

Diversity Seek (DivSeek):

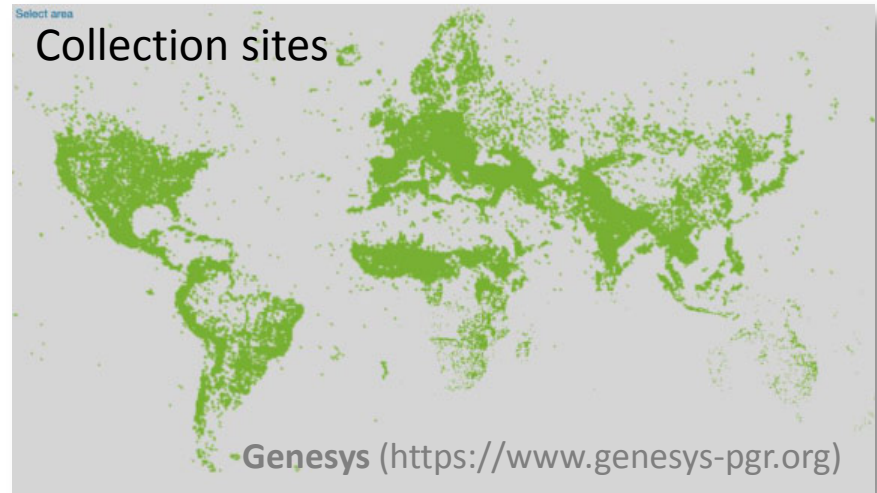
An international partnership to harness the genetic potential of crop diversity

Peter Wenzl, Ruth Bastow, Daniele Manzella, Wayne Powell, Susan McCouch

10 Nov 2015

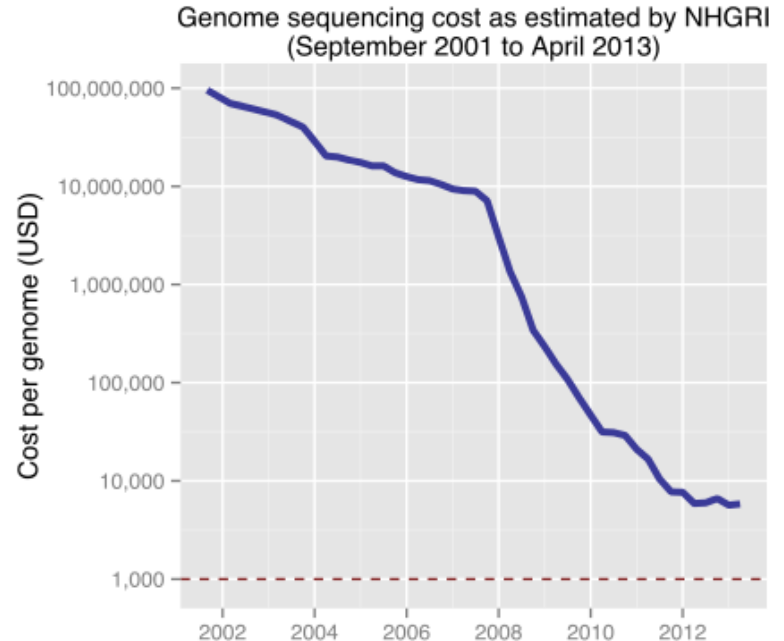
Genetic resources

- **Biological basis** for our food supply
- FAO: **+60%** by 2050
- Climate change $+1^{\circ}\text{C} \rightarrow -2\%$
- **>7M accessions** in 1,750 genebanks
- Profoundly underutilized
- Untapped **opportunity**



Shifting technology landscape

- **Next-gen DNA sequencing** → plummeting genotyping costs
 - From *genotyping-by-assay* to *genotyping-by-sequencing*
 - Simultaneous discovery & classification of DNA polymorphism
 - Minimizes ascertainment bias
- **Phenotyping** increasingly image-based and automated
- **‘Big-data’** approaches



Profoundly underutilized

- Entire **maize genebank** at CIMMYT genotyped (27,000 acc.; mostly landraces, 550 elite lines)
- **1.2 M markers** (SNP, PAV)
- % alleles used in breeding programs



Sarah Hearne, CIMMYT

Convergence of ideas & concepts across crops and organizations:

