OUR AGRICULTURAL DEVELOPMENT STRATEGY

We aim to catalyze country-led inclusive agricultural transformation by developing and scaling products, services, policies, and system-wide innovations that benefit smallholder farmers, empower women, and improve nutrition.

Increasing crop productivity is a cornerstone of improving livelihoods and of the agricultural transformation process that we want to catalyze.
Helping move farmers to routinely replace their varieties with newer ones will help drive agricultural transformation

- Productivity increases leading to poverty alleviation
- A reduced environmental footprint for agriculture
- Effective and constant adaptation to a changing climate and intensifying cropping systems
INNOVATION IS REQUIRED AT MANY POINTS IN THE SEED CHAINS

**Breeding programs**: need to deliver a high rate of genetic gain in the form of farmer, consumer, and processor-preferred varieties.

**Hand-off**: Seed systems have strong, clear, and correct recommendations from breeding organizations about which new products should replace currently-grown varieties.

**Seed availability**: Ensuring that the seed system (especially public) is incentivized and accountable for ensuring that seed of the new variety is available.

**Policy**: Ensure that there are no counterproductive administrative bottlenecks, and ensuring that obsolete varieties are not receiving public investment.

**Seed/propagation technology**: Helping remove technical bottlenecks to the production of clean VPC seed and low-cost hybrid seed (no real tech bottlenecks in pure line seed, just policy and varietal superiority issues).

**Demand creation for new varieties**: Once a decision has been made to replace an obsolete variety, public investment must support that decision through extension, marketing, and promotion. Innovation is needed in sustainable approaches to creating demand.
BMGF FOCUS CROPS

Sub-Saharan Africa

- Rice
- Wheat
- Maize
- Sorghum
- Millets
- Cassava
- Sweet potato
- Yams
- Banana
- Common bean
- Cowpeas
- Groundnuts (peanuts)
# SEED INNOVATION, HYBRID CROPS

<table>
<thead>
<tr>
<th>Seed System Archetype</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Sector Dominant</td>
<td>Quality seed of improved varieties that is both attractive for private sector actors to produce and that produces crops the market demands, resulting in robust private sector investment with minimal public sector involvement</td>
</tr>
</tbody>
</table>

*Seed Innovation, Hybrid Crops* | Local Check | Hybrid |
---|---|---|

### SEED INNOVATION, VARIETALS

<table>
<thead>
<tr>
<th>Seed System Archetype</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public-Private Collaboration</td>
<td><strong>Grains and legumes</strong> Quality seed of improved varieties for varietal crops with <strong>strong market demand</strong> but for which the demand risk create barriers to private-sector investment and innovation resulting in public sector involvement, particularly for EGS.</td>
</tr>
<tr>
<td><strong>Grains and legumes</strong></td>
<td>Quality seed of improved varieties for crops that are <strong>not highly desirable or profitable to produce</strong>, but which are promoted by the public sector to advance a public goal such as food security or seed security.</td>
</tr>
</tbody>
</table>

**Rice**  
**Cowpea**  
**Sorghum**  
**Groundnut**
<table>
<thead>
<tr>
<th>Seed System Archetype</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public-Private Collaboration</td>
<td>Quality seed adoption, and varietal replacement is driven by a combination of access to new resistant varieties, and clean delivery systems. Bulky materials, demand risks, and inadequate quality assurance protocols, are barriers to private-sector investment and innovation resulting in public sector involvement, particularly for EGS.</td>
</tr>
</tbody>
</table>

**Seed Systems, Vegetatively Propagated Crops**

- **Cassava Plantlets**
- **Yam aeroponics**
- **Sweetpotato vines**
- **Banana Tissue Culture**
OUR CHALLENGE – WHY GENETIC GAIN - WHAT ARE WE SOLVING FOR?

Iowa vs Eastern Africa Maize Yields

- Iowa t/ha
- Eastern Africa

126 kg/ha/yr
17 kg/ha/yr
BREEDING INNOVATION – PROGRAMS & RESOURCES

SAMPLE OF SEVERAL OF THE PROGRAMS SUPPORTED BY THE BILL & MELINDA GATES FOUNDATION AND OTHERS
BREEDING PROGRAM ASSESSMENT TOOL (BPAT)

- Provides standardized criteria and instruments for evaluating the effectiveness of breeding programs
- The BPAT is an effort to **distill criteria** used in the private sector into a form useful for public sector research managers and donors
- Provides a **common evaluation framework** to help identify systemic issues and for comparisons
- The BPAT can be used both as an **evaluation scorecard** and as the **basis for developing improvement plans**
- Free information and download for self-evaluation (http://plantbreedingassessment.org/)
# THE BPAT ASSESSES NINE COMPONENTS

