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Developing assessment and rating tools for Plant Breeding Capacity and Functionality

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Based on a GIPB white paper by Fred Bliss

Seminis Director of World-Wide Breeding, Retired



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GIPB, Global Partnership Initiative for Plant Breeding Capacity Building
Convened by FAO / AGP M G

Springboard: International Treaty on Plant Genetic Resources for Food and Agriculture, a timely opportunity to draw attention to need for **effective use** of plant genetic resources.

GIPB Mission: To enhance the capacity of developing countries to improve crops for food security and sustainable development through better plant breeding and delivery systems.

Five GIPB goals:

Support for policy development on plant breeding and scientific capacity;

Education and training in plant breeding and related scientific capacities;

Facilitate access to technologies for finding genetic solutions to crop constraints;

Facilitate exchange of plant genetic resources for public and private enterprises;

Information sharing of newly available knowledge to policy makers and breeders.



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GIPB's Rationale for project on capacity assessment:

1. Sustainable use of plant genetic resources does not follow automatically from well-managed collections.
2. It requires effective plant breeding programs, whose outcomes are *new varieties that address problems or opportunities and are adopted by farmers* (F. Bliss, 2010 unpub.).
3. Effectiveness of plant breeding programs can be enhanced through use of well-designed planning and assessment tools.
4. Such tools can increase impact of investments in both plant breeding and plant genetic resources.

Mutual benefit: Useful at any scale or stage of development.



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GIPB is developing a framework method for assessing plant breeding capacity and functionality

The goal is a simple, objective approach that can also be used to design and implement programs well-structured for success.

The method should be:

- Low-cost

- Rapid to use (compared to a standard one-week review)

- Usable by:

 - The breeding program itself,

 - Its administration,

 - An external reviewer,

 - A donor partner.

Hoped-for future goal: A tool to help communicate – with groups such as:

- Colleagues, other sciences: often unaware of dimensions of plant breeding programs;

- Urban citizens: unaware that they both depend upon plant breeding, and influence it.



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The GIPB method is intended for use to:

- √ Document and communicate the *configuration, status, and success* of an existing plant breeding program
- √ Increase probability of successful outcomes when developing a plant breeding program
- √ Improve functionality of an existing program, e.g.
 - √ Identify missing components that inevitably constrain outcomes
 - √ Assess which components to develop in-house, vs., via external linkages
 - √ Link effectively to access missing components
 - √ Allocate existing or additional resources for maximum impact
 - √ Determine if capacity suffices to add additional crops or new technology
- √ Enhance partner confidence that investments will result in intended outcomes



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The GIPB plant breeding capacity assessment method

– DRAFT version --

Uses a capacity matrix and a series of increasingly detailed tables

Matrix cells correspond to a set of check lists and questionnaires

Used for:

- Capturing relevant data

- Rating components

- Identifying capacity gaps



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Generic elements of capacity

Capacity Components *	Examples
Human	<p>People</p> <p>Their knowledge, skills, abilities</p> <p>Science and technology, methods, know-how</p>
Tangible	<p>Materials</p> <p>Physical facilities e.g., Fields, labs, structures, equipment</p> <p>Funding</p>
Arrangements (“Organizational”)	<p>Governmental mandate</p> <p>Policies, laws, regulations; policy-making procedures</p> <p>Coordination, linkages, networks</p> <p>Management and operational procedures</p> <p>Communication and delivery procedures</p>
Social	<p>Political and popular understanding and support</p>

* Source: Danida, 2000 cited in Brennan and Quade, 2004



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“Broad sense” elements of sustainable and efficient use of plant genetic resources

Agricultural sector information, data			
Coordination - oversight - leadership *			
Crop & soil management	Genetics		
	Genetic Resources	Plant Breeding	Seed Delivery
Outcomes New varieties for sustainable productivity and value (*)			

(*) In this context, other outputs (*e.g.*, *germplasm characterization, publications, IPR, seed distribution, etc.*) considered *contributions* (inputs) to the outcome, adopted varieties.



