Enhancing Global Capacity for Pre-breeding: The GIPB Platform

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Plant Production and Protection Division

Food and Agriculture Organization of the United Nations
for a world without hunger
Outline

• In Context
  – Food security-related global development issues and drivers
  – Imperative for harnessing PGRFA

• GIPB --- meeting the challenge
  – what, who, how
  – Overview of pre-breeding interventions

• Perspectives
Profiling Food (In)Security

- Wake up call in the recent food price increases
  - Post-green revolution complacency
- 1 billion people go hungry today
- At current rates, population by 2050 estimated at 9 billion
  - Need to produce 70% more food
- Uncertainties exacerbated, odds lessened by:
  - Climate change and variations
  - Demographics, changing dietary patterns
  - Competing diversions of foodstuff to bioenergy, livestock feeds, fibers

MDG Report, 2012
Crunching the Numbers

<table>
<thead>
<tr>
<th>Year</th>
<th>Past production</th>
<th>Future needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>1500</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>2500</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>3500</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>4000</td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td>4500</td>
<td></td>
</tr>
<tr>
<td>2033</td>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>2042</td>
<td>5500</td>
<td></td>
</tr>
</tbody>
</table>

Total global cereal production (millions of tons)

- **Maize**: 2007 data: 158 x 10^6 ha, production: 792 x 10^6 tons, yield: 5.0 t/ha
- **Rice**: 2007 data: 156 x 10^6 ha, production: 660 x 10^6 tons, yield: 4.2 t/ha
- **Wheat**: 2007 data: 214 x 10^6 ha, production: 606 x 10^6 tons, yield: 2.9 t/ha

Increasing Crop Production ----

- Finite natural resources base
  - Available water and arable land either stagnant or dwindling
  - Prohibitive cost of agricultural inputs
- So, increased productivity is the most viable option!
  - Genetic gain accounts for 50% of increased crop yield
  - Balance is due to improved agronomic practices

CIAT
It's All About Nature and Nurture!

- Re-enact the drivers for agriculture
  - Evolution, Domestication, Speciation
  - Green revolution
- Plant Breeding
  - Science of altering the genetic pattern of plants in order to increase their value
- Sources of heritable variations

Scientific American, Jan. 2009

Plant Production and Protection Division
Genealogical analysis of diversity of Russian winter wheat cultivars (*Triticum aestivum* L.)

S.P. Martynov and T.V. Dobrotvorskaya

The overwhelming majority (96%) are the descendants of cultivars Bezostaya 1 and/or Mironovskaya 808.
Who --- GIPB in PGRFA context

- FAO-convened multi-party initiative of knowledge institutions committed to developing strong and effective plant breeding capacity globally

- Partnership of stakeholders from the public, private and civil society sectors, that catalyze and support national, regional and global action relevant to PGRFA

- Underpins the efforts towards the realisation of Article 6 of the IT-PGRFA:
  - sustainable use of plant genetic resources via better plant breeding and seed delivery systems
GIPB Strategic directions

GIPB functions through interactions with a wide range of stakeholders. It prioritizes five objectives synergistically aligned towards plant breeding capacity building. Knowledge and information sharing holds the key to allow GIPB to deliver efficiently at all levels.

Objective 1: Support to policy dialogue and development to strengthen and sustain developing countries’ capacity to use plant genetic resources for food and agriculture.

Objective 2: Support to education and training in plant breeding and related scientific capacities relevant to utilization of plant genetic resources.

Objective 3: Facilitate access to technologies: in the form of tools, methodologies, know how and facilities for finding genetic solutions to crop constraints.

Objective 4: Facilitate exchange of plant genetic resources from public and private breeding programs, that can enhance the genetic and adaptability base of improved cultivars and productivity systems in developing countries.

Objective 5: Sharing of information focused on plant breeding capacity building to deliver newly available knowledge to policy makers, managers, leaders and breeders in developing country programs.

What --- 5-point Agenda

• Policy
• Education & Training
• Access to Technologies
• Exchange of PGRFA
• Sharing of Information
How --- Strategies adopted

- Establish the **baseline**: national capacity surveys

- Define the **interventions and approaches** that work

- Develop **national plans** for best use of plant genetic resources for agriculture

- Build **capacity** for highest effectiveness
Surveys of national capacities for plant breeding

- General information about the organizations involved
- Scientists in PB and related fields
- Budgets by crop
- Breeding and biotechnology activities and priorities by crops
- Sources of germplasm by crop
- Varieties released
- International collaboration
- Constraints of effectiveness of PB program and assistance needed

81 countries surveyed
Country & crop case studies on investment strategies in plant breeding

