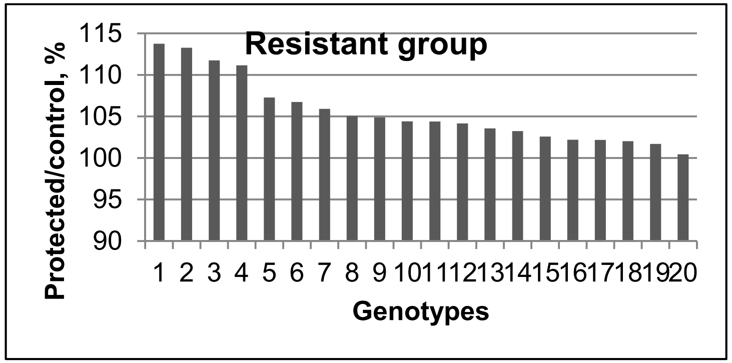
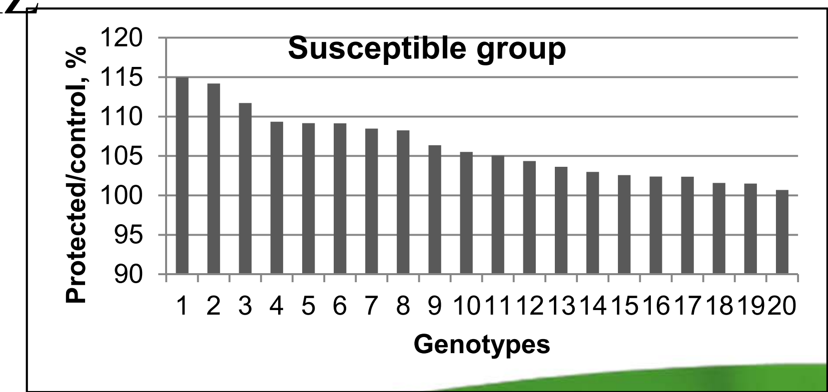
Kazakhstan-20 varieties x 3 resistant groups x 1 fungicide

Trait	Resistant group		Intermediate group		Susceptible group	
	Control	Protected	Control	Protected	Control	Protected
Leaf rust, %	0	0	11.2[a1]	2.2[b]	39.5[a]	22.0[b]
Days to heading from Jan. 1,13	142.8	142.6	143.3	143.2	144.0	143.8
Plant height, cm	91.5	91.7	109.4	109.7	119.5	112.5
NDVI, 27.05.13	0.79	0.79	0.79	0.79	0.76	0.76
NDVI, 05.06.13	0.75	0.74	0.75	0.74	0.72	0.72
NDVI, 14.06.13	0.69	0.70	0.69	0.70	0.68	0.68
NDVI, 24.06.13	0.52[b]	0.57[a]	0.52[b]	0.57[a]	0.52	0.53
1000 kernel weight	42.9[b]	45.2[a]	44.3[b]	46.8[a]	45.5[b]	48.3[a]
Grains per spike	58.2	57.4	55.9	58.2	55.9	55.3
Grain weight per spike	2.39	2.51	2.38[b]	2.64[a]	2.47	2.60

In cooperation with IPPB and KIZ





Alex Morgounov, Beyhan Akin, Lütfi Demir, Mesut Keser, Alma Kokhmetova, Sergey Martynov, Şinasi Orhan, Fatih Özdemir, İzzet Özseven, Zagipa Sapakhova, Minura Yessimbekova Yield gain in leaf rust resistant and susceptible winter wheat varieties due to fungicide application. (Crop and Pasture, under revision)

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Wheat landraces improvement

- National inventory of wheat landraces in Turkey: 2009-2013
- In total, 61 provinces, 161 counties, 506 villages and more than 1500 farmers were surveyed
  - Preliminary communication to local agricultural authorities and researchers and identification of potential landraces growing areas
  - Surveys and collection by teams of 2-3 individual during season
  - Socio-agronomic survey, random collection of spikes and seed
- Unexpectedly high frequency and diversity
- Wheat landrace inventory in Uzbekistan and Tajikistan jointly with FAO:
  - Uzbekistan; 30 landraces collected and being chracterized
  - Tajikistan: the main results will come this season