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Capacity Matrix for
Sustainable and efficient use of Plant Genetic Resources

Capacity Components	Agricultural sector information			
	Coordination - oversight - leadership			
	Management, Crop and Soil	Genetics		
		Genetic Resources	Plant Breeding	Seed Delivery
Human				
Tangible				
Arrangements				
Social				
Outcomes: New varieties				



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Sustainable and efficient use of Plant Genetic Resources:

Maximum benefit from a given investment requires attention to capacity ✓ in each

Capacity Components	✓ Agricultural sector information			
	✓ Coordination - oversight - leadership			
	Management, Crop & Soil	Genetics		
		Genetic Resources	Plant Breeding	Seed Delivery
Human	✓	✓	✓	✓
Tangible	✓	✓	✓	✓
Arrangements	✓	✓	✓	✓
Social	✓	✓	✓	✓

If one cell is missing or weak, the others cannot fully do their jobs



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Self –limited intent at this stage:

The tool is mainly “about” effectiveness of plant breeding.

While it indicates the importance of integration with genetic resources and seed systems, it is not intended to be a definitive description for how all three systems (conservation, use, delivery) should operate

Meant to “pull out” information, to help the user “see” how a plant breeding program is working, and help to make it better –

including indicating if attention to linkages with conservation and delivery need attention.



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Capacity assessment tools for Plant Breeding

		Agricultural sector information			
		Coordination - oversight - leadership			
Comp- onents	Crop & Soil Mgt.	Genet. Res.	Genetics		Seed Del.
			Plant Breeding	Tools for Planning and Assessment existing in draft form May 2010	
Human			People Knowledge, skills, abilities Science, technology, breeding methods, know-how	Human resources Scientific information, knowledge and know-how	
Tan- gible			Materials Physical facilities, e.g., fields, labs, structures, equipment Funding	Internal and external germplasm collections Commercial cultivars & farmers landrace cultivars Spill-in of potential new cultivars from other programs Plant materials in core of active breeding program Physical facilities for operations and field testing Funding and administration for operations and testing	
Ar- range- ments			Governmental mandate Policies, laws, regulations; policy-making procedures Coordination, linkages, networks Management and operational procedures Communication and delivery procedures	Funding and administration for operations and testing Policies, laws and regulations for seed systems Linkages for access to supporting technologies Types of seed systems, plant breeding programs, delivery systems Formal & informal seed delivery systems to farmers Communication between breeders/distributors and farmers (providers and customers)	
Social			Political and popular understanding and support		
Outcomes: Key indicators of system functionality: New varieties, adoption and performance					



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Where are genetic resources? —see the tools in **bold**

Comp- onents	Agricultural sector information				
	Coordination - oversight - leadership				
	Crop & Soil Mgt.	Genetics			
		Genet. Res.	Plant Breeding	Tools for Planning and Assessment	Seed Del.
Human		People Knowledge, skills, abilities Science, technology, breeding methods, know-how	Human resources Scientific information, knowledge and know-how		
Tan- gible		Materials Physical facilities, e.g., fields, labs, structures, equipment Funding	Internal and external germplasm collections Commercial cultivars & farmers landrace cultivars Spill-in of potential new cultivars from other programs Plant materials in core of active breeding program Physical facilities for operations and field testing Funding and administration for operations and testing		
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Social		Political and popular understanding and support	Tbd		
Outcomes: Key indicators of system functionality: New varieties , adoption and performance					



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Where are seed delivery linkages? –see the tools in **bold**

Agricultural sector information					
Coordination - oversight - leadership					
Comp- onents	Crop & Soil Mgt.	Genetics			
		Genet. Res.	Plant Breeding	Tools for Planning and Assessment	Seed Del.
Human			People Knowledge, skills, abilities Science, technology, breeding methods, know-how	Human resources Scientific information, knowledge and know-how	
Tan- gible			Materials Physical facilities, e.g., fields, labs, structures, equipment Funding	Internal and external germplasm collections Commercial cultivars & farmers landrace cultivars Spill-in of potential new cultivars from other programs Plant materials in core of active breeding program Physical facilities for operations and field testing Funding and administration for operations and testing	
Ar- range- ments			Governmental mandate Policies, laws, regulations; policy-making procedures Coordination, linkages, networks Management and operational procedures Communication and delivery procedures	Funding and administration for operations and testing Policies, laws and regulations for seed systems Linkages for access to supporting technologies Types of seed systems, plant breeding programs, delivery systems Formal & informal seed delivery systems to farmers Communication between breeders/distributors and farmers (providers and customers)	
Social			Political and popular understanding and support	Tbd	
Outcomes: Key indicators of system functionality: New varieties, adoption and performance					