<table>
<thead>
<tr>
<th>Country’s Plant Breeding and Seed Systems Studied</th>
<th>Reference Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>Rice, Vegetables, Maize and Pulses</td>
</tr>
<tr>
<td>Thailand</td>
<td>Maize, Cassava and Rice</td>
</tr>
<tr>
<td>Uruguay</td>
<td>Rice</td>
</tr>
<tr>
<td>Sub-Saharan Africa --- Ghana, Kenya and Malawi</td>
<td>rice, maize, cassava, beans and vegetables</td>
</tr>
</tbody>
</table>
Overview of Findings

- Growth of the 1970s and 80s declining along with donor support since the 1990s
  - Severely depleted human resource pool, especially in Africa
  - Lack of sustained funding mechanisms

- Generally weak policy regimes

- Linkage between plant breeding and seed systems is crucial, but often weak.

- Public sector roles will remain pre-eminent for years to come.
  - Roles in the seed sector likely to decline while roles in regulation and certification will require more capacity and resources.
Enhancing Capacity in Pre-breeding

<table>
<thead>
<tr>
<th>Venue (Country)</th>
<th>No. of Participants</th>
<th>No. of Countries of participants</th>
<th>Continent Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Philippines</td>
<td>46</td>
<td>16</td>
<td>Africa and Asia</td>
</tr>
<tr>
<td>Belgium</td>
<td>2</td>
<td>2</td>
<td>Africa</td>
</tr>
<tr>
<td>Thailand</td>
<td>45</td>
<td>14</td>
<td>Asia</td>
</tr>
<tr>
<td>Venezuela</td>
<td>41</td>
<td>18</td>
<td>Latin America &amp; the Caribbean</td>
</tr>
<tr>
<td>Brazil</td>
<td>65</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Partners: IRRI, Kasetsart University, PROCITROPICOS, Embrapa, Bioversity, WARDA....
Pre-breeding for effective use of plant genetic resources
an e-Learning Course

Introduction
The Global Partnership Initiative for Plant Breeding Capacity Building (GIPB) is pleased to announce the release of an e-learning course on Pre-breeding for Effective Use of Plant Genetic Resources. As part of a comprehensive strategy to develop a critical mass of personnel skilled in the genetic improvement of crops, this course aims at strengthening capacities at the interface between germplasm conservation and its use in plant breeding.

Pre-breeding refers to all activities designed to identify desirable characteristics and/or genes from unwieldy plant materials that cannot be used directly in breeding populations and to transfer these traits to an intermediate set of materials that breeders can use further in producing new varieties for farmers. It is a necessary first step in the use of diversity arising from wild relatives and other unimproved materials.

These activities are a collaboration between the germplasm curator and the plant breeder who need to work together to understand the scope and value of germplasm collections and how new traits from these collections can be bred into new varieties. The adoption of pre-breeding facilitates the efficiency and effectiveness of crop improvement programmes by enabling increased access to, and use of, genetic variations conserved in genebanks.

Audience
The target audience for this e-learning course is primarily germplasm curators and plant breeders and their support and collaborating personnel. University lecturers and students engaged in germplasm management and/or crop improvement will also find this course very useful. The course is also recommended for extension agents, seeds specialists, field technicians and relevant research administrators and managers.

Overview of the Course Contents
The course consists of five Units which require about 16 hours of self-paced instruction to complete. The Units cover a range of theoretical and practical topics from the basic concepts and applications of pre-breeding to germplasm distribution and regulatory issues. Every lesson achieves a specific set of learning objectives, using interactive step-by-step instructions and exercises which help reinforce the internalization of the subject matter.

The course is complemented by bibliographic references including online resources for each Unit and a rich glossary of terms. The structure of this e-learning course, characterized by stand-alone Units, allows the learner to take the course as a whole or select specific lessons depending on individual needs and circumstances.

http://km.fao.org/gipb/
Pre-breeding to build capacity for effective use of plant genetic resources

COURSE MENU

UNITS
1. Introduction to Pre-breeding
2. Genebank Management relevant to Pre-breeding
3. Pre-breeding Project Management
4. Creating and Managing Variation
5. Distributing, Use and Regulatory Issues

DESCRIPTION

Unit 1:
Explains defines pre-breeding and its context, identifying the situations to which it is best applied and its possible limitations. The potential of pre-breeding to make optimal use of the benefits represented by Plant Genetic Resources is also outlined. The unit introduces the criteria to define when pre-breeding is an advisable option, and introduces basic concepts of plant biology and genetics necessary to set up a successful pre-breeding programme.