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Synthetic wheat

- **AABBDD Synthetic derivatives**

T. durum
AABB

T. tauschii
DD

Hexaploid Synthetic
AABBDD

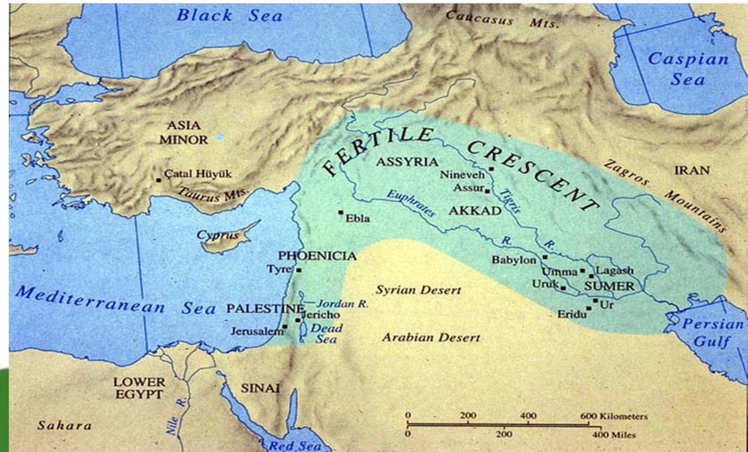
Ogbonnaya et al (2013) – recent review

National Association of Plant Breeders
NAPB
Improving Plants to Improve Lives

NAPB Newsletter
February 2014

Success Stories—Synthetic Hexaploid Wheat

Synthetic Hexaploid Wheat (SHW) is derived by the hybridization of a tetraploid (unusally) wheat and an accession of *Aegilops tauschii*, followed by chromosome doubling to convert the resulting triploid to a hexaploid. MCfadden and Sears first reported a success in deriving SHW in 1946. Much of the current work and utilization of SHW originated at CIMMYT in the 1980s, with an effort to find resistance to Karnal bunt. Following success in developing lines with such resistance via the use of SHW, an effort was initiated to further develop SHW that resulted in 1000 such lines by 2008. To develop these lines, *Ae. tauschii* accessions were screened and desirable phenotypic traits identified, followed by random hybridization with *Triticum turgidum* cultivars. Over 500 synthetic hexaploids were grown in both Obregon and El Batan centers that were scored for morphological, abiotic, and biotic characteristics. From these, 95 elite SHW were chosen as the elite set I and distributed among breeding programs in 2001. A second set of 33 SHW were identified as having resistance to leaf, stem, and stripe rust, along with other diseases, and distributed in 2002. These SHW provided genetic diversity comparable to the original landraces used before the green revolution but with the added benefits of higher yields, host plant resistance, abiotic stress tolerance and sometimes better end-use quality. Some of the variability found in these SHW lines derived from *Ae tauschii* includes resistance to: leaf and stem rust, strip rust, tan spot, karnal bunt, powdery mildew, Russian wheat aphid, green bug, Hessian fly, cereal cyst nematode, root lesion nematode, spot blotch, septoria tritici blotch, *stagonospora nodorum* leaf spot, barley yellow dwarf, and soil-borne wheat mosaic virus.



Synthetic wheat: pre-breeding

- 100 lines (F7) planted as preliminary yield trial at 5m^2 plots in Turkey and Kazakhstan
- Evaluation for several traits:
  - Rusts (Ankara)
  - Soil Born pathogens (Cereal Cyst Nematodes and Crown Rot) (Eskisehir)
  - Common Bunt (inoculated in Eskisehir) and Almaty (Kazakhstan)
  - Growth habit (spring planting)
  - Grain quality
  - Root system
  - Physiological traits related to drought resistance
- Elite set of winter synthetics identified with resistance to yellow rust. Leaf rust, stem rust, common bunt, cereal cyst nematodes, crown rot, moisture stress.
- The set will be tested in few key sites in the region for evaluation and initiation of crossing program

AISBERG/AE.SQUARROSA (369)
AISBERG/AE.SQUARROSA (511)
LEUC 84693/AE.SQUARROSA (409)
LEUC 84693/AE.SQUARROSA (1026)
UKR-OD 952.92/AE.SQUARROSA (1031)
UKR-OD 1530.94/AE.SQUARROSA (310)
UKR-OD 1530.94/AE.SQUARROSA (1027)
PANDUR/AE.SQUARROSA (223)
PANDUR/AE.SQUARROSA (409)

