Wheat Productivity Enhancement Program (WPEP)

WPEP: A research collaboration partnership to enhance the productivity of wheat in Pakistan
USDA – PARC – CIMMYT - ICARDA

National Partners (11)
• PARC
• Punjab
• Sindh –
• Khyber Pukhtunkhuwa
• Baluchistan
• AJK

USDA Partners
• USDA-ARS-MN
• USDA-ARS- WA
• USDA- ARS-NC
• US AID

CG Centers
• CIMMYT
• ICARDA
WPEP Objectives

Objectives (work areas)
- Surveillance
- Pre-breeding
- Breeding
- Seed
- Agronomy
- Coordination &
- Capacity Build

Co-leadership
- PARC/CIMMYT
- PARC/ICARDA
Objective 1: Surveillance

Major Activities:

• Upgrading technical capacity and infrastructure for rust research in Pakistan
• Detect yellow and stem infections and identify races
• Collect and maintain live samples of rust
• Coordinate rust information
Objective 1: Major Achievements

• Upgraded the capacity at main rusts laboratory at Murree - facilitating:
  • To maintain live samples of rusts
  • To determine virulence in local rusts population

• Infrastructure including sprinkler irrigation/misting system established at CDRI Karachi to screen for stem rust under field conditions
Objective 1: Achievements Cont.

All three rusts – data in Rust Tracker – 2012-13

Yellow rust

Stem rust

Leaf Rust

Member of Survey team collecting stem rust samples
Objective 1: Achievements Cont.

- 36 stem rust samples were revived and preserved
- 63 samples of yellow rust were revived and preserved;
- 34 leaf rust samples were revived and 17 were analyzed at CDRI-Murree
- 20 single pustules were inoculated on the North American set of differential and stem rust race RRTTF was typed
- USDA-ARS WSU found 14 YR races among 17 samples during 2012 from samples collected from KPK, Punjab and Sindh.
Objective 2: Pre-breeding

Activities

• Baseline resistance study
  • Find what rust resistance genes are in Pakistani germplasm
  • Marker-based gene postulation (USDA-NC)
  • Seedling phenotype based gene postulation (Murree, USDA-MN/WA)
  • Field to distinguish major gene/APR (CDRI-Karachi [stem rust], other Pakistan sites, and CIMMYT Kenya)

• Marker assisted parent breeding
  • Create high value Pakistan breeding parents with two gene combinations (rust resistance) through accelerated backcrossing (USDA-NC)

• Enhance Pakistan capacity to field screen for stem (Karachi CDRI) and yellow rust adult plant reaction (multiple locations)
Objective 2: Major Achievements

- ~1000 lines – NUWYT, Released Varieties and other germplasm were studied at
  - Kenya - APR for Ug-99 and USDA-ARS MN – local races
  - USDA-ARS MN – Seedling - US local (QFCSC), Ug-99 (TTKSK; TRTTF) and Pakistan (RRTTF)
  - USDA- WA - Stripe rust - Seedling (US races) and APR
  - USDA NC – Genotyped – Sr2, Sr24, Sr25,1RS (Sr31, Lr26 and Yr9, pm6), Sr26, Sr36, Sr38-Lr37-Yr17, Lr21,Lr34, Lr19,
Objective 2: Achievements Cont.

Stem Rust Seedling Screening at USDA-ARS-MN

- Materials were tested with multiple stem rust races at the seedling stage (3 listed as an example).
- Genes effective to Ug99 were postulated if possible.
- A high proportion of the germplasm was susceptible to Ug99.
- Most of the Ug99 resistant lines were also resistant to Pakistani and US stem rust races.

<table>
<thead>
<tr>
<th>Year</th>
<th>Entries</th>
<th>% resistant to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TTKSK (Ug99)</td>
</tr>
<tr>
<td>2011</td>
<td>220</td>
<td>6.8</td>
</tr>
<tr>
<td>2012</td>
<td>324</td>
<td>8.6</td>
</tr>
<tr>
<td>2013</td>
<td>440</td>
<td>12.0</td>
</tr>
</tbody>
</table>
Objective 3: Breeding

Activities:

• Increase amount and precision of field performance trial data in Pakistan wheat improvement
  • Field and other key hardware upgraded
  • New experimental designs employed
• Increase early flow of promising rust resistant materials within and into Pakistan
• Increase capacity and use of summer nursery at Kaghan
• Invest in pre-release multiplication to ensure seed supply at release does not limit a varieties impact.
Objective 3: Major Achievements

Modernizing National Breeding Programs

Locally manufactured small plot threshers
Objective 3: Achievements Cont.

Imported plot planter and harvester

- Harvester and planter for WRI-Faisalabad and NARC-Islamabad
- Vehicle for WRI-Faislabad, NARC, CCRI etc.

30 years old Machines replaced with new
Objective 3: Achievements Cont.

