Sustainable rice, wheat and maize systems for ensuring global food security

Thematic Area 3

**Rice**: AfricaRice – CIAT – IRRI

**Wheat**: CIMMYT – ICARDA

**Maize**: CIMMYT – IITA

with input from GCP, IFPRI and partners
# Importance of maize, rice and wheat

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Number of countries where more than 30% of food calories come from these crops, 2003</th>
<th>Population of the countries (millions), 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize only</td>
<td>10</td>
<td>248</td>
</tr>
<tr>
<td>Rice only</td>
<td>18</td>
<td>802</td>
</tr>
<tr>
<td>Wheat only</td>
<td>17</td>
<td>564</td>
</tr>
<tr>
<td>Maize, rice and wheat</td>
<td>94</td>
<td>4,574</td>
</tr>
</tbody>
</table>

Note: There are only ten other countries in the developing world with a combined population of 370 million people where another crop accounts for more calories than rice, wheat or maize.

Von Braun et al 2009
Food for poor consumers, livelihoods for poor farmers

Poverty in maize growing areas (Sonders, 2010)
The world eats more than rice, wheat and maize ... however

- If we do not address the challenges associated with rice, wheat and maize, it will have tremendous implications on the world and the world poor, and may be the cause for social unrest.
- Rice, wheat and maize => “Global food security crops”

Location of other crop & livestock research – Various suggestions
- Locally important crops => Thematic Area 1
- Root and tubers => Thematic Area 2 or 3
- Pulses and vegetables => Thematic Area 4
- Trees => Thematic Area 6
- Livestock => Thematic Area 2 or 4
- Rice, wheat and maize have individually huge challenges to address => Separate Management Units?
Challenges to the developing world
Demand increases

![Bar chart showing demand increases for Maize, Rice, and Wheat from 2000 to 2050.]

Maize
- 2000: 300
- 2025: 500
- 2050: 700

Rice
- 2000: 400
- 2025: 500
- 2050: 600

Wheat
- 2000: 200
- 2025: 300
- 2050: 400

IFPRI March 2010
Challenges to the developing world
Climate change impact on production

IFPRI March 2010
• 3 IPCC Climate Models
• Increasing Heat Stress (wheat)
• 17-38% Reduction in High Potential Zone
1 billion people = 1/7 of the world population affected
Annual loss in 2025: USD 7.7 billion

- 3 IPCC Climate Models
- Increasing Heat Stress (wheat)
- 17-38% Reduction in High Potential Zone
Consequences to the developing world
Price increases

Maize Rice Wheat

IFPRI March 2010
Impact of climate change on weather variability and price fluctuations

Additional challenges

- Fertilizer will become scarce/more expensive
- Water will become more expensive
- > 80% of production increase has to come from same land area
- Soil degradation

Cordell et al 2006

FAOSTAT 1960 - 2008

IMF Vulnerability Rankings vs Cereal Imports 2006

Data sources:

NOTE: Symbols scaled on total cereal imports only
Rice: what the world needs
(to keep rice prices affordable at around $300 per ton)

Rice yield increase needs to be 1.5%\%/yr instead of <1\%/yr

S. Mohanty, IRRI
Challenges summarized: 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 1.3% to 2.3% for wheat
- On essentially the same land area, with less water, nutrients, fossil fuel, labor

- The more we delay investments, the steeper the challenge
- Time to act is now
- Need for coordinated investment
Whose challenge?

Region X

International Research – What?
- Focus: International Public Goods
- Cutting-edge technologies
- Elite, diverse germplasm
- Know-how
- Policy analysis
- Capacity building
- Catalyst/Facilitation

International Research – Who?
- IARCs
- NARS & ARIs (IPR, adaptation)
- Private Sector (IPR, margin orientation)
Whose challenge? => Regional planning

Region X

Impact targets

- Prices for maize – rice – wheat
- Yield growth rates maize – rice – wheat
- Area under adoption
- Poverty reduction in maize, rice and wheat based farming systems
  - Farmers < USD 1
  - Malnourished children
- Sustainability
  - Water and fertilizer efficiency
  - Soil productivity

Impact targets
Interventions
Roles

National Research
International Research
Development Partners
Defining the international research agenda