Genome re-sequencing

Genome profiling

Field trials

Phenomics, metabolom.
(Pre)breeding

	Genome re-sequencing	Genome profiling	Field trials	Phenomics, metabolom.	(Pre)breeding
3,000 Rice Genomes Project (IRRI)	✓		✓		
Seeds of Discovery (CIMMYT)		✓	✓		✓
3,000 Chickpea Genomes (ICRISAT)	✓		✓		
Bean_Adapt (ERA-CAPS)	✓	✓	✓	✓	
Crop Wild Relatives Project (GCDT)		✓	✓		✓
BRIDGE Project (IPK)	✓	✓	?		
BamYIELD (CFF)		✓	✓		✓
Digital Seed Bank (GPC)		✓	✓	✓	
Several H2020 proposals, ...					

Asilomar meeting, Dec 2012



The International Center for Tropical Agriculture in Colombia holds 65,000 crop samples from 141 countries.

Feeding the future

We must mine the biodiversity in seed banks to help to overcome food shortages, urge **Susan McCouch** and colleagues.

4 JULY 2013 | VOL 499 | NATURE | 23

San Diego, Jan 2014/15

90 participants, 21 countries: Breeders, bioinformatics experts, genebank managers, data managers, IT professionals, sequencing service providers, experts on evolutionary theory, policy specialists, donors, private sector participants, lawyers, representatives of international organizations and a treaty, phylogeneticists, taxonomists, molecular ecologists, experts on big data, software engineers



Consortium



From seed banks to seed/gene banks

Seed banks

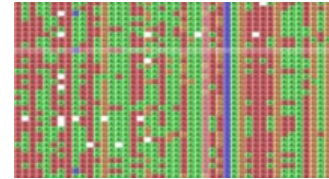


Identity by appearance



Physical
(germplasm,
traits, ...)

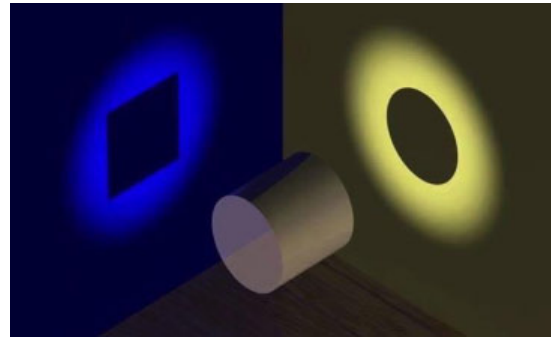
Gene banks



Identity by state/descent



Informational
(alleles, haplotypes,
QTL, ...)



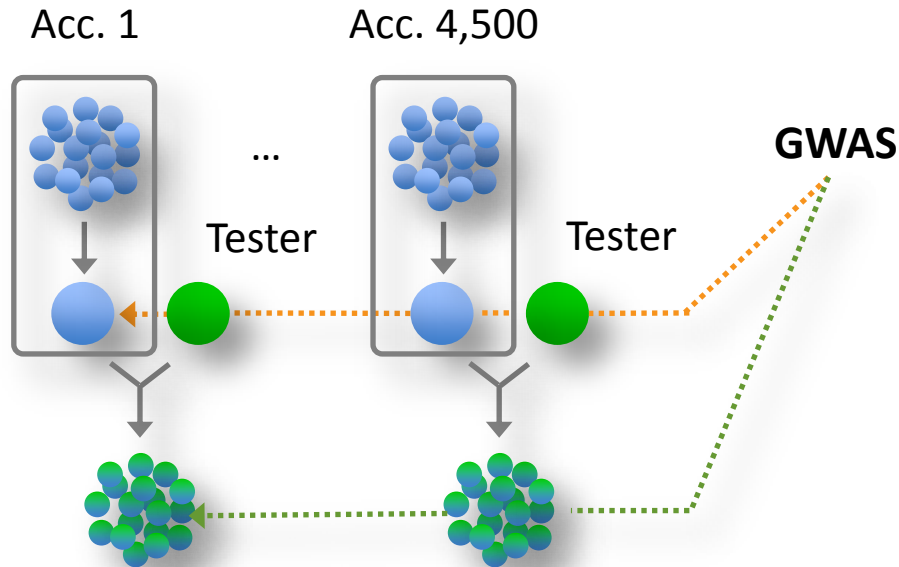
Genebank
accessions



An example: maize



Willcox, Burgueño, Romero, Hearne et al. (CIMMYT)