14NURSERY	14ENTRY	CNAME		ESKISEHIR GULER C.BUNT %	ESKISEHIR KEMAL 3 JULY STEM RUST
14SYNT-JAPAN	3	LANGDON/AE 929	-	15.2	60S
14SYNT-JAPAN	4	LANGDON/IG 48042	-	11	0
14SYNT-JAPAN	5	LANGDON/IG 126387	-	8.6	0
14SYNT-JAPAN	6	LANGDON/IG 131606		11.3	10MS
14SYNT-JAPAN	7	LANGDON/KU-20-8	var. typica	no plant	5MS a.f.plan
14SYNT-JAPAN	8	LANGDON/KU-2039	var. typica	9.5	0
14SYNT-JAPAN	9	LANGDON/KU-2074	ssp. strangulata Eig	0.0	10MS a.f.plar
14SYNT-JAPAN	10	LANGDON/KU-2075	ssp. strangulata Eig	0.0	60S one plar
14SYNT-JAPAN	11	LANGDON/KU-2080	ssp. strangulata Eig	12.6	5MS
14SYNT-JAPAN	12	LANGDON/KU-2088	ssp. strangulata Eig	0.0	0
14SYNT-JAPAN	13	LANGDON/KU-2092	ssp. strangulata Eig	0.0	10MS
14SYNT-JAPAN	14	LANGDON/KU-2096	ssp. strangulata Eig	18.0	0
14SYNT-JAPAN	15	LANGDON/KU-2097	var. typica	4.0	80S
14SYNT-JAPAN	16	LANGDON/KU-2098	var. typica	12.5	80S
14SYNT-JAPAN	17	LANGDON/KU-2100	var. meyeri	18.7	80S
14SYNT-JAPAN	18	LANGDON/KU-2105	var. typica	55.0	80S
14SYNT-JAPAN	19	LANGDON/KU-2106	var. typica	11.3	60S
14SYNT-JAPAN	20	GEREK		37.3	60S
14SYNT-JAPAN	21	LANGDON/KU-2124	var. typica	no plant	
14SYNT-JAPAN	22	LANGDON/KU-2144	var. typica	no plant	
14SYNT-JAPAN	23	LANGDON/KU-2159	var. typica	9.6	60S
14SYNT-JAPAN	24	LANGDON/KU-2829A	var. typica	29.9	10MS
14SYNT-JAPAN	25	LANGDON/PI 476874	-	9.2	50S
14SYNT-JAPAN	26	LANGDON/AT 55	-	1.1	10MS
14SYNT-JAPAN	27	LANGDON/AT 76	-	0.0	50MS
14SYNT-JAPAN	28	LANGDON/AT 80	-	2.4	60S
14SYNT-JAPAN	29	LANGDON/AE1090	-	2.9	0
14SYNT-JAPAN	30	LANGDON/IG 47259	-	0.0	5MR

Funding from the Government of Kazakhstan

Title of the project	**Improvement of Crops Genetic Yield Potential and Agricultural Technologies for Different Agroecological Zones of Kazakhstan**
Project Period	**2012-2014**
Donor	**Ministry of Agriculture of Kazakhstan, “KazAgroInnovation” JSC**
Project Budget	**$ 200,000 per year**
Objectives (subprojects)	**1) Developing of high-quality, drought and rust resistant spring bread wheat varieties for North, West, Central and East Kazakhstan based on „Shuttle Breeding“ and KASIB international breeding programs** **1) Introduction of high-yielding drought resistant sorghum varieties and Conservation Agriculture for feed production improvement in the different regions of Kazakhstan**

