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Accelerated Breeding

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CGIAR Breeding: Who benefits and how to increase those benefits

For: **GROW Webinar, Crop Trust**

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On: **April 27, 2023**

CGIAR Germplasm

- CGIAR Genebanks
- CGIAR Breeding Programs

Impact areas:

- Nutrition, Health & Food Security
- Poverty Reduction, Livelihoods & Jobs
- Gender Equality, Youth & Social Inclusion
- Climate Adaptation & Mitigation
- Environmental Health & Biodiversity

Crops and Forages

- Bananas
- Barley
- Beans
- Cassava
- Chickpea
- Cowpea
- Faba Bean
- Forages
- Grass Pea
- Groundnuts
- Lentil
- Maize
- Millets
- Pigeon Pea
- Potato
- Rice
- Sorghum
- Soybean
- Sweet Potato
- Wheat
- Yam

CGIAR Breeding Has a Wide Reach

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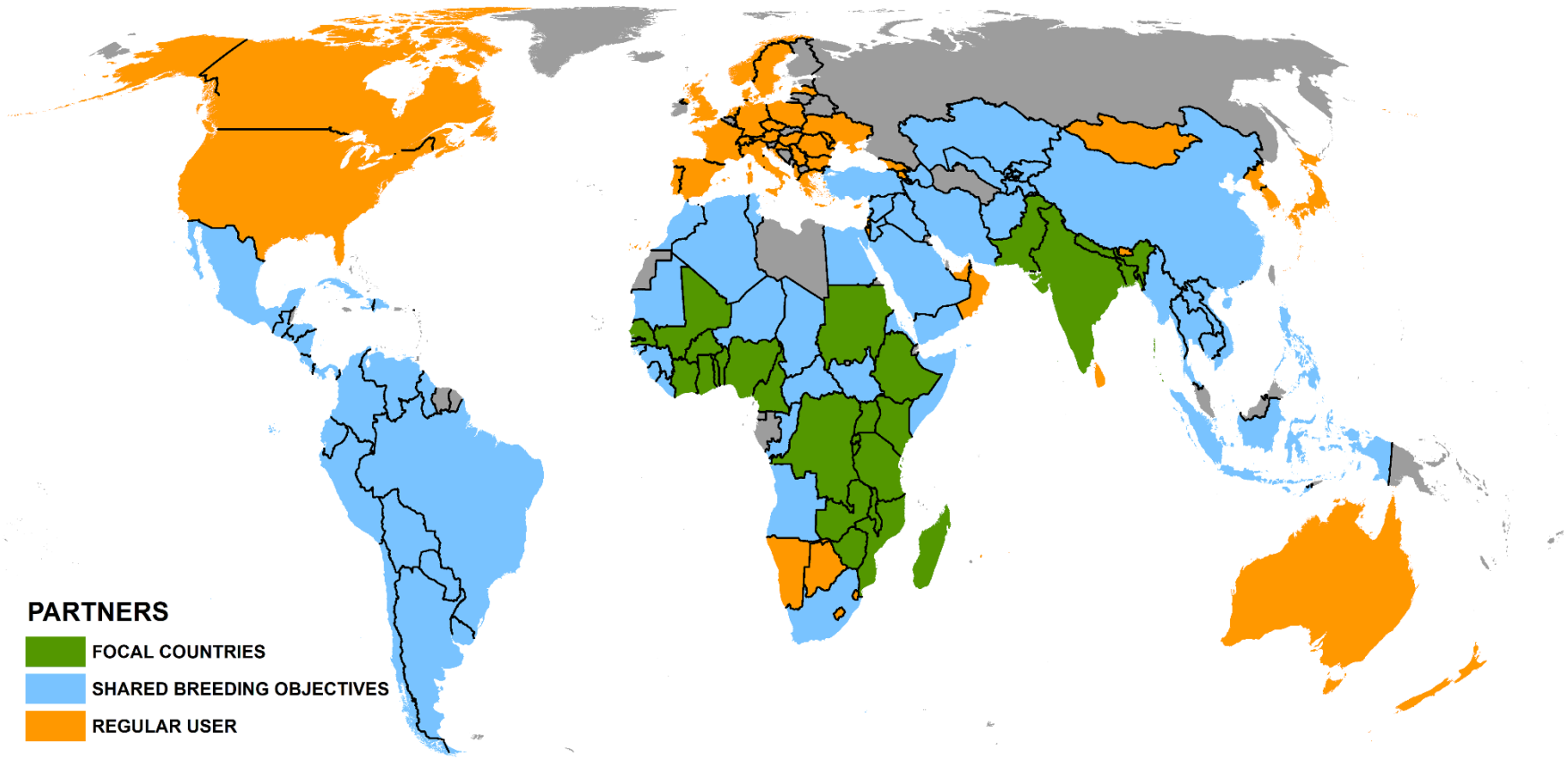