## Breeding Program Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Education, Experience Support</strong></td>
<td>Plant breeder, allied scientific personnel and staff, Genetics, agronomy, statistics, information systems, etc</td>
</tr>
<tr>
<td><strong>2 Infrastructure</strong></td>
<td>Lab, glasshouse, &amp; seed facilities, Mechanization support infrastructure</td>
</tr>
<tr>
<td><strong>3 Design, Execution Field support</strong></td>
<td>Clarity of objectives, Appropriate methods, best practices, Metrics of scale, speed, efficiency</td>
</tr>
<tr>
<td><strong>4 Cultivar development, release &amp; production</strong></td>
<td>Speed of cultivar development &amp; release, Robustness of testing and advancement, Breeder seed production</td>
</tr>
<tr>
<td><strong>5 Product support</strong></td>
<td>Agronomic package with variety, Marketing &amp; extension support, Feedback loop</td>
</tr>
<tr>
<td><strong>6 Market impact</strong></td>
<td>Process to measure market share, Productivity increases, Program impact on SHFs, others</td>
</tr>
</tbody>
</table>

## Enabling Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7 Strategic planning &amp; management</strong></td>
<td>Shared vision, strategic planning, alignment, succession planning, Collaboration and partnership</td>
</tr>
<tr>
<td><strong>8 Budget &amp; finance</strong></td>
<td>Budget management, Equipment replacement strategy, Financial planning, metrics</td>
</tr>
<tr>
<td><strong>9 Performance management</strong></td>
<td>Performance evaluation process, Individual and team incentives, Training opportunities, Recruiting-sourcing, selection</td>
</tr>
</tbody>
</table>
A suite of interconnected software applications specifically designed to help breeders manage their day-to-day activities:

**Programme management**
Customise preferences and monitor programme activities from the Workbench, a dashboard application with integrated tools to manage and query crop information across the system.

**Marker-assisted breeding**
Select germplasm and design crosses by complementing phenotypic selection with marker technology, for integrated breeding decisions.

**Breeding activities**
Prepare trials and nurseries, manage seed inventories and keep continuous genealogy records season after season.

**Statistical analysis**
Analyse field and lab data with powerful statistics and mixed model comparisons of locations and genotypes.

BMS 6.0 (July 2017): Stand alone and server versions
COMING TOGETHER - THE EXCELLENCE IN BREEDING PLATFORM OF THE CGIAR

1. **Breeding program excellence**: Help breeding programs adopt cutting edge approaches (breeding program designs and operational upgrades)

2. **Trait discovery and breeding tools and services**: A common platform to share tools, information and training modules. Host and implement BMS & other tools.

3. **Genotyping and sequencing**: Broker access to genotyping services at reduced cost, and support breeding programs to optimize the use of genotyping in their work. (INTERTEK Shared High-throughput platform)

4. **Phenotyping**: Adapt cutting-edge phenotyping approaches for routine use in breeding programs, broker access to phenotyping expertise and improve infrastructure.

5. **Bioinformatics and data management**: Harness the power of genotype, phenotype and other data by providing access to integrated bioinformatics tools and biometrics support. (GOBII)
**GENOMIC OPEN-SOURCE BREEDING INFORMATICS INITIATIVE (GOBII)**

**GOBII** is a large-scale public-sector effort to systematically apply high-density genotypic information to staple crops in the developing world.

It is developing and implementing genomic data management systems to enhance the capacity of public sector breeding programs to deliver increased rates.

CGIAR Rice, maize, wheat, sorghum and chickpea programs on-board.

GOBII released its first production version of a new tool ‘Cascadilla’ this fall to assist crop breeders to use huge volumes of genomic data effectively in breeding programs.
GENOTYPING – COMMERCIAL SCALE, HIGH-THROUGHPUT FACILITY

- SNPLine (KASP) marker technology
  - Uniplex SNP assays

- INTERTEK platform:
  - 14 days data turnaround
  - > 95% data recovery
  - ~ $2.00 per sample (10 SNPs, DNA extraction & QC, Genotyping & Data curation)

Being integrated with GOBII, BMS; data stays in GOBII

INTERTEK Sweden
INTERTEK Hyderabad
INTERTEK Australia
SUMMARY OF KEY PUBLIC BREEDING TOOLS


2. *Breeding Management System* (BMS) of the Integrated Breeding Platform at CIMMYT; [https://www.integratedbreeding.net/breeding-management-system](https://www.integratedbreeding.net/breeding-management-system)