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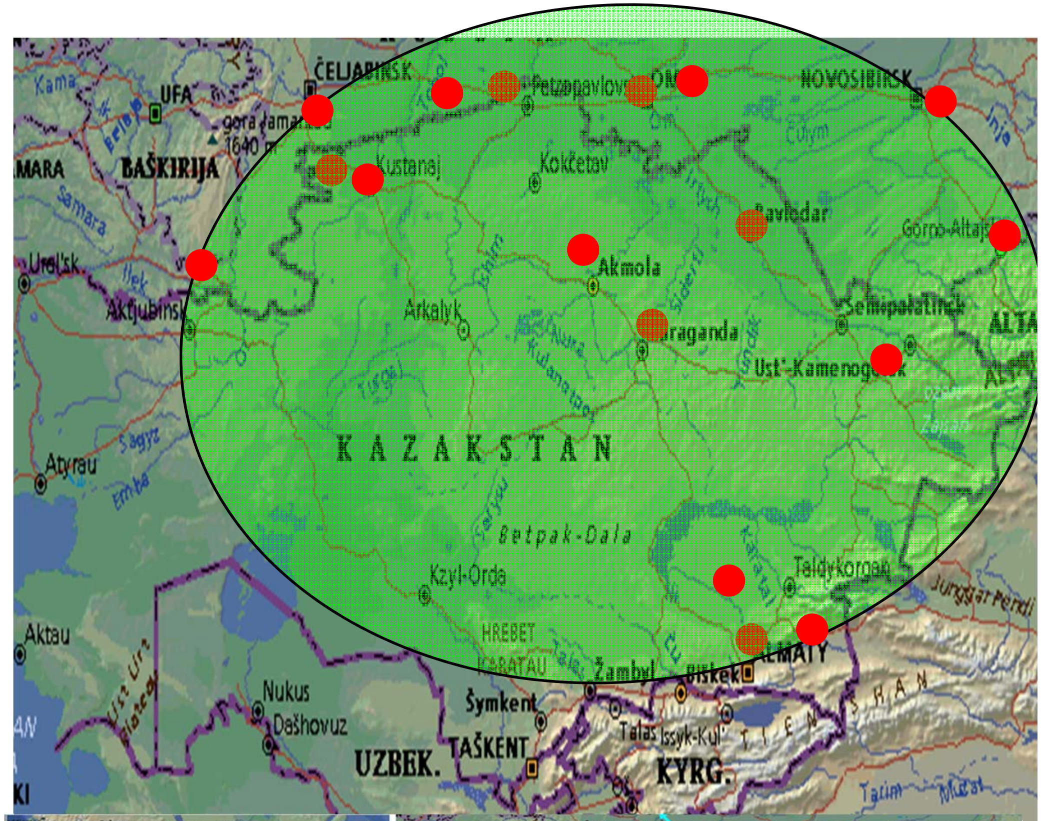
KASIB (Kazakhstan-Siberia) Network Activities (Also supported by Russian Federation)

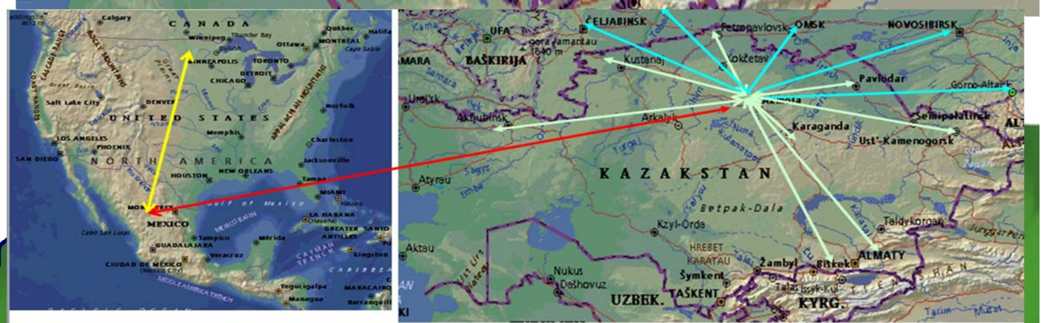
In 2000: KASIB established
By 2014: 14th KASIB SBW
14th KASIB SDW

For the period 2000-2014:
605 varieties studied,
among them:
469 BW varieties
136 DW varieties

The main breeding traits:
- ✓ Yield potential
- ✓ Drought resistance
- ✓ Cold resistance
- ✓ Disease resistance (LR, SR, Septoriosis etc.)
- ✓ Grain quality