GWAS to identify unused, beneficial alleles

- Core collection (4,500 acc. of 27,000 maize landraces)
- One individual per accession test-crossed
- Hypothesis: alleles replicated across accessions

Traits evaluated

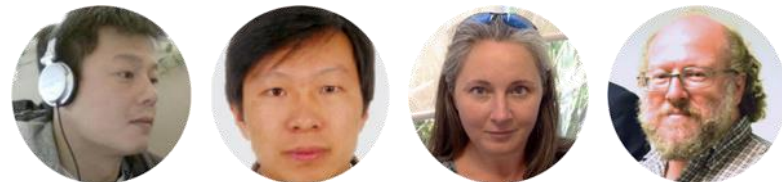
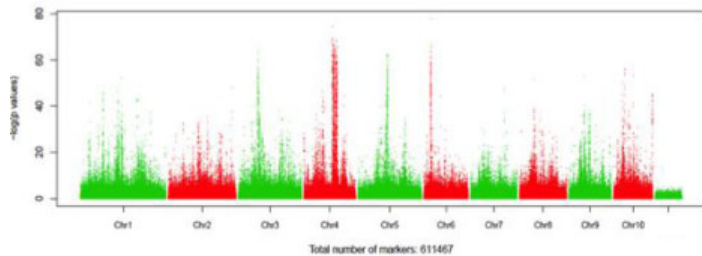


Willcox, Burgueño, Romero, Hearne et al. (CIMMYT)



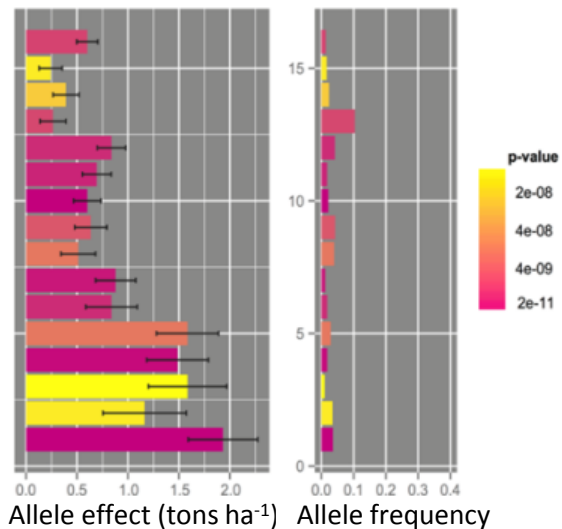
- Drought, heat, low N
- Tar spot, ear rot, stalk rot, GLS
- Grain protein, hardness, AA, phenolics





Chen, Chen, Hearne, Burgueño et al. (CIMMYT)

