

**2006 NCR-167 Annual Station Report  
North Dakota State University  
Calendar Year 2005**

**Mission of unit**

The mission of the corn-breeding program at NDSU is to conduct research in corn breeding for the northern Corn Belt emphasizing germplasm adaptation and improvement, inbred line and population development, and hybrid testing. Specific objectives are:

- 1) Identify elite exotic genetic materials for adaptation
- 2) Maximize genetic improvement of corn germplasm adapted to North Dakota
- 3) Develop improved early maturing corn elite inbred lines and populations for the high and low yielding environments of the northern Corn Belt
- 4) Assess the potential for corn profitable diversification through elite corn population hybrids and other profitable alternatives
- 5) Coordinate hybrid maize performance testing trials
- 6) Educate future applied plant breeders

**Major accomplishments**

**Identification of early-maturing lines for North Dakota**

Average corn productivity in North Dakota during 2005 was the highest on record with dryland potential grain yield approaching those of the central Midwest. However, even in the best year most popular early-maturing commercial hybrids needed drying causing the farmer significant reduction in profitability especially with the gas prices we had during the past fall. Specific hybrid combinations between North Dakota inbred line ND2000 and commercial inbreds have demonstrated an average three to four percent significant grain moisture at harvest reduction when comparing with Pioneer 39D82, the most popular 87 RM hybrid grown by farmers. As a consequence of these results across 15 state environments and the first time pressure from crop insurance companies, several seed companies have initiated large-scale production of NDSU early maturing lines. SBARE-ND Corn Utilization Council, \$39,000, March 2005 – February 2006.

**Adaptation of elite late-maturing germplasm to North Dakota**

Three are the ways we are utilizing to adapt germplasm: EarlyGEM project, Stratified mass selection, and pedigree selection.

We have defined 'EarlyGEM' as the long-term and continuous effort to incorporate GEM elite germplasm into the northern Corn Belt. We have produced 25% GEM backcross lines for use as grain hybrids in the northern Corn Belt. This project was

previously funded as parent project, 4296-5050-1510 'EarlyGEM: Incorporating GEM Elite Lines in Early Maize'. This is the first research devoted to germplasm enhancement with tropical material in the northern Corn Belt. However, without current funding the project has reduced its speed since 2000 and the first testcrosses of [(GEMxND2000)xND2000] S1 lines with commercial testers were produced in 2005 for test across six locations in 2006.

Stratified mass selection for earliness continued in 2005 on BS11, BSK, BS1011, and a CIMMYT Highland Composite improved populations. First year testing of 3-4 cycles of selection has shown an average 5-7 days improvement in earliness across populations. In addition, correlated responses to selection have shown an improvement on grain yield too.

Pedigree selection with duplication of breeding nurseries for S1 and S2 early generation lines have shown improvement on fast dry down.

### **Maize Population Hybrids**

Our maize population hybrid project was initiated in 1999. This is a consequence of the identification alternative heterotic patterns for the northern Corn Belt. We have continued testing of our maize population hybrids in 2005 for not only grain yield performance but also with the purpose to identify groups of genetic diversity for grain quality traits (Ph.D. thesis). The difference with previous year is that we have increased the number of diallel mating designs. We have added locations to the original design with one set of crosses plus parents. In 2004 we have produced seed for two sets of crosses including the best populations from the previous diallel in order to estimate not only GCA and SCA effects but also maternal and reciprocal effects. Therefore, we have evaluated the new diallel across seven eastern and western ND locations which served as a thesis for an MS student. A third diallel was produced between the best improved adapted populations and the earlier versions of the stratified mass selection program. This diallel has served as another thesis study. NDSU Research Foundation is in the process of protecting NDSU corn populations. However, the intention of the breeder and the Department is to make them available to anyone interested in them. There have been over 20 requests from major and minor companies, land-grant U.S. and international universities, and non-government organizations for latest released genetically broad-based improved population NDSAB(MER-FS)C13.