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Where are farmers? –see the tools in **bold**

Agricultural sector information					
Coordination - oversight - leadership					
Comp- onents	Crop & Soil Mgt.	Genetics			Seed Del.
		Genet. Res.	Plant Breeding	Tools for Planning and Assessment	
Human			People Knowledge, skills, abilities Science, technology, breeding methods, know-how	Human resources Scientific information, knowledge and know-how	
Tan- gible			Materials Physical facilities, e.g., fields, labs, structures, equipment Funding	Internal and external germplasm collections Commercial cultivars & farmers landrace cultivars Spill-in of potential new cultivars from other programs Plant materials in core of active breeding program Physical facilities for operations and field testing Funding and administration for operations and testing	
Ar- range- ments			Governmental mandate Policies, laws, regulations; policy-making procedures Coordination, linkages, networks Management and operational procedures Communication and delivery procedures	Funding and administration for operations and testing Policies, laws and regulations for seed systems Linkages for access to supporting technologies Types of seed systems, plant breeding programs, delivery systems Formal & informal seed delivery systems to farmers Communication between breeders/distributors and farmers (providers and customers)	
Social			Political and popular understanding and support	Tbd	
Outcomes: Key indicators of system functionality: New varieties, adoption and performance					



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Assessment and rating tools – Draft Examples

- # 1. Internal and external germplasm collections
- # 9. Formal and informal seed delivery systems to farmers

Handouts:

- #4. Funding and administration for breeding program operations and testing
- #8. Types of seed systems, plant breeding programs and delivery systems
- #12. Key indicators of system functionality: New varieties: their adoption and performance

Citation: Appendices to: Bliss, F. 2010. Unpub. Management and support of plant breeding: Assessing and strengthening plant breeding capacity (PBC). GIPB Consultancy paper.



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Tool 1. Internal and external germplasm collections DRAFT

DRAFT

Plant Breeding Capacity (PBC) – Infra-structure Needs and Sufficiency			
	Country:		Crop:
			On-line format for assessment tools (a simple example)
<i>DRAFT</i>	Breeding program location:		
	Completed by (name):	Individual opinion ___ or group __ consensus?	
	Plant Genetic Resources		
	Component - Internal and external germplasm collections		
	Overall Component Grade [click cell to right]		
	Grade the capacity to which each source is providing germplasm for use in this country/crop breeding program		
	Source of germplasm		Grade [click cell below]
Internal collections			
	Farmers' material (e.g., landraces) for local regions		
	This breeding program's germplasm collection	“Clickable” comments and grading scale of 1 to 5, based on: 1 Little or no use of internal & external germplasm in breeding program 2 Breeding program using <i>internal</i> germplasm for line development 3 Breeding program using some of <i>both internal + external</i> germplasm 4 Breeding program making <i>good use</i> of internal; more external needed 5 Breeding prog. using internal; + has <i>strong</i> exchange + use of external	
	This country's national gene bank		
External collections			
	Plant introductions to this program via bi-, or multi-lateral agreements		
	Accessions and breeding lines from participation in evaluation networks		
	CGIAR Genebanks		
	Public genebanks in industrialized countries		
	Public genebanks in non-industrialized countries		
	Private sector businesses, seed companies, other organizations		
<i>DRAFT</i>	ENTER ADDITIONAL COMMENTS IN CELL TO RIGHT		<i>DRAFT</i>



Tool 9. Formal and informal seed delivery systems to farmers *DRAFT*

DRAFT

Infrastructure Needs and Sufficiency	Country:		Crop:
	Breeding program location:		
<i>DRAFT</i>	Completed by (name):	Individual opinion ___ or group __ consensus?	
	Seed Delivery Systems		
	Component - Formal and informal seed delivery systems to farmers		
	Overall Component Grade [click cell to right]		
Grade each type of seed delivery system for current capacity to deliver ongoing flow of new, genetically-improved cultivars to farmers that they can acquire at appropriate cost, and in time to meet their needs each growing season			
	Delivery system	Grade ([click each cell below])	
Informal systems			
	Farmers' own seeds saved from season to season		
	Trade and barter at local markets		
	Agricultural and seed fairs		
Formal systems - Private sector			
	NGO's and similar organizations		
	Small, locally-owned seed companies, dealers, distributors, etc.		
	National and regional seed companies, dealers, distributors, etc.		
	Multi-national seed companies, dealers, distributors, etc.		
	Farmer-run seed and farming cooperatives		
Formal systems - Government managed			
	National (government) seed distribution system		
	State (government) seed distribution system		
	Universities, institutes and centers		
<i>DRAFT</i>	ENTER ADDITIONAL COMMENTS IN CELL TO THE RIGHT		<i>DRAFT</i>