Select a unit to see the list of its lessons. To start a lesson, please select the lesson from the list and press the "GO" button or double-click the lesson.
### Field Activities in Pre-breeding

<table>
<thead>
<tr>
<th>Location</th>
<th>Activity</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burkina Faso, INERA</td>
<td>Morphophysiological characterization of Burkina Faso rice collection for drought and iron toxicity tolerance.</td>
<td>30 rice accessions identified: 9 for drought tolerance, 21 for tolerance to iron toxicity.</td>
</tr>
<tr>
<td>CIP, Lima, Peru</td>
<td>Broadening the genetic base of potato for the tropics in preparation for climate change.</td>
<td>24 progenitors identified: combinations of desired traits, adaptations to agroecologies of Ecuador and Chile.</td>
</tr>
<tr>
<td>Malaysia, Universiti Kebangsaan Malaysia</td>
<td>Improvement of rice varieties/breeding lines for low water availability in South and Southeast Asia.</td>
<td>About 5000 BC₁F₂ plants from 18 plants carrying 3 desired QTLs being field tested.</td>
</tr>
<tr>
<td>Philippines, University of the Philippines, Los Banos</td>
<td>Evaluation of activation of endogenous banana streak virus sequences in Musa germplasm from Southeast Asia and the Pacific.</td>
<td>Endogenous BSV, of three known species, present in all 58 accessions surveyed, The BSV in two plants were novel.</td>
</tr>
<tr>
<td>Philippines, PhilRice, Nueva Ecija</td>
<td>Recurrent and genomewide selection for enhancing yield in rice.</td>
<td>419 F₃ lines with a combination of high yield and wide genetic background identified.</td>
</tr>
<tr>
<td>South Africa, African Centre for Crop Improvement (ACCI), KwaZulu Natal</td>
<td>Improvement of African maize germplasm by introgressing temperate genes to enhance nutritional quality and adaptability to climate change.</td>
<td>50 lines selected for superiority: 10 for heat and drought tolerance, 20 for earliness, 20 for low phytate content.</td>
</tr>
</tbody>
</table>
Field Activities in Pre-breeding

**Priority Setting for R&D**

<table>
<thead>
<tr>
<th>Traits</th>
<th>Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought resistance</td>
<td>pearl millet, sorghum and cowpea</td>
</tr>
<tr>
<td>Resistance to <em>Striga</em> gesnerioides</td>
<td>sorghum and cowpea</td>
</tr>
<tr>
<td>Resistance to <em>Maruca</em></td>
<td>cowpea</td>
</tr>
<tr>
<td>Higher yields</td>
<td>sorghum, yams, cowpea, pearl millet</td>
</tr>
<tr>
<td>Short cycle</td>
<td>pearl millet and sorghum</td>
</tr>
</tbody>
</table>

**Outputs of Pilot Field Activities**

- Advanced breeding lines of cowpea and sorghum in multi-locational trials
- Drought resistant yam genotypes being evaluated in new environments
- Data on completed agro-morphological characterization of >1000 accessions available to breeders

**Priority Setting for Enabling Environment**

- Capacity building for public institutions
- Increased awareness for all stakeholders
- Increased information and knowledge on farmers' needs

Increase farmers' access to conserved diversity of sorghum, pearl millet, cowpea and yams in West Africa. Funded by the Gates Foundation. In collaboration with the Global Crop Diversity Trust.
Consultation to Promote a Public-Private Partnership for Pre-breeding

in response to the

Rio Six-Point Action Plan for the International Treaty on Plant Genetic Resources for Food and Agriculture

Rome, Italy. 30 & 31 May 2013

8 countries – Agricultural R&D, Universities; 2 CGIAR centers; UPOV; Syngenta Foundation; International Treaty on PGRFA; FAO; Civil Society; Seed company
Consultation to Promote a Public-Private Partnership for Pre-breeding

Objectives

• Stock taking on the status of pre-breeding;

• Identification of opportunities, partnerships and resources for strengthening national capacities for pre-breeding;

• Development of an action plan for forging partnerships between the public and private sectors in pre-breeding;
Consultation to Promote a Public-Private Partnership for Pre-breeding

Report will:

• Clarify the importance of pre-breeding and provide basis for the establishment of a global platform

• Define phased process including presentations of outcomes to:
  • The Third High-level Roundtable on the International Treaty on Plant Genetic Resources for Food and Agriculture (Bandung, Indonesia, 02-04 July 2013)
  • The Fifth Session of the Treaty’s Governing Body (Muscat, Oman, 24-28 September 2013)

• Propose the establishment of steering committee to drive:
  • Identification of sector-, region-, country-specific interventions
  • Advocacy, fund-raising, information dissemination
Perspectives: The PGRFA Continuum

- **Collections**
  - In-Situ
  - Ex-Situ

- **Conservation**

- **Utilization**
  - Crop Improvement
    - Breeding
    - Pre-breeding

- **Seed Sectors**
  - Formal
  - Informal

- **Delivery**
Perspectives: The PGRFA Continuum

Not always continuous. Indeed, broken often
Thank you very much!!!