Africa

Prioritization and collaborative implementation

Asia

Prioritization and collaborative implementation

Latin America

International research agenda
Building on a history of strong collaboration

Cereal Systems Initiative

Wheat Yield Consortium

Drought Tolerant Maize for Africa Partnership
## Objectives and outcomes

<table>
<thead>
<tr>
<th>Level</th>
<th>Objectives</th>
<th>Development outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic components</strong></td>
<td><strong>A. Genetic diversity and discovery: Genes to improve crop productivity and value in the face of changing climate</strong></td>
<td>Use by global research and breeding community</td>
</tr>
<tr>
<td></td>
<td><strong>B. Genetic improvement and seed systems, targeted at the main farming systems in Africa, Asia, Latin America</strong></td>
<td>Accelerated adoption of more productive varieties</td>
</tr>
<tr>
<td><strong>Maize-, rice-, wheat-based farming systems</strong></td>
<td><strong>C. More productive, sustainable, resilient, diversified maize-, rice-, wheat- based systems, linked to effective value chains</strong></td>
<td>Realize sustainable productivity increases on actual farms</td>
</tr>
<tr>
<td><strong>Countries &amp; institutions</strong></td>
<td><strong>D. Institutional innovations, information and policy support</strong></td>
<td>Pro-poor income growth and gender sensitive impacts</td>
</tr>
</tbody>
</table>

**Decision criteria:** Relevance to poor maize, rice, wheat farmers and consumers
A. Genetic diversity and discovery:
Utilizing the untapped biodiversity of maize, rice and wheat

> 110,000 ancestral genotypes per crop

*New technologies enable us to unlock the entire native genetic diversity of maize, rice or wheat for the price of commercializing 1-2 transgenics*
Product: Usable diversity within 5-7 years

1. **Web based access to the entire genetic diversity**
   - Molecular and phenotypic make-up
   - Diversity at distinct gene locations

2. **Global use**: Marker-assisted introgression of genetic diversity into breeding programs world-wide

3. **Building a living data base**: characterization returned into the database

**Research partners**
- Genebanks: IARCs and potentially others
- Private sector: eg. KB Biosciences, Triticarte
- ARIs in China, France, Japan, Mexico and USA
- GCP Molecular Breeding Platform
- Global phenotyping network
- Everybody
B. Rice genetic improvement and seed systems

• New stress-tolerant varieties for poor farmers: submergence, drought, salinity, heat
• New varieties for conservation agriculture systems
• New rice varieties for better nutrition
• New inbred and hybrids with higher yield potential
• Breakthrough: C4 rice with 50% higher yield

• New partnerships:
  • Genomics: ARI, private sector
  • Hybrid Rice Development Consortium (HRDC, 24 private companies, 1 NGO, 24 NARS)
  • SKEPs with the private sector
  • African Rice Breeding Task Force
  • Seed production sector: small entrepreneurs, NGOs, government
B. Wheat genetic improvement and seed systems

Averting a USD 1 billion losses in wheat

- **Durable Rust Resistant Wheat:** Global effort to develop Ug99 resistant cultivars; Kenya and Ethiopia major partners.

Facing the food, water and climate change challenge

- **Borlaug Institute for South Asia:** Catalyze a second Green Revolution and avert a food crisis in South Asia.
- **ICARDA-CIMMYT Wheat Improvement Program** for Central and West Asia and North Africa
- **GCP Initiative** on drought tolerant wheat in Asia

Breaking the wheat yield barrier

- **Wheat Yield Potential Consortium:** increase yield potential by 50%; CIMMYT with Australia, China, France, Germany, India, Spain, UK, US
- **Hybrid Wheat Consortium** - Public-private co-investment to develop transgenic hybrid wheat
B. Maize genetic improvement and seed systems

Averting hunger and production shortfall from drought and climate change
- Drought tolerance maize for Africa
- Water use efficient maize for Africa
- Lack of investment: Asia and Latin America

Meeting doubling demands for maize
- High rainfall areas: biotic stresses
- Postharvest issues: storage, mycotoxins
- Nutrient use efficiency

