Global Trends, Challenges and Opportunities for Maize: Lessons for Asia

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Maize: Global Status

- Maize is cultivated in 184 million hectares globally, with a production of 1016 million metric tonnes.

- By 2023, maize will account for the greatest share (34%) of the total area harvested, followed by wheat (23%) and oilseeds (17%) (OECD-FAO, 2014).
64% of the total maize production comes from low- and middle-income countries.
Maize alone contributes over 20% of total calories in human diets in 21 low-income countries, and over 30% in 12 countries (home to a total of more than 310 million people)

Source: CIMMYT (2015)
Maize in Asia
Impressive growth!

- Maize’s importance in Asia’s cropping systems has grown rapidly due to its multi-faceted uses (food, feed, fodder, specialty corn, and industrial uses).

- In Asia, maize has recorded the fastest annual growth (around 4 per cent), as compared to other cereals.
Improving Maize Yields in the Tropics

Maize current yield levels
- Low: <3 t/ha
- Medium: 3-5 t/ha
- High: >5 t/ha
What are Asia’s stakeholders demanding?

• Climate resilient maize
• Wider genetic base in maize varieties
• Increasing genetic gains through novel tools / techniques
• Sustainable cropping systems
• Biofortified maize
• Maize with improved end-use traits
• Asia’s maize seed industry requires a new discourse, greater regulatory capacity, better metrics, better data and more insightful analysis
• Engaging youth and women farmers
• Better quality seed through PPPs
• Maize innovation platforms
• Conductive policy environment
MAIZE Phase-II (2017-2022)

• Maize-based agri-food systems are defined as agricultural lands with more than 25% of maize in crop rotation, and inhabited by 219 million poor (< US$ 1.25 per day).

• Maize growing areas include all areas where maize is grown; these are inhabited by 977 million poor.
MAIZE Flagship Research Projects

Stress-resilient & Nutritious Maize

FP 2: Novel diversity and tools to improve genetic gains

FP 3: Stress tolerant and nutritious maize

FP 4: Sustainable intensification of maize-based systems for better smallholder livelihoods

FP 5: Adding value for maize producers, processors and consumers

Adoption and use

FP 6: Scaling up and Scaling out

FP 1: Foresight, targeting, adoption and impact
Maize Mega-environment in S & SE Asia

80% area drought-prone and ~60 heat stress-prone

- **20% Irrigated**
  - 7% Spring
  - High-input environment, but heat stress-prone

- **80% Rainfed**
  - 13% Winter
  - High-input/high yielding environment
  - 11% Optimal moisture
  - Good environment w/o major stresses
  - 16% Drought
  - <500mm rainfall, drought + heat stress-prone
  - 15% Excess moisture
  - >1500mm rainfall, excess-moisture/water-logging
  - 38% Drought / Excess moisture
  - Erratic distribution pattern of monsoon rains; prone to drought (+ heat) and waterlogging within the crop cycle
Elite stress resilient and nutritious maize germplasm developed and distributed globally by CIMMYT

<table>
<thead>
<tr>
<th>Products</th>
<th>Breeding locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought tolerance</td>
<td>Africa; Asia; Latin America</td>
</tr>
<tr>
<td>Drought + heat tolerance</td>
<td>Asia; Africa; LA</td>
</tr>
<tr>
<td>Acidity / Al toxicity tolerance</td>
<td>LA</td>
</tr>
<tr>
<td>Waterlogging tolerance</td>
<td>Asia</td>
</tr>
<tr>
<td>DT + Waterlogging tolerance</td>
<td>Asia</td>
</tr>
<tr>
<td>Insect-pest resistance</td>
<td>Africa; LA; Asia</td>
</tr>
<tr>
<td>Disease resistance</td>
<td>LA; Africa; Asia</td>
</tr>
<tr>
<td>Nutrient use efficiency</td>
<td>Africa; LA; Asia</td>
</tr>
<tr>
<td>Nutritious maize (Provitamin A, QPM, Kernel Zn)</td>
<td>LA; Africa; Asia</td>
</tr>
</tbody>
</table>
Improved Maize Germplasm Flow from CIMMYT
Maize in Pakistan

- Maize is 3<sup>rd</sup> most important cereal, and the highest yielding cereal in the country
- Two Maize crops a year: **Spring (Jan-Jun)** & **Autumn (July-Nov)**
- Major area (0.189 m ha) of spring crop in Punjab
- Significant increasing trend in area of spring crop is mainly due to good yields of hybrids (7-8 tons/ha)
- About 60% spring crop is sown after harvesting of potato (during 2<sup>nd</sup> fortnight to March); grain filling stage in May-June when average maximum temperature goes above 40°C affecting yield