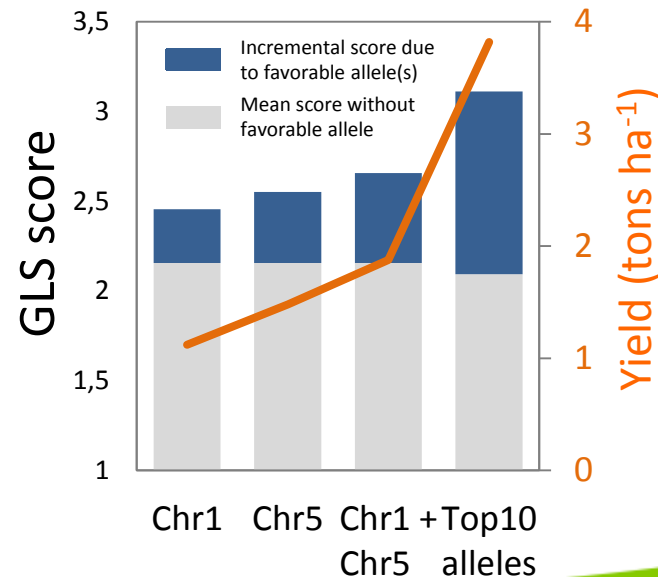
Tar spot



Drought

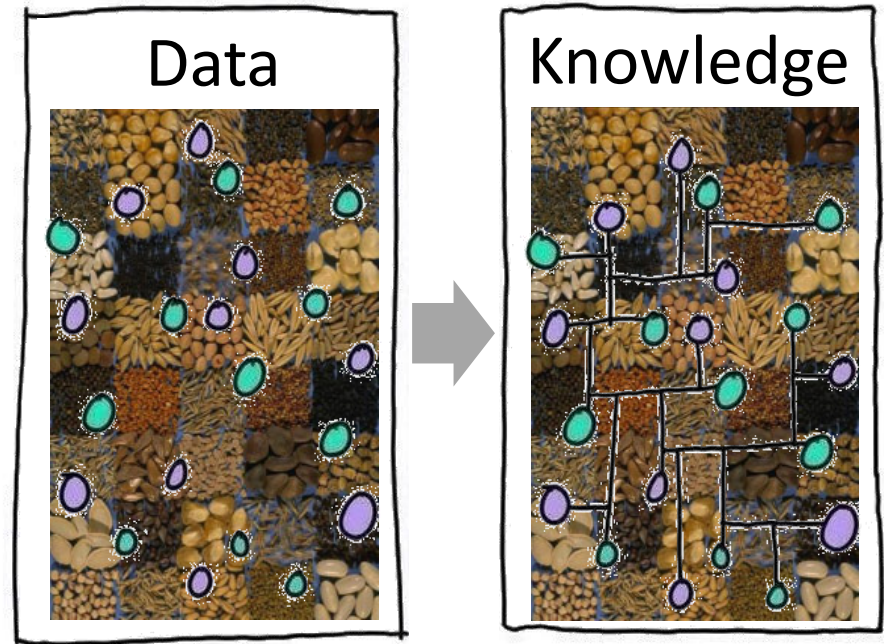
Chr.	Region	N	CML allele frequency
2	1	288	-
2	2	211	-
3	1	306	-
3	2	405	-
6	1	258	97.3
7	1	398	97.2
8	1	271	94.0
9	1	419	97.9
9	2	334	93.6
9	3	368	94.8

Grey leaf spot



Knowledge-exchange platform

- Research **approaches**, **lessons** learned
- Software **tools**, data **standards**, meta-analyses
- **Capacity** building, student training
- **Data-sharing** and re-use rules





International Potato Center



Queensland Alliance for Agriculture & Food Innovation

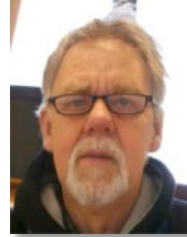


DivSeek Charter

- *“To cross-link, support and add value to individual activities that **harness the power of crop diversity** for food and nutritional security and societal and economic benefits,*
- *by enabling breeders and researchers to mobilize genetic variation,*
- *in order to **accelerate crop improvement**”*

Steering Committee

- **Broad expertise:**
 - Genebanks, genetics/genomics, software and standards, governance
- Supported by **operational unit** ('Joint Facilitation Unit'):
 - *Peter Wenzl* (GCDT)
 - *Ruth Bastow* (GPC)
 - *Daniele Manzella* (ITPRFA)
 - *Wayne Powell* (CGIAR CO)



*David
Marshall, JHI*



*Elizabeth
Arnaud,*



*Emily Marden,
UBC*



*Sarah Ayling,
TGAC*



*Susan McCouch,
Cornell Univ.*



*Rajeev Varshney,
ICRISAT*



*Peter Bretting,
USDA-ARS*



*Ruairaidh Sackville
H., IRRI*



*Andreas
Graner, IPK*

Landscape of ongoing projects

- **24 projects evaluating crop diversity:** rice, maize, wheat, chickpea, barley, bambara groundnut, pea, cassava, tomato, common bean, brassicas, potato, eggplant, pepper
- **11 crop portals** and databases
- 13 projects & initiatives developing **software tools and data standards**
- 1 project generating **reference genome sequences** for a diverse set of 'orphan crops'

Ongoing...

- Refining the **identity & goals of DivSeek**
 - Meeting & knowledge-exchange platform
 - Platform for common action, e.g.:
 - Assemble an information system to manage and link genotypic & phenotypic data back to genebank accessions
 - Offer training opportunities for young scientists
- Elaborating an effective **organizational framework**, e.g.:
 - Lessons learned from previous comparable initiatives
 - Independently funded operational unit
 - Public-private partnerships
 - Use of Permanent Unique Identifiers (PUID) for germplasm samples



THANK YOU

WWW.DIVSEEK.ORG