Up to 40% of KASIB material is involved in breeding program





Shuttle Breeding Mexico—Turkey-Kazakhstan/Russia.
Shuttle material performance

Variety	Nursery-originator	Cross	Yield, t/ha				% to Local check
			2011	2012	2013	Aver.	
Akmola 2	KASIB	Local check	5.28	2.50	4.29	4.02	-
Fiton C-44	3 KSBN	Ersp35/Long92-291/Milan	5.84	2.56	5.54	4.65	115
Fiton C-7	3 KSBN	Ersp35/Long92-291/Milan	5.80	2.64	5.06	4.50	112
Fiton C-50	5 KSBN	HY320/NB402//Tselin 3C/3/KASO2	5.65	3.23	4.51	4.46	111
Fiton C-35	3 KSBN	Ersp35/Long92-291/Milan/3/ Tselin 24	4.98	3.12	5.11	4.40	109
Lut.C-19 SB	5 KSBN	Omskaya 28//SRMA/TUI / 3/ MN 94382	5.36	2.24	5.40	4.33	107
Fiton C-36	3 KSBN	Ersp35/Long92-291/Milan/3/ Tselin 24	5.62	2.75	4.61	4.33	107
Fiton C-41	4 KSBN	Pavlodar 27/3/Babax/ KS 93U76/Babax	5.24	3.18	4.34	4.25	106
Fiton C-40	4 KSBN	Omskaya 33/Bercut	5.54	3.10	3.96	4.20	104
Lut.94-13	1 KSBN	Tselin. 3C/Altar 84(Aeg.Squar)//Opata	5.04	2.43	4.98	4.15	103
Fiton C-39	4 KSBN	Omskaya 33/Bercut	5.58	2.68	4.02	4.09	102
Fiton C-38	4 KSBN	Omskaya 33/Bercut	5.82	2.02	4.32	4.05	101
Fiton C-20	4 KSBN	Saratovskaya 29/Seri/Rayon	4.78	2.52	4.90	4.07	101
Lut. C 24	**KSBN**	**Uralochka /Line 100-3**	**4.98**	**2.23**	**4.57**	**3.92**	98

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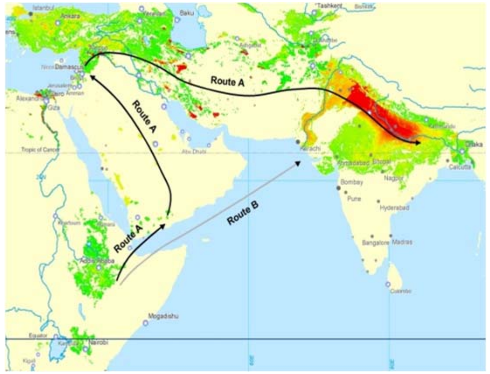
Stem rust Ug99 resistance in Russian and Kazakh spring wheat varieties

More than 1500 lines and varieties tested in Kenya

Оригинатор	Число линий
Сиб. НИИСХ	45
ОмГАУ	16
Курган	3
Саратов	19
Самара	48
Фитон	8
Актобе	1
Алтай	2
Челябинск	3
Карабалык	4
Отар	14

Gene	markers	availability in lines
Sr2	wms533	
	csSr2	in 1 lines
Sr22	cfa2123	
	CSPK81	absent
Sr24	Sr24#12	absent
Sr25/Lr19	wmc221	present
Sr26	Sr26#43	absent
Sr33	Xbarc152	*need Sr33 line
	Xcfd15	absent?*
Sr31/Lr26/Yr	Scm009	present
Sr35	XAK335187	present
Sr36	stm773-2	in 1 lines
VPM(Sr38(Lr37/Yr17/Cre5)	Ventriup +Ln2	absent
Sr39/Lr35	Sr39#22 BE500705	absent
Sr44	BE404728	?, need Sr44 line
	BE473884	
Sr47	gwm47	? bad marker
	gpw4165	? bad marker
SrWeb	gwm47	? bad marker
Sr52	BE497099	?, need Sr44 line
	wms570	
SrCad	FSD-RSA	?, need SrCad line
Sr57/Lr34/Yr38/Pm38	CSLV34	present

Genes	No. of lines
Sr2	1
Sr25	30
Sr31	17
Sr25+Sr31	31
Sr31+Sr36	1
Sr31+Sr57	1
Sr35	4
Sr36	3
Sr57	11
Sr6Ai	3
No genes	63