Yield Potential and Ug99 resistance combines in the new lines

COMBINED YIELD DATA NUWYT LINES (IRRIGATED) 2011-12

<table>
<thead>
<tr>
<th>Line Name</th>
<th>Pakistan (35 Sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>NR-399</td>
<td>4824</td>
</tr>
<tr>
<td>NR-378</td>
<td>4714</td>
</tr>
<tr>
<td>NR-379</td>
<td>4432</td>
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</table>
## Objective 3: Achievements Cont.

Yield Potential and Ug99 resistance combines in the new lines

**COMBINED YIELD DATA OF NUWYT LINES (RAINFED) 2011-12**

<table>
<thead>
<tr>
<th>Line Name</th>
<th>Punjab (8 Sites)</th>
<th>KPK (6 Sites)</th>
<th>Pakistan (15 Sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR-397</td>
<td>3125</td>
<td>3881</td>
<td>3347</td>
</tr>
<tr>
<td>NR-392</td>
<td>3012</td>
<td>3769</td>
<td>3256</td>
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<tr>
<td>NR-390</td>
<td>2998</td>
<td>3643</td>
<td>3210</td>
</tr>
<tr>
<td>06FJS3013</td>
<td>3057</td>
<td>3481</td>
<td>3198</td>
</tr>
</tbody>
</table>
Objective 3: Achievements Cont.

NUWYT – 2012-13 – Number of entries increases with the introduction of Alpha- lattice design

- 45 locations for irrigated trials with 36 entries and two time of planting
- 25 Locations for rainfed with 24 entries
- Number of entries with Ug99 resitance increased in the national testing (NUWYT)
Ug99 Resistance Variety – NARC 2011

- US ambassador Richard Olson visited National Agricultural Research Center to recognize the success of the WPEP and inaugurate the harvesting ceremony for the Ug99 resistant wheat variety-NARC 2011
- New lines such as NR 397 with resistance to Ug99 and other rusts are in pipeline for release

The frequency of Ug99 resistance gene(s) increased through incorporation of resistance sources in the 2012-13 crossing blocks of the national program
Objective 4: Seed

1. Identifying rust (Ug99, Yr) resistant and high yielding wheat varieties with desirable characteristics

2. Fast track variety testing and release by advocating flexible policy and/or regulatory options with partners

3. Accelerated pre-release seed multiplication of promising lines (breeder to basic) and large-scale seed production (certified) of released varieties through formal and informal channels

4. Popularization and promotion of rust resistant varieties with farmers (including targeted small-pack seed distribution) to initiate informal farmer-to-farmer diffusion

5. Capacity building in technical aspects of seed production and provision of infrastructure (training and critical equipment)

6. Creating awareness among policy makers, partner institutions and farmers on the imminent threat of rusts on food security
Objective 5: Agronomy

- Relay cropping of wheat in standing cotton: Up scaling
- Ridge Planting in irrigated wheat: Up scaling & demonstration
- Fertilizer management: Farmer field trials
- Integration of legumes in cropping system
  - Mung - wheat in Rainfed area: Farmer field trials
  - Berseem in Rice – wheat: Farmer field trials
Relay cropping of wheat in standing cotton
- 20% increase in grain yield (time savings)

- Farmers adoption in Punjab during 2012-13
  • Area: more than 70000 acres

- Major adoption in districts of:
  • Rahim Yar Khan
  • Bahawalpur
  • Lodhran
Ridge Planting:
- Farmers adoption in Sindh and cotton-wheat area of Punjab
- Demonstration in rice-wheat area
- 15-20% yield increase
- 30% saving in water
- Reduced lodging
Objective 6: Coordination and Capacity

- PARC and CIMMYT organized an annual national travelling wheat seminar
- CIMMYT-Pakistan worked closely with USDA (FAS and ARS) to assist in selection of Borlaug Fellows, especially from the WPEP partner institutions
- Visits by expert scientists – David Marshall and Xianming Chen, USDA-ARS
- CIMMYT also facilitated in country training.

2013 Wheat traveling Seminar
Travelling Wheat Seminar

• A group of around 30 wheat scientists form all parts of Pakistan
• Travel through Sindh, Punjab, Khyber Pukhtunkhuwa, Baluchistan, AJK
• Visit
  – Research centers / institutes
  – Seed companies
  – Farmers / fields
  – NUWYT
  – Jointly assess the status of crop
  – Wheat production issues
  – Identify priority research areas

➢ Two Travelling Seminar
  ➢ 2012
  ➢ 2013
Coordination and Capacity

USDA-ARS researchers work directly with Pakistani wheat breeders to learn from each other in the field in Pakistan.
Participants: Annual Planning/WPEP meeting
September 12-13 2012

National Annual Coordinated Meeting - 2012
Learn techniques and protocols

The 2012 Borlaug Fellows: Zahid Mahmood, Yahya Rauf, Nadeem Ahmad, Javed Mirza, and Naeela Qureshi learning protocols for race identification, evaluation of stem rust at seedling stage, field rust evaluation, barberry identification, and molecular markers.
Pakistan Project

Common Pakistan variety: Susceptible to Ug99

Recent Pakistan variety: Resistant to Ug99

Recent Pakistan variety: Susceptible to Ug99

Breeding line heterogeneous for Ug99 resistance