

Executive summary of discussions held at the 2009 NCCC-167 meeting, Allerton Illinois

On The Future of Corn Breeding

In March of 2007, leaders in the maize genetics community met for a two-day retreat to discuss the strengths, challenges, and initiatives that define the future of maize genetic research in the post-genome era. The maize genetics community generated a report entitled “The Future of Maize Genetics: Planning for the Sequenced Genome Era” with the following short-term and long-term planning objectives:

Short Term Planning (1-3 years):

1. Current sequencing/annotation will be completed and additional map-based sequencing efforts initiated.
2. Centralized databases with increased funding are needed now.
3. Indexed reverse genetic resources need to be finalized and will accelerate many areas of research. Current mutagenesis libraries should be indexed with new technologies.
4. Expression platforms and informatic tools should be selected and developed.
5. Transformation capacity should be enhanced in the public sector. Continuous support mechanisms for public transformation need to be resolved.

Long Term Planning (Start now, with sustained efforts over the next decade):

1. Databases and stock center capacity will be enhanced, coordinated and supported.
2. Map-based sequences of other inbreds, races, and teosintes will be available.
3. A phenomics initiative will be underway, with large scale and multi-dimensional phenotyping capabilities for multiple environments available for the entire community.
4. The maize scientific community will be large, diverse, well-trained, and interactive.

The Maize Genetics Executive Committee adopted to these planning objectives, and has pursued funding to realize these objectives.

In March of 2009, the NCCC167 Corn Breeding group was asked to hold similar discussions about the future of corn breeding in the post-sequenced genome era. Many of the “Challenging unanswered questions in biology” presented in the 2007 maize genetics report are in line with those of breeders, although from a slightly different viewpoint:

- How is genomic diversity maintained, and how does it change *during selection*?
- What is the underlying molecular genetic basis for specific traits?
- Can natural variation provide information to develop novel breeding traits?
- How are *genetic effects* impacted by interaction with the environment (*i.e. GxE*)?
- What is the genetic, molecular and physiological basis of hybrid vigor (heterosis)?

With respect to the Maize Genetics Community short-term planning list, the Corn Breeding Community related most closely with objectives concerning databases. For the Corn Breeding Community to apply genetic and genomic techniques to breeding programs, the breeding community needs a database for integrating pedigrees, phenotypes, markers, QTL, and genes. Of the currently available databases, Gramene is the closest to meeting our needs, except that phenotype and pedigree information would need to be incorporated.

The Maize Genetics Community long-term planning list is largely compatible with the expertise of the breeding community: germplasm, phenotypes, and integrative research.

- While the breeding community acknowledges the importance of B73 for the reference genome sequence, breeders, by their very nature, cannot be restricted to using a single inbred line or even a set of 100 inbred lines. Breeders constantly generate new materials by breeding and selection, often resulting in inbred lines that are used in genetic studies.
- Phenotypes are an area of specialty for corn breeders, although breeders tend to define a phenotype differently than geneticists (i.e. a phenotype is more than just the result of a single gene knockout). Specific needs in this area include a need to standardize phenotypes across the community (e.g. consistent disease rating scales) and high-throughput phenotyping tools.
- Breeding is integrative discipline, requiring knowledge in breeding methodology, statistics, quantitative genetics, plant pathology, entomology, physiology, etc. The number of institutions that have active corn breeding programs and/or rigorous quantitative genetics programs has diminished over the last decade, leaving fewer institutions to meet private sector demand for graduates with corn breeding experience. Thus the corn breeding community will need to be large, diverse, and well-trained. The breeding community must also strive for more collaboration. These collaborations will be between public and private corn breeding programs, and between breeding and genetics. A primary need in this area is a funding mechanism to support breeding-oriented collaborations.

Over the past decade, there have been increasing concerns about the role of public corn breeders, especially in light of the fact that the North Central Region Corn Breeding Committee has recently changed from a "research committee" to a "communications committee." An added challenge to public corn breeders is to "bridge the gap" between breeders and the larger community of maize geneticists, i.e. to take results of genetic studies from the lab to the field. Finally, public corn breeders must find a niche that is distinct from private corn breeders, yet foster collaborations that are beneficial to both private and public breeders.