- **Focal Countries:** Collaborating countries that receive most technical support from CGIAR, and share breeding objectives and market segments for a large number of crops.
- **Shared Breeding Objectives:** Collaborating countries that share breeding objectives and market segments for one or several crops.
- **Regular Users:** Countries that regularly access CGIAR breeding materials.

Value from germplasm

Farmers are always growing *something*

- Landraces
- Older varieties
- Newly improved varieties
- Mixtures and/or intercrosses of above

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Value from germplasm

The farmer defines from what they derive value, for example:

- Variety that is resilient to drought
- Variety that fetches a higher price
- Variety that tastes good

Challenge to breeders is to understand what provides value to farmers; to substantial number of farmers in a somewhat variable context (e.g., seasonal differences, within community differences).

Farmers needs are diverse

- Breeding is appropriate when there are many farmers with similar needs.
- In this situation, an improved variety can provide farmers with a lot of value, but breeding is not the solution for everything.
- Because of this, diversity will always exist and, in itself, has value.

Perceptions about CG breeding

Awareness:

- CG breeding has had impact – more productive, drought tolerant, disease resistant varieties

Also critique:

- “Green revolution” approach
- Focused on yield and disease only
- Breeding for varieties requiring lots of fertilizer
- Varieties that work everywhere

CG breeding has changed & is changing

Of the known variety releases in 2022 deriving from CGIAR pipelines :

- 77% are more climate resilient, due to selection for tolerance to drought, heat, flooding, etc.
- 35% are biofortified and/or improved food legumes, helping to reduce malnutrition, in particular among small children and women
- At least 12% both

So, the picture is changing.

CG Breeding is changing further

- Understanding and breeding for farmers' needs
  - Understanding Target Product Profile
  - Large scale on-farm trialing
  - Farmer feedback
- Structured breeding process, improved linkages with trait discovery and including with genebanks
- Increasing effectiveness of conventional breeding
- Co-development of varieties with partners

Impact areas:

Nutrition, Health & Food Security

Poverty Reduction, Livelihoods & Jobs

Gender Equality, Youth & Social Inclusion

Climate Adaptation & Mitigation

Environmental Health & Biodiversity

Greater emphasis on package of traits needed

Target Product Profile Cassava:

- Post harvest deterioration
- Mealiness / taste
- Multi-purpose use (e.g., Gari, Fufu or chips)
- Cassava bacterial disease and blight resistance
- Cooking time
- Low cyanogenic potential
- Yield

Source: Parkes, Rabbi, Egesi and Kulakow 2022, IITA

Women selling dried fermented cassava chips in local market. *Source: IITA flickr*

Across CG, each crop currently reviews 5 to 30+ Target Product Profiles in view of farmers', consumers' and markets' needs

Ensure varieties perform under smallholder farmers' (often sub-optimal) conditions