### **Reciprocal Full-Sib Recurrent Selection**

In addition to our several efforts on intra-population recurrent selection we have initiated three reciprocal full-sib recurrent selection programs as a consequence of the extensive testing we have preformed for choice of germplasm. We have identify potential alternative heterotic patterns: BS21(R)C7 x CGSS(S1-S2)C5; BS21(R)C7 x CGL(S1-S2)C5; BS21(R)C7 x NDSAB(MER-FS)C13; and BS22(R)C7 x Leaming(S)C4 with an average high-parent heterosis of 37.4%. First cycle of selection among reciprocal full-sib families based on S1 progenies from BS21(R)C7 and CGSS(S1-S2)C5 was completed. S1 progenies have provided enough seed for reciprocal full-sib family selection across at least six two-rep locations of testing reducing GxE interactions.

## **Biotechnology and Molecular Markers**

Our breeding program supports biotechnology research for broadly approved events and the assessment of molecular research that can impact breeding. We have continued the use of GMO commercial testers for the identification of public lines with commercial potential. We have performed DNA fingerprinting on potential releases for characterization purposes and with the intention to classify our unrelated lines into heterotic groups without much success. Inconsistency between genotypic and phenotypic data continue to suggest that even for unrelated material extensive phenotyping should be priority over the use of SSR markers. We still need to assess if other type of markers could be useful.

Transformation of ND lines was not approved nationally by a Committee between NDSU Administration and NDSU Research Foundation. However, there is an agreement that will allow transformation of the lines internationally with a potato gene that increases the level of amylase in corn.

Every year our breeding program duplicates our S2 early generation lines in a disease nursery with infection of corn leaf diseases. The identification of QTLs for eyespot resistance is under way with the purpose to identify potential escapes that our disease nursery might miss in addition to increase our knowledge on a disease without much research done. SNPs markers are being utilized in a Ph.D. thesis.

## **Current Personnel**

M. J. Carena, Project Leader

Duane Wanner, Research Specialist

Xihua Zhang, Visiting Scientist

Marcelo Melani, Ph.D. Student (QTLs for Disease Resistance)

Juan Osorno, Ph.D. Student (Identifying Groups of Genetic Diversity/Quality Traits)

Bahadir Sezegen, MS Student (Cold Tolerance/S1Divergent Selection)

Colins Eno, MS Student (Choice of Germplasm in Exotic Populations to ND)

## **Graduations**

Clarissa Barata, currently a corn scientist in the Monsanto Trait Integration Program

McDonald Jumbo, currently Ph.D. student in corn breeding, University of Delaware

## **Collaborators**

### ***State Cooperation***

Dr. D. Hopkins, Salinity Tolerance

Dr. L. Rio, Disease Screening and Resistance

Dr. C. Bradley

Dr. W. Wilson, Market Analyses

Dr. T. Wijetunga, Molecular Analyses

Dr. T. Teigen, Isolations and Disease Nursery, Casselton location

Dr. B. Hanson, Cold Tolerance, Langdon location

Dr. B. Schatz, Plots, Drought Tolerance, Carrington location

Dr. E. Eriksmoen, Hettinger location

Dr. M. Halvorson, Minot location  
Dr. N. Riveland, Williston location  
Dr. F. Kutka, Dickinson location  
Mr E. & R. Stover, Larimore location  
Mr. D. Moffatt, Barney location  
Mr. Wallie Hardie, ND Corn Council Utilization  
Mr. John Bollingberg, ND Corn Growers Association  
Mr. Paul Langseth, Golden Growers Cooperative/Cargill Plant  
Ms. Theresa Podoll, Northern Plains Sustainable Agriculture Society (NPSAS)

***Major Cooperation off Campus***

Dr. L. Pollak, Germplasm Enhancement Maize (GEM) Project  
Dr. M. Blanco  
Dr. W. Salhuana  
Dr. C. Bauland, INRA (National Agriculture Research Institute)  
Dr. P. H. Auriel Agri-Obtentions, France  
Dr. J. Hatmann, BayWa Ag., Germany  
Dr. Z. Wicks, South Dakota State University  
Dr. E. Lee, University of Guelph  
Dr. L. Reid, Agriculture and Agri-Food Canada, Ottawa  
Dr. M. Smith, Cornell University  
Dr. A. Hallauer, Iowa State University

***Industry cooperation:***

Dr. D. Hoffman Syngenta, Inc Biotechnology  
Dr. D. Leford, Winter Nursery Kauai  
Dr. J. Gebauer, Winter Nursery, Chile  
Dr. R. Pinnisch, Dupont/Pