CIMMYT Achievements and Challenges in a Changing Climate with focus on Central Asia

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Global Wheat Program, Mexico

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Importance of wheat

- Globally the most important food crop
- Second most important food crop in the developing world after rice
- Food to 2.5 billion poor people (< 2 USD) in 89 countries
- Provides calories (20%) and protein (20%) in LDC
- Most traded food crop (20%)
WORLD WHEAT YIELD TRENDS
(5 Year Moving Average - ton/ha)

Source: Chudleigh, 2008

Extreme climatic events in 2010...

- Floods in Pakistan in July 2010
- Fires and drought in Russia in summer
- Floods in Queensland, in December

New record high in Food Price Index in December 2010 (FAO/GIEWS)
Expected Climate Change Effects in Kazakhstan

- Rise in the seasonal and annual surface air temperature
- Almost constant or increase in winter precipitation
- Decline in summer precipitation
- An increase of precipitation will not compensate for increase in air temperature
- Increased irregularity of rainfall in time
- For all scenarios, the change trends towards increased aridity/drought

North and Central Kazakhstan. Summer, 2010

For food prices to remain constant, annual yield gains would have to increase

- From 1.6% to 2.4% for maize
- From 0.9% to 1.5% for rice
- From 1.0% to 1.7% for wheat
Ten Strategic Initiatives for WHEAT

1. Technology targeting for impact
2. Sustainable wheat-based systems
3. Fertilizer and water-use efficiency
4. High yield wheat varieties
5. Durable disease and pest resistance
6. Enhanced heat and drought tolerance
7. Breaking the wheat yield barrier
8. More and better seed
9. Seeds of Discovery – open the black box of genetic diversity
10. Strengthening R&D capacities

10 Wheat Strategic Initiatives to Address the Threats to Global Food Security and Poor People
Core breeding priorities

- Grain yield potential and yield stability
- Durable resistance to rusts (including Ug99) and other diseases
- Water and nutrient use efficiency
- Heat tolerance
- End use quality
- Adaptation to conservation agriculture
- High Zn and Fe concentration

Kazakhstan

<table>
<thead>
<tr>
<th></th>
<th>Rainfed</th>
<th>Irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat area, ha</td>
<td>14.1 min</td>
<td>0.8 min</td>
</tr>
<tr>
<td>Yield, t/ha</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Major diseases</td>
<td>Leaf rust, Stem rust, Septoria</td>
<td>Yellow rust, Leaf rust</td>
</tr>
<tr>
<td>Major abiotic stresses</td>
<td>Drought</td>
<td>Low temperatures, Drought</td>
</tr>
<tr>
<td>Major varieties</td>
<td>Omskaya 18, Pamyati Aziyeva, Akmola 2</td>
<td>Steklovidnaya 24, Almaly, Progress</td>
</tr>
</tbody>
</table>
CIMMYT-Kazakhstan Program on Wheat Improvement

- Wheat germplasm enhancement: spring wheat high latitude and winter wheat breeding
- Efficient soil and water management: Conservation Agriculture for wheat production and crop diversification
- Capacity Building and NARS strengthening

Wheat Germplasm Enhancement

1. Kazakhstan-Siberia Network on Spring Wheat Improvement (KASIB)
2. Shuttle Breeding “Mexico-Kazakhstan/Siberia” for Spring Wheat
3. Winter Wheat Breeding
4. Biofortification on Iron & Zinc Content in Wheat
Kazakhstan-Siberia Network on Wheat Improvement (KASIB)

Objectives:

- Spring wheat germplasm exchange within 17 Northern Kazakhstan and Siberian (Russia) programs which grow more than 20 mln ha of spring wheat
- Evaluation of the germplasm; promotion of the best varieties into farmers fields; involving the best germplasm in breeding programs
- Communication through annual meetings, traveling seminars, visits and publications

Presently KASIB Network includes all breeding programs of the region – 17 institutions, i.e. 100% coverage!!!

KASIB Network Activities

2000: KASIB establishing
2010: 12th KASIB SBW
12th KASIB SDW

For the period 2000-2010:
505 varieties studied
  370 BW varieties
  135 DW varieties

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

Up to 40% of KASIB material are involved in breeding programs
Wheat germplasm enhancement

SHUTTLE BREEDING

Mexico - Kazakhstan/Siberia

CIMMYT

Parents include Kazakh, Siberian, CIMMYT, US and Canadian lines. Backcrosses and top-crosses made.

Crosses

F2

Mexico, Obregon

F3

Mexico, Toluca

F3

Mexico, Obregon

F4

Mexico, El Batan

F4

Kazakhstan/Siberia

F4

Kazakhstan/Siberia

Selection (2-3 years)

Plots derived from individual F2 plants; grown under lights; Stripe rust inoculated; quality tested.

Increased under fungicide; test plots inoculated with leaf rust.

Advanced line
Shuttle Breeding Mexico-Kazakhstan/Siberia. Efficiency of F7 selection (9th KSBN) in the different locations (2010)