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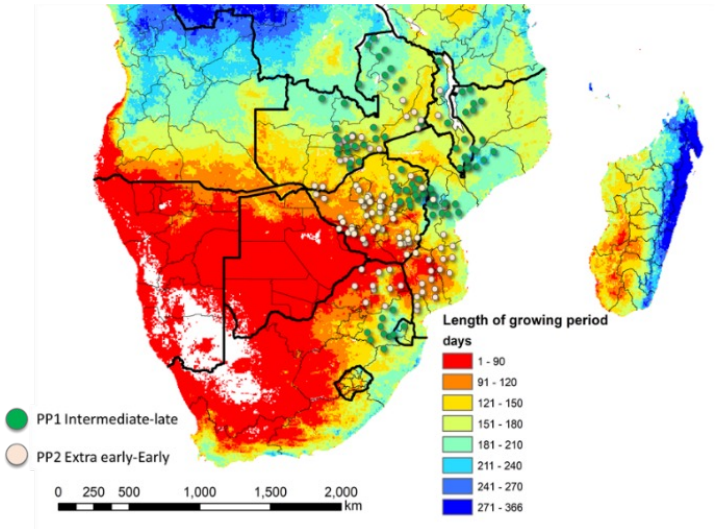
Maize in southern Africa:

- Performance on farm in 5 countries in 2021/22
- 720 trials, on-farm, under farmers' conditions and management
- Over 37% managed by women farmers
- Conducted through partnerships with NARES, seed companies, NGOs and others
- Captured gender disaggregated "variety scores" by farmers and "willingness to purchase seed if available" for each variety tested

Source: Zaman-Allah 2022, CIMMYT



Locations of maize trials in southern Africa.
Source: ABI 2022 crop report, Zaman-Allah 2022, CIMMYT

Rice in South Asia and East Africa:

- Final stage advancements in 2022 made together with over 40 partners based on trial data from 53 locations and including farmer feedback

Source: Hussain 2022, IRRI

Want feedback from men and women farmers and consumers

460 on-farm potato trials in East Africa:

- Rwanda farmers prefer pre-1990 varieties
- Traits driving farmer preference = yield, taste, marketability after storage and tuber quality
- Led to updated Target Product Profile

Source: Mendes 2022, CIP

- Highlights the challenge of variety replacement
- How to measure end-use preferences (e.g., taste) at large scale during the breeding process?

Finding priority traits

Systematic revision of Target Product Profiles gives us much better indication of which traits are the highest priority

System wide stocktaking of 350 Trait Discovery and Deployment (TD&D) activities;

- 34% biotic stresses, 25% abiotic stress, and 28% on nutritional and end-use traits

Conclusions:

- Importance to farmers of end-use traits
- Many traits bringing the most value are difficult to work with – complex inheritance and/or suboptimal donor sources
- We're not always selecting for and/or looking for the most important traits
- TD&D and variety development not always completely aligned

Where do “traits” come from?

Breeders select from following donor sources:

1. Improved, adapted → own breeding program
2. Improved, unadapted → other breeding programs
3. Unimproved, adapted → local landraces
4. Unimproved, unadapted → exotic landraces or closely related species

*Normally in above order of preference; breeding ease, lack of linkage drag, faster and lower cost development.

- #3 and #4 sourced from genebanks
- #2, #3 and #4 often go through TD&D pipeline before becoming a parent in a variety development program

Very challenging to bring in new traits

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Adapted varieties are like a high-performance vehicle, carefully bringing together many components.

Adding a trait, would ideally be like...

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Reality of adding a complex trait from donor that is very different

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Response to the TD&D Challenge

1. Prioritization of traits
   - Consider likelihood of success
   - Consider time and cost of success with expected impact

2. Formal & closer linkages of TD&D with variety development and of TD&D with genebanks

3. Collaborative research required, including with genebank community and with farmers
   - Understanding traits of value
   - Identifying best donor sources

Understanding traits of value

- Farmers frequently link value to end-use characteristics
- Improving what farmers value is how we provide benefits
- Example: valued landraces for blue maize, but there were no improved varieties
- Once developed, there can be huge demand
- May not be a mainstream example, simply highlights what is possible with greater end use focus

'Demand has skyrocketed': Mexicans are willing to pay a premium for blue corn

By Niamh Michail
05-Dec-2019 - Last updated on 05-Dec-2019 at 16:22 GMT

SHARE

Blue corn tortilla chips. GettyImages/bonchan

RELATED TAGS Native Ingredients

Demand for blue corn products in Mexico is booming and consumers are willing to pay a premium price of up to 33%, according to recent research by CIMMYT.