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Conservation Agriculture for wheat production and crop diversification

Ploughing up of the virgin lands in the mid of 1950s had led to the dramatic loss of soil fertility in Kazakhstan

Conservation Agriculture for Wheat Production in Kazakhstan

In the beginning of 2000s CIMMYT initiated large-scale Conservation Agriculture activities in North Kazakhstan. Due to these efforts, the area under CA-based practices has been increasing

from: ***0 ha in 2001***

to:

500,000 ha in 2007

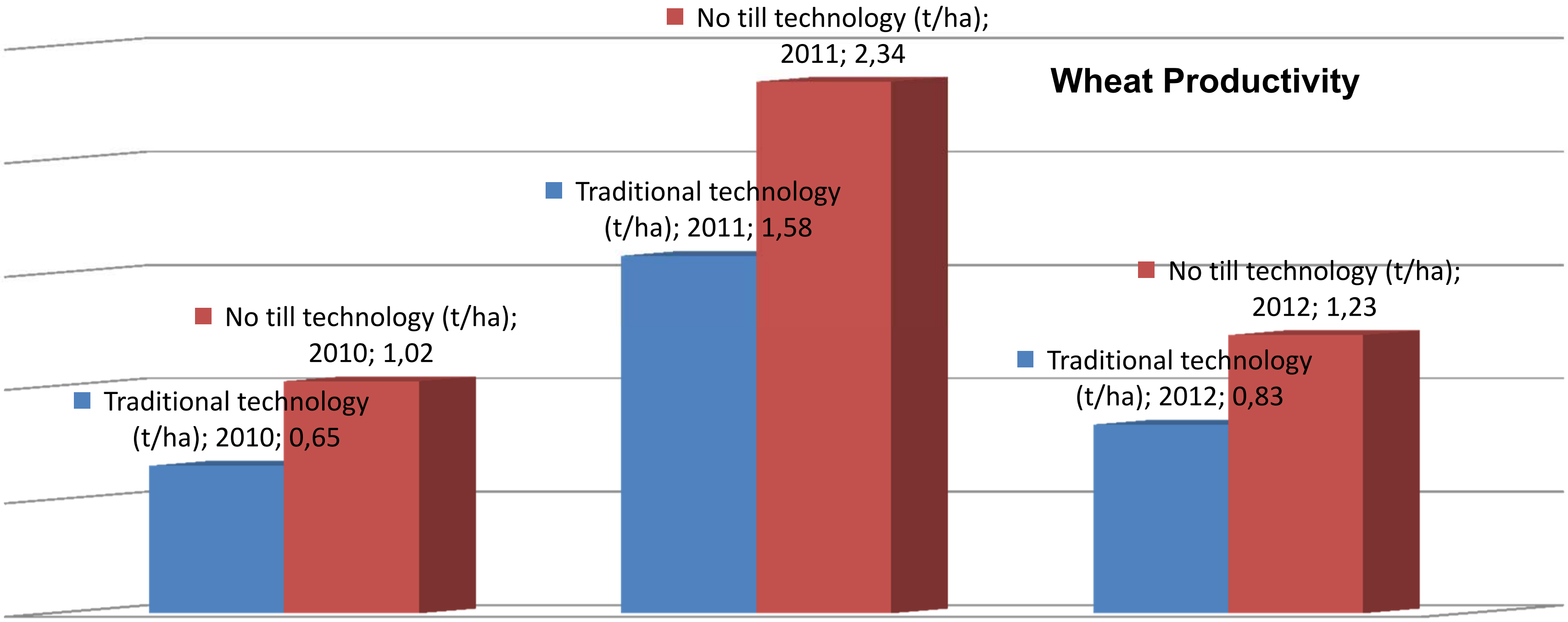
1,200,000 ha in 2008

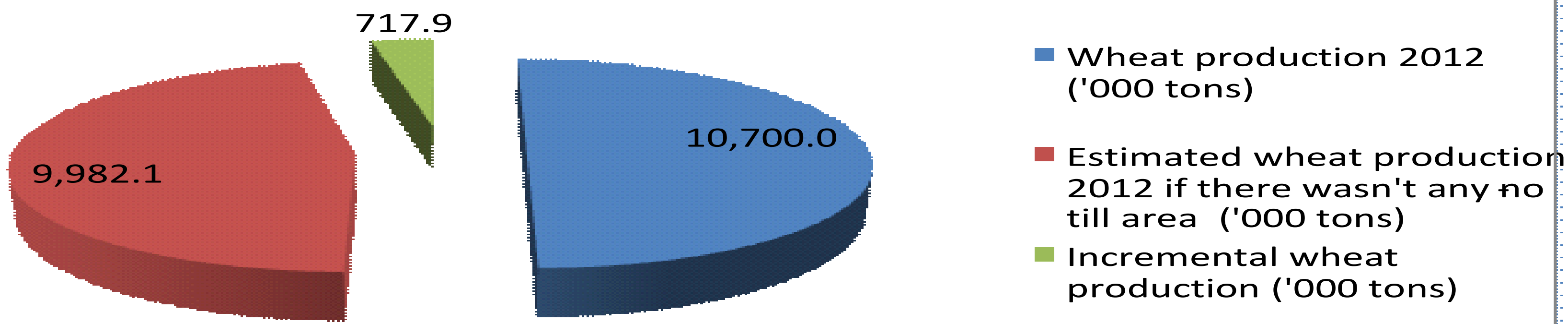
1,600,000 ha in 2011

2,000,000 ha in 2013

with continued rapid increases in area. The utilization of CA-based technologies has become an official state policy in agriculture in Kazakhstan.

With this Kazakhstan is now included among the top 10 countries with the largest areas under No-tillage in the world ***(Source: R.Derpsch & T.Friedrich. Global Overview of Conservation Agriculture Adoption. 2009, FAO)***





(Actual production from no-till area in 2012 is 1.8 million tons)

CIMMYT
International Maize and Wheat Improvement Center

informa
No. 1895 • 30 June- 04 July 2014

World Food Prize Winner Boosts Wheat Training at CIMMYT

Karen Willenbrecht

THE WORLD FOOD PRIZE

Two additional trainees — one from Afghanistan and one from Ethiopia — had the opportunity to participate in CIMMYT's Basic Wheat Improvement Course this year, thanks to the generous donation of US$ 20,000 by Dr. Sanjaya Rajaram, former director of CIMMYT's Global Wheat Program (GWP) and winner of the 2014 World Food Prize.

"Training is something very close to my heart, and I would like to see more donors supporting this important function at CIMMYT," he said during a 3 July visit to CIMMYT headquarters.