<table>
<thead>
<tr>
<th>Locations of the selection</th>
<th>Number of planted populations</th>
<th>Number of selected populations</th>
<th>% of selected populations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kazakhstan</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Actobe ARS</td>
<td>202</td>
<td>138</td>
<td>68</td>
</tr>
<tr>
<td>East-Kazakhstan ARI</td>
<td>202</td>
<td>151</td>
<td>75</td>
</tr>
<tr>
<td>Karaganda ARI</td>
<td>202</td>
<td>101</td>
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<td>Karabalyk ARS</td>
<td>202</td>
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<tr>
<td>Pavlodar ARI</td>
<td>202</td>
<td>202</td>
<td>100</td>
</tr>
<tr>
<td>Fiton Breeding Company</td>
<td>202</td>
<td>51</td>
<td>39</td>
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<tr>
<td><strong>Russia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kurgan ARI</td>
<td>140</td>
<td>121</td>
<td>60</td>
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<tr>
<td>Kurganseed Company</td>
<td>140</td>
<td>59</td>
<td>25</td>
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<tr>
<td>Omsk ARI</td>
<td>140</td>
<td>22</td>
<td>16</td>
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<tr>
<td>Omsk ASU</td>
<td>140</td>
<td>131</td>
<td>94</td>
</tr>
<tr>
<td>Novosibirsk ARI</td>
<td>140</td>
<td>136</td>
<td>97</td>
</tr>
<tr>
<td>Tyumen ARU</td>
<td>140</td>
<td>136</td>
<td>97</td>
</tr>
<tr>
<td>Chelyabinsk ARI</td>
<td>140</td>
<td>71</td>
<td>51</td>
</tr>
</tbody>
</table>

First “shuttle” variety ”Stepnaya 60”

New drought resistant bread spring wheat variety “STEPNAYA 60” developed by CIMMYT and Aktobe Experimental Station. Authorship Certificate No. 367 as of 2 July 2010
Ug99 Stem Rust resistance of Kazakh/Russian wheat varieties. Kenya, 2008-2010

<table>
<thead>
<tr>
<th>Variety</th>
<th>2008 Main season</th>
<th>2008-2009 Off season</th>
<th>2009 Main season</th>
<th>2010 Main season</th>
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<tr>
<td>Susceptible checks, Kenya</td>
<td>100S</td>
<td>60-70S</td>
<td>70-80S</td>
<td>80-90S</td>
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<tr>
<td>Stepnaya 62</td>
<td>5RMR</td>
<td>TR</td>
<td>-</td>
<td>20MRMS</td>
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<tr>
<td>Lutescens 12 65/93</td>
<td>10MR</td>
<td>5MR</td>
<td>-</td>
<td>15RMR</td>
</tr>
<tr>
<td>El-4-11/7</td>
<td>-</td>
<td>-</td>
<td>5RMR</td>
<td>5R</td>
</tr>
<tr>
<td>Omskaya 37</td>
<td>10MR</td>
<td>-</td>
<td>-</td>
<td>5R</td>
</tr>
<tr>
<td>Omskaya 38</td>
<td>30MRMS</td>
<td>5MR</td>
<td>-</td>
<td>15R</td>
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<tr>
<td>Lut.242/97-2-9</td>
<td>-</td>
<td>-</td>
<td>5R</td>
<td>5R</td>
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<td>Tt - 173</td>
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<td>TR</td>
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<tr>
<td>Lut.242-97-2-32</td>
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<td>5MR</td>
<td>5R</td>
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<td>BC2 Er.59/L.20639</td>
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<td>-</td>
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<td>5R</td>
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<td>Niva2/Lut.22211</td>
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<td>-</td>
<td>5RMS</td>
<td>5RMR</td>
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<tr>
<td>Lut. 23419</td>
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<td>-</td>
<td>10MR</td>
<td>5R</td>
</tr>
</tbody>
</table>

CA for wheat production and crop diversification

Adoption of Conservation Agriculture in Northern Kazakhstan
Crop Diversification

- Canola
- Sunflowers
- Field Peas
- Lentils
- Chickpeas
- Buckwheat
- Winter Wheat
- Flax

Conservation Agriculture for Wheat Production in Kazakhstan

- In 2000 CIMMYT initiated large-scale Conservation Agriculture activities in North Kazakhstan
  0 ha (2001), 500,000 ha (2007), 1,200,000 ha (2008), 1,500,000 ha (2009) with continued rapid increases in area according to a recent assessment conducted by CIMMYT
- Utilization of CA-based technologies has become an official state policy in agriculture in Kazakhstan
- Since 2008, the government of Kazakhstan has been subsidizing farmers who are adopting CA-based technologies
- Kazakhstan among the top 10 countries with the largest areas under no-tillage in the world

III. Strengthening NARS capacity

Seminars/Workshops/Field days/Human resource development activities in 2010/11

<table>
<thead>
<tr>
<th>#</th>
<th>Event</th>
<th>Status</th>
<th>Number of events</th>
<th>Number of people</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conference (CA)</td>
<td>International</td>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>Workshops (CA, Breeding, Biotechnology)</td>
<td>International, National</td>
<td>4</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>Seminars/trainings (CA, Breeding, Biotechnology)</td>
<td>International, National</td>
<td>5</td>
<td>220</td>
</tr>
<tr>
<td>4</td>
<td>Traveling seminars (Conservation Agriculture, Breeding, PGR, Biotechnology)</td>
<td>International, National</td>
<td>5</td>
<td>120</td>
</tr>
<tr>
<td>5</td>
<td>Field days (CA, breeding)</td>
<td>National</td>
<td>10</td>
<td>500</td>
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<tr>
<td>6</td>
<td>Visits/travels/trainings of Kazakhstan scientists/specialists abroad</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Bringing international scientists and specialists to Kazakhstan for providing consultations</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td>1270</td>
</tr>
</tbody>
</table>

Conclusions

- Predictions of changes in major crops as a result of Climate Change still contain great uncertainties
- Adapting control measures to climate change is not likely to be fundamentally different from adjustment to technological innovations or changes in the economic framework
- Breeding for wide adaptation and disease resistance is paramount
- Sustainable agronomic practices are needed for the yield potential of new varieties to express
- There will be surprises: If the main prediction is surprises, the capacity to deal with these is to provide the correct scientific advise investing in a diverse scientific base to provide effective solutions.