Need for breeding to make step changes

Second challenge: For farmers to recognize a difference, there must be a **step-change** in the offering. Farmers are not statisticians

- Some traits are obvious to farmers, e.g. disease, maturity
- Other traits less obvious e.g., yield

Farmers grow different varieties in different fields, sowing times, years – difficult to make comparisons for quantitative traits like yield.

Farmers change variety when they can observe a benefit.

Need for breeding to make step changes

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Breeding is a cyclical process:

1. Progenies created
2. The best of these selected
3. Intercrossing generates the next generation

The faster breeders turn this cycle, the more likely desirable trait combinations are developed
→ Accelerated Breeding

Modern breeding tools and approaches enable breeders to turn this cycle faster.

Accelerating the breeding process

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East Africa Bean program:

- Targeting challenging traits: e.g., cooking time, nutritional content, multiple disease resistances, yield, etc.
- Speed breeding / rapid generation advance → 3-year breeding cycle
- Uses genomic relationships for more accurate selection of parents
- Uses managed stress trials together with on-farm trials to understand performance for farmer relevant conditions

Source: Mugisha Mukankusi 2022, CIAT

Example: Yam breeding network in West Africa

Fourteen partner organizations

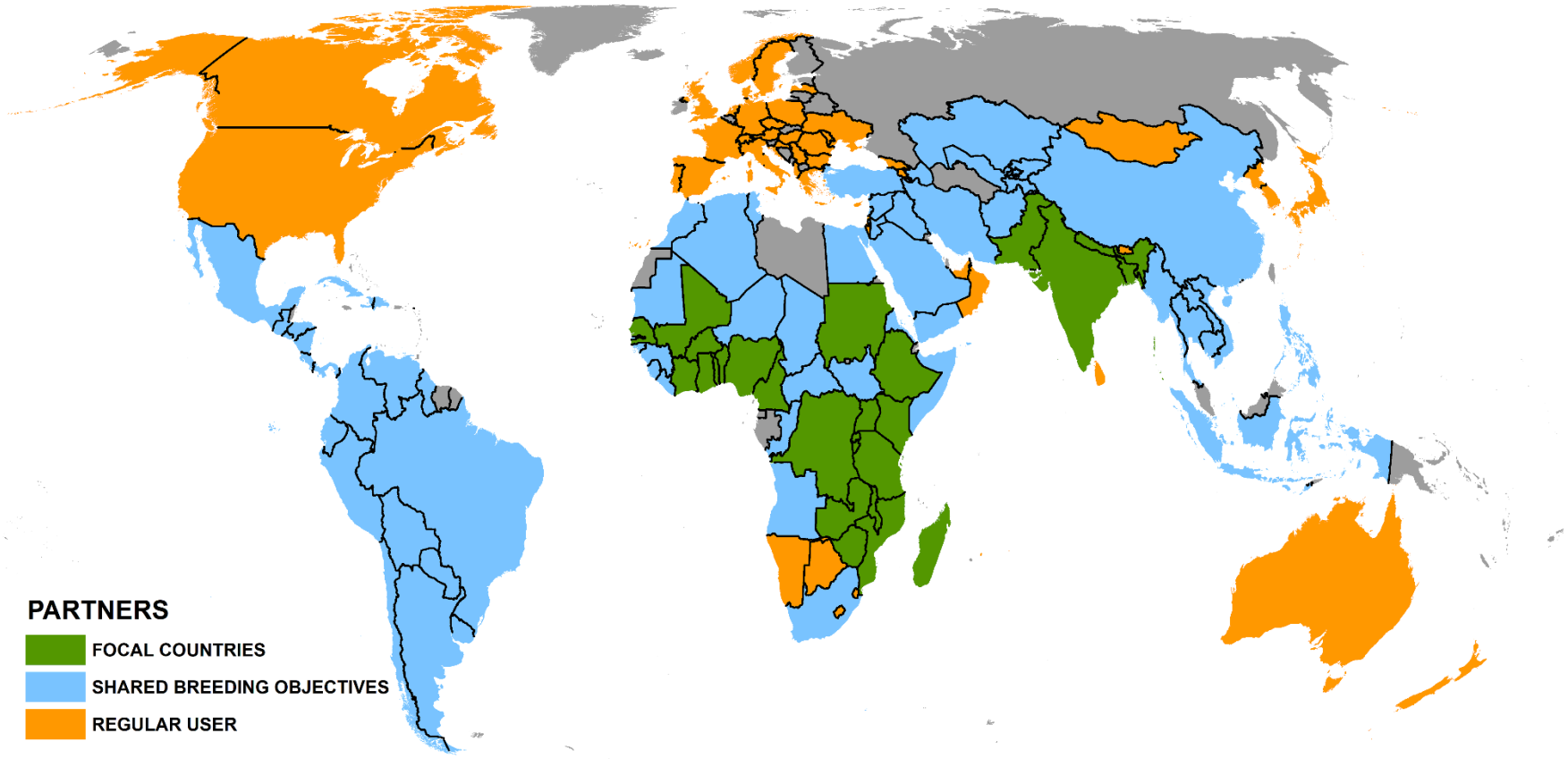
- 8 private companies e.g., GoSeed
- 4 NARES e.g., CSIR - Crops Research Institute
- 2 universities e.g., Ebonyi State University