**On-line format for assessment tools
(another simple example)**

“Clickable” comments and grading scale 1 to 5:
1 = System does not exist
2 = System exists, but non-functional
3 = System functions but poorly
4 = System functions, quality variable
5 = System is a reliable source for farmers



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Next steps

for developing GIPB assessment and rating tools
for plant breeding capacity and functionality

Short term:

Further consultation to edit and improve the method:

- Global e-Consultation among plant breeders and related disciplines -- 2010
- Publication of revised method

Mid- to Long term Goals:

GIPB planning and assessment method for plant breeding capacity used in :

- Project planning and evaluation
 - (e.g. by project designers, donor program officers)
- Education and training programs

GIPB planning and assessment method for plant breeding is **cross-linked** to tools for **genetic resources** and **seed systems** capacity and functionality.



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Other orientation? Side-by-side comparison

	Capacity elements			
	Human	Tangible	Arrangements	Social
Ag sector data; information				
Coordination, oversight, leadership				
Crop & soil management				
Genetic Resources				
Plant Breeding	People Knowledge, skills, abilities Science and technology, breeding methods, know-how	Materials Physical facilities, e.g., fields, labs, structures, equipment Funding	Governmental mandate Policies, laws, regulations; policy-making procedures Coordination, linkages, networks Procedures for: Management + operation; Communication + delivery	Political and popular
Seed Delivery				
Outcomes = New varieties, adoption and performance				

Rotated:
Suggested by FAO colleagues for easier conceptualizing the integration of genetic resources + plant breeding + seed systems (?)

Original concept

Capacity Components	Agricultural sector information			
	Coordination - oversight - leadership			
	Management, Crop and Soil	Genetics		
		Genetic Resources	Plant Breeding	Seed Delivery
Human				
Tangible				
Arrangements				
Social				
Outcomes: New varieties				



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Elements of
Sustainable and efficient use of
Plant genetic resources

GIPB leaflet series:

Leaflets on sustainable use of plant genetic resources
through plant breeding

Available at <http://km.fao.org/gipb/>:

- Food security
- Climate change
- Bioenergy

Drafted new leaflet: **Nutrition** (ready except for acknowledgements)

DRAFT



GIPB GLOBAL PARTNERSHIP INITIATIVE FOR
PLANT BREEDING CAPACITY BUILDING
harnessing plant genetic resources for development

Health and Nutrition through Plant Breeding and Plant Genetic Resources

Globally, inadequate nutrition is the primary factor in child mortality. Vitamin and mineral deficiencies are common, even where general under-nutrition is absent. At the same time, obesity is increasing, with its associated health problems. Health systems are burdened with high costs of treating obesity-related diseases, while also fighting malnutrition.

Plant breeding is one of the shortest and most effective routes to improving global health through better nutrition.



***Poor nutrition is the world's
most serious health problem***

Poor nutrition is more common in low-income groups, where it causes losses to individuals estimated at more than 10% of lifetime earnings and productivity.

Improvements in nutrition benefit public health, individual opportunity, and national economies.

Plant breeding outcomes that affect nutrition include:

- ***Improved intrinsic nutritional value of low-cost staple foods, to bring better nutrition even to very difficult or isolated situations.***
- ***Better availability and affordability of fruits, vegetables, whole grains, and healthful oils, to make it practical for all households to obtain recommended nutrition.***

Examples of usable genetic diversity for increasing nutritional value and diversifying diets:

- Enough genetic diversity exists for mineral content of common beans, for example, to develop varieties with 80%



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Literature cited

Bliss, F. 2010. Unpub. Management and support of plant breeding: Assessing and strengthening plant breeding capacity (PBC). GIPB Consultancy paper.

Brennan, J.P., and K.J. Quade. 2004. Measuring the impacts of improving research capacity: the case of training in wheat disease resistance. 48th Annual Conf. of the Australian Agricultural and Resource Economics Society. Melbourne, 2004.

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