"If I can use my platform as World Food Prize winner to bring more attention to CIMMYT's research and training — which are critical for addressing the challenges of the next 50 years in producing food and maintaining ecosystems — I will work very hard to do that."

— Dr. Sanjaya Rajaram

When he presented the check to CIMMYT last fall, Rajaram said he "hoped it would serve as an example to other people who believe in training."

Rajaram started his CIMMYT career as a post-doctoral fellow, working alongside Dr. Norman Borlaug. He then went on to lead the bread wheat breeding team from 1973-1995 and develop wheat varieties among the most widely-grown worldwide. He served as director of the GWP from 1996 to 2002.


Sanjaya Rajaram, left, presents a check to Hans-Joachim Braun.

In his four decades at CIMMYT, Rajaram trained more than 400 wheat scientists. "He influenced so many trainees who lead wheat breeding in their home countries, and many became national research leaders," said current GWP Director Hans-Joachim Braun.

Find out how Dr. Rajaram has influenced top CIMMYT scientists in our new video series, which debuted this week on YouTube. Dr. Ravi Singh, a wheat breeder, talks about his mentor in the first video.

This classic photo of Dr. Sanjaya Rajaram, left, and Dr. Norman Borlaug studying data at the Ciudad Obregón experiment station in the 1990s was taken by **Gene Hettel** of the International Rice Research Institute. The photograph has been in CIMMYT's archives for years, but there was no information about the photographer. We're delighted to learn more about the photo and to give Hettel credit for his work.

Acknowledgements

- CIMMYT-Turkey is financially supported by
  - Ministry of Food, Agriculture and Livestock of Turkey
  - CRP WHEAT (CGIAR)
  - Eurasian Center for Food Security (Russian Federation)
- CIMMYT-Kazakhstan is financially supported by KazAgroInnovation
- Numerous cooperators

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