3. *High-throughput Genotyping Service* (HTGS); Intertek Sweden and Hyderabad, India; contact [http://excellenceinbreeding.org/](http://excellenceinbreeding.org/)

4. *Genomic Open-source Breeding Informatics Initiative* (GOBII) located at Cornell; [http://cbsugobii05.tc.cornell.edu/wordpress/](http://cbsugobii05.tc.cornell.edu/wordpress/)

5. Excellence in Breeding Platform located at CIMMYT-Mexico to coordinate use of these tools; [http://excellenceinbreeding.org/](http://excellenceinbreeding.org/)
Public breeding programs must **learn from the seed industry**

- Product development focus
- Highly refined product profiles to guide breeder-market research
- Cost-effective genotyping capacity for forward breeding
- Mechanization & automation to increase throughput precision and reduce costs
- Digital data collection, information management, and decision support systems
- Robust testing networks to ensure selection pressure for yield in multi-location trials
SYSTEM HANDOFFS – ENSURING THAT...

• Seed systems have strong, clear, and correct recommendations from breeding organizations about which new products should replace currently-grown varieties

• There is a clear plan for who will produce at each level of the seed chain (particularly EGS for public varieties)

• We understand the capacity needs of the seed chains to make seeds available
Helping move farmers to routinely replace their varieties with newer ones will help drive agricultural transformation

- Productivity increases leading to poverty alleviation
- A reduced environmental footprint for agriculture
- Effective and constant adaptation to a changing climate and intensifying cropping systems
THE TRUSTWORTHY SEED SYSTEM

• Seed breeding systems connected to global network and free exchange of germplasm
• Product concepts informed by the consumption and commercial needs of growers
• Widespread testing network with robust data collection and analytics before varieties are released for registration
• Efficient seed varietal release and registration systems
• Facilitative seed certification system supported by good government capacities and facilities
• Sufficient incentives for the entrepreneurs that produce and distribute the various seed classes
• Industry campaigns around “Newer is Better” to mitigate and adapt to climate change
• Sustainable view of smallholder farmers as long term viable clients, and not merely recipients of seed aid
Questions for breeders - How do you describe your approach to plant breeding?
• Are you primarily scientist working as a plant breeder?
• Are you product designers?
• Or specialists in understanding purchasing behavior?

If smallholder farmers are your customers, what drives them to purchase seed?
• Consumer preference, what they like to eat?
• Market?

Are you developing products for today’s demand?
• What is the timeline for developing and bringing a new variety or hybrid to market?
• Are you taking into account what will be driving the market at that time?

How much time do you spend looking at food, population and climate trends, regional and international markets?
• Crop attributes – which attributes are farmers willing to pay more for?
• Can you create demand for an attribute in increasingly commercially and industrial markets?
• Do you want to play in the niche markets? Or more generic ones where you are competing for yield?
CASE STUDY – US Sweetpotato breeding – “Beat Beauregard”

Yield and Certified Seed Acres Over Time

- **Seed Acres**
- **Yield**
- **Linear (Yield)**


(2) Source: North Carolina Crop Improvement Association

(3) Source: USDA National Agricultural Statistics Service
### MARKET IMPACT OF ‘COVINGTON’ SWEETPOTATO VARIETY

<table>
<thead>
<tr>
<th>Varietal Adoption</th>
<th>United States</th>
</tr>
</thead>
</table>
| ~90% of all sweetpotatoes grown in NC are ‘Covington’  
• ~3,500 acres in 2005 to ~85,000 acres in 2016 (>355 M annual farm-gate value) | ~40% of of the US sweetpotato crop is of the ‘Covington’ variety (NC production is the driver) |

<table>
<thead>
<tr>
<th>Value Creation</th>
<th></th>
</tr>
</thead>
</table>
| • US farm-gate value > $550M/yr  
• Dominant US export variety, ~25% of crop  
• 2005 to 2015 > $2.5 Billion in farm revenue | |

Production and Value Sources: NCDA & CS and USDA NASS
Industry campaigns around “Newer is Better” to mitigate and adapt to climate change

Our African Challenge

• What will it take to help farmers understand the benefits of continually replacing their seed with modern varieties, leveraging the best in your breeding innovations?

• Is this an area that AFSTA could work together with industry, philanthropic partners, and governments to develop brand-agnostic campaigns to increase adoption of hybrid crops, and regular replacement of self-pollinated crops with newer ones that can help farmers increase productivity, and stay one step ahead of climate change?
THANK YOU