While the Maize Genetics Community is following a clear advancement of research, breeders are experiencing a paradigm shift. It used to be that breeders were simply trying to advance a trait via selection; now breeders are being asked to use far more information than before. How are breeders going to get the traits to the field, integrating new tools with selection. The private sector has figured this out, but the public hasn't. If this is merely a capacity issue, perhaps the Corn Breeding Community need to ask for more money to increase our capacity? Perhaps the Corn Breeding Community should mimic the Maize Genetics Executive Committee, which has been very successful in their ability to prioritize the needs of the community as a whole and pursue funding to address those needs.

At the 2008 NCCC-167 business meeting, an ad hoc executive committee (Bill Beavis, Torbert Rocheford, Liz Lee, Wenwei Xu, Jim Hawk, and Bill Tracy) was formed to begin addressing some of the above issues. Goals included 1) define who might be interested in the breeding group; 2) implement a survey of important topics; 3) decide on an interim meeting date and location; and 4) define the mission of the new group. A subset of the members met at the Plant Breeding (SCCC-80) meeting in June, but little progress was made on reaching these goals.

At the 2009 NCCC-167 meeting, a provisional Corn Breeding Executive Committee (CBEC) (Martin, Paul, Sherry, Travis Frey, and Tom Brutnell) was formed. The provisional committee was charged with the following responsibilities: 1) draft a mission statement for Corn Breeding Community; 2) draft by-laws for the CBEC; 3) expand the Corn Breeding Community by emailing various groups including the IL Corn Breeders School attendees, the 2006 Plant Breeding Survey responders, the Maize BioList, and the Maize Genetics Community ListServe, using self-definition as corn breeder as the primary qualification; 4) approve the by-laws by the newly defined group; 5) conduct formal elections for the Executive

Committee; and 6) develop a new web page for the broader Corn Breeding Community, independent of the NCCC167 group.

To summarize, the Corn Breeding Community has identified several short term goals and/or needs: development of databases for integration of breeding information; establishment of a high throughput phenotyping capacity; increased collaboration between genetics and breeding research, and between public and private breeders; and a mechanism for funding breeding-oriented research projects. In order to address these needs, the Corn Breeding Community will need to expand its membership, and appoint an Executive Committee that will represent the Corn Breeding Community and pursue funding to support public corn breeding.

Attendance:

Researchers/Faculty/Staff		Students	
Tom Brutnell	Cornell Univ.	Anastasia Bodnar	Iowa State Univ.
Peter Peterson	Iowa State Univ.	Milly Kanobe	Iowa State Univ.
Walter Goldstein	Michael Fields Ag. Inst.	Andrew Burt	Univ. Guelph
Travis Frey	Monsanto	Gloria Iriarte	Univ. Guelph
David Mies	Syngenta	Talon Becker	Univ. Illinois
Richard Pratt	The Ohio State Univ.	Eunsoo Choe	Univ. Illinois
Martin Bohn	Univ. Illinois	Yang Fu	Univ. Illinois
Kevin Montgomery	Univ. Illinois	Andrew Hauck	Univ. Illinois
Natalia de Leon	Univ. Wisconsin	Cathy Kandianis	Univ. Illinois
Shawn Kaeppler	Univ. Wisconsin	Greg Mahone	Univ. Illinois
Bill Tracy	Univ. Wisconsin	Juan Marroquin	Univ. Illinois
Candice Gardner	ARS Ames, IA	Joana Novair	Univ. Illinois
Paul Scott	ARS Ames, IA	Sofia Silva	Univ. Illinois
Sherry Flint-Garcia	ARS Columbia, MO	Tim Gustafson	Univ. Wisconsin
Chris Grainger	Univ. Guelph	Candice Hansey	Univ. Wisconsin