From four countries in West Africa

- Benin
- Cote D'Ivoire
- Ghana
- Nigeria

Source: Asrat 2022, IITA

CGIAR has 36 such networks



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Who is involved / benefiting

CGIAR has 1,075 crop specific germplasm collaborations with an estimated 600 institutions in 136 countries
Arising from 36 crop by region breeding networks

Institutions:

- 38% are national agricultural research organizations
- 23% are universities
- 34% are private or parastatal companies = Scaling partners

Countries:

- 12% in low-income countries
- 45% in lower-middle income countries
- 26% in upper-middle income countries
- 17% in high income countries

Main target countries

Mostly interested in wheat (51%), legumes (19%), maize, barley, rice, cassava, potato and sweet potato

Insights from partnership analysis

- CGIAR has a relevant breeding agenda; 600 institutions regularly access breeding materials
- Open access is practiced
- Role of private sector is increasing
- While many positive changes are occurring, we can do even better, including by strengthening NARES' role and engagement

Partnership approaches: Areas of ongoing work

- On-farm trials – completely reliant on partners
- Enhancing breeding capacity of, and ownership by, NARES
- NARES-CGIAR synergies resulting in more effective breeding and downstream linkages
- Informed setting of breeding goals: Ensure alignment between national and network priorities

Conclusions

Overarching goal is to provide benefit to farmers and civil society at large

CG Breeding is changing to increase these benefits

Greater alignment of breeding with what provides greatest benefit to farmers. “More focused”

New approaches (“faster”) and wide partnerships (“collaborative and equal”) are crucial for achieving this

Collaboration with genebank community is essential to **better understand traits of greatest value** and **identify high value sources**

Acknowledgements

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Examples provided by:

- *Parkes, Rabbi, Egesi and Kulakow 2022, IITA*
- *Zaman-Allah 2022, CIMMYT*
- *Hussain 2022, IRRI*
- *Mendes 2022, CIP*
- *Mugisha Mukankusi 2022, CIAT*
- *Asrat 2022, IITA*

Colleagues from across CGIAR: Alliance of CIATand Bioversity, AfricaRice, CIMMYT, CIP, ICARDA, IITA, IRRI

National partners

Accelerated Breeding and Market Intelligence Teams

CGIAR Funders

Thank you!

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