<table>
<thead>
<tr>
<th>Province</th>
<th>Area ‘000 ha</th>
<th>Production ‘000 Tons</th>
<th>Avg. Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punjab</td>
<td>689</td>
<td>4021</td>
<td>5.84</td>
</tr>
<tr>
<td><strong>Autumn</strong></td>
<td>500</td>
<td>2587</td>
<td>5.17</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
<td>189</td>
<td>1434</td>
<td>7.59</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1168</td>
<td>4944</td>
<td>4.23</td>
</tr>
</tbody>
</table>

*Source: Agricultural Statistics of Pakistan 2013-14*
Heat Tolerant Maize for Asia

Increase in heat-stressed area (%)

<table>
<thead>
<tr>
<th>Month</th>
<th>Relative area exposed to heat stress (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>0</td>
</tr>
<tr>
<td>Feb</td>
<td>0</td>
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<tr>
<td>Mar</td>
<td>0</td>
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<td>Apr</td>
<td>0</td>
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<td>May</td>
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<td>Jun</td>
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<td>Jul</td>
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<td>Aug</td>
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<td>Sep</td>
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<td>Oct</td>
<td>0</td>
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<td>Nov</td>
<td>0</td>
</tr>
<tr>
<td>Dec</td>
<td>0</td>
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2030: Yellow bars
2050: Red bars

Spring: March, April, May
Rainy-season: June, July, August, September, October, November, December
Selection of HTMA hybrids across S Asia (Bangladesh, Nepal, India, Pakistan)

- Hybrids with wider adaptation (Across agro-ecologies, target for National programs/MNCs)
- Hybrids with reasonable adaptation (within specific agro-ecologies; target for MEs/SAUs)
- Hybrids with specific adaption/niche markets (within sub-agroecologies, target for SEs)
We need to accelerate breeding process, improve breeding efficiency and enhance genetic gains.
We need to **shorten, widen and improve** the breeding funnel...

Source: Based on Cooper et al. (2014)
Doubled haploid (DH) technology

“DH technology may be considered the third most important methodological achievement for maize breeding, after hybrid technology and off-season nurseries.” – Seitz (2004)
Maize DH Development Service through a Centralized Platform

DH development service to NARS and SME seed company partners, besides CIMMYT and IITA

~60,000 DH lines developed from 235 source populations in the first year of operations

A similar DH Platform needs to be established soon in Asia.
Integration of modern breeding methods

New Varieties & Breeding Populations

MARS/GS for trait enhancement and rapid genetic gains

Field testing for complex traits
  Testcrossing field evaluation

DH for deriving large numbers of homozygous lines

Seed DNA-based MAS
  Markers for key traits to eliminate over 90% of DH lines before planting
Strengthening seed systems is important for breeding programs to make an impact

In the past:
Number of improved crop varieties generated

Shift to

Today:
Demonstrated impact in farmers’ fields

- Reducing the time to release new varieties
- Easy-to-produce hybrids
- Rapid seed scale-up
- Wider scope = more farmers
- Gender and social inclusion

The sooner the farmers, especially smallholders in the hitherto unreached areas, have access to improved varieties and complementary agronomic package of practices, the greater the opportunity to increase productivity.
Increasing farmers’ uptake of stress tolerant maize varieties

1. Extensive on-farm demos, intensive communications, and extension
2. Product targeting (= market segmentation and targeted deployment)
3. Replacing very old varieties with the improved (= frequency of variety turnover)
4. Enhancing profitability of our seed company partners (= market demand)
HTMA Hybrid Field-day

4th June 2015; Pakistan

No. of Participants = 32, including local seed companies (20), MNCs (3), NARS (8) and CIMMYT (1)

Md. Arshad & Mian Md. Shafique, MMRI, Pakistan
Improving smallholders’ livelihoods requires much more than just improved maize seed

• Generating awareness about improved technologies. Knowledge is power!
• Sustainable intensification (improved varieties + agronomy + policies)
• Buffering farming communities from climate-induced risks
• Strengthening linkages to the markets
• Policies and incentives for financial institutions to invest better in agriculture and strengthening the value chains

Opportunity for AIP project to address some of these important elements, while drawing synergies from complementary initiatives (e.g., HTMA, IMIC-Asia).
Thanks for your support, partnership and commitment to the cause!