How?
- Pyramiding native genetic variation through modern tools (30-50%)
- Selected transgenics from the private sector and ARIs (10-15%)
- Accelerating variety replacement by strengthening 150 local seed companies

Targeting: maize calories consumed by the poor

<table>
<thead>
<tr>
<th>Region</th>
<th>Total</th>
<th>CWANA &amp; CAC</th>
<th>Latin America &amp; Caribbean</th>
<th>South, South-East &amp; East Asia</th>
<th>Sub-Saharan Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3%</td>
<td>13%</td>
<td>27%</td>
<td>57%</td>
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</tbody>
</table>
C. More productive, sustainable, resilient, diversified maize-, rice-, wheat-based systems

- 65% of all stunted children (120 million) live in 12 farming systems where maize, rice or wheat are the most important crops (Hyman et al 2008)
- Targeted multi-institutional, public-private interventions to increase productivity, sustainability and resilience, and decrease poverty and childhood malnutrition
- On-going examples: CSISA (Asia), FLAR (LAC), IVC (Africa), SIMLES (Africa)
Cereal Systems Initiative in South Asia (CSISA)

Critical ingredients

• Demand: linkage to market
• Suitable technologies (R&D)
• Access to relevant information
• Available inputs (seeds, fertilizers, pesticides, machinery, ….)
• Credit, Insurance
• People on the ground for customized management solutions that farmers want

• Public – private; NARSs – IARCs
• Multiple crops, livestock
• 200 partners in total
D. Information and policy support

- **Where?** - Main maize, wheat, rice consuming countries (94)
- **What?** - Forecasting - Targeting - Value chain and market analysis
- **Why?** - Accelerating pro-poor, gender-sensitive impact through development partners

Schmidt 2009

Mohanty 2009
D. Institutional Innovation and Capacity Building

Shares of crops researchers in 57 developing countries

N. Beintsma, IFPRI, 2008
Next steps

• **10 May 2010**: Draft proposals for maize, rice and wheat to the Consortium Board

• **May – Sept 2010**: Continued partner input for 5-year (mid-term) plan/10-year vision

• **Sept/Oct 2010**: Mid-term plan and Business plan

• **January 2011**: Implementation
Challenges summarized: For food prices to remain constant, annual yield gains would have to increase

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Issues for discussion

General:
1. Main scope and focus
2. Comments on key issues and challenges

What are ..
3. Specific global challenges to maize – rice – wheat
4. Specific regional challenges to maize – rice – wheat
5. Strategic partners and their role, by region
6. Linkage to important development investments, by region

How to achieve ...
7. Joint commitment to impact targets between Development partners, National Research and International Research
<table>
<thead>
<tr>
<th></th>
<th>Food-deficit</th>
<th>Resource-poor farmers</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Subsistence</td>
<td>Surplus sales</td>
<td>Maize for income</td>
</tr>
<tr>
<td><strong>Yield</strong></td>
<td>0.5 – 2.5 t/ha</td>
<td>1.5 - 4 t/ha</td>
<td>&gt; 3 t/ha</td>
</tr>
<tr>
<td><strong>Genetic resources</strong></td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td><strong>Research</strong></td>
<td>Public</td>
<td>Public</td>
<td>Private</td>
</tr>
<tr>
<td><strong>Seed production</strong></td>
<td>Private</td>
<td>Private</td>
<td>Private</td>
</tr>
<tr>
<td><strong>Seed dissemination</strong></td>
<td>NGO &amp; GO</td>
<td>Private</td>
<td>Private</td>
</tr>
</tbody>
</table>

### Average trial yield (t/ha)

<table>
<thead>
<tr>
<th>Yield increase over checks</th>
<th>0%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
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<tbody>
<tr>
<td>0-1</td>
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<td>***</td>
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<td>+</td>
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<tr>
<td>1-2</td>
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<tr>
<td>2-3</td>
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<tr>
<td>8-9</td>
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<td>***</td>
<td>+</td>
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<tr>
<td>&gt;9</td>
<td></td>
<td></td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>+</td>
</tr>
</tbody>
</table>

### Trial #:

- 18
- 41
- 38
- 48
- 31
- 27
- 21
- 22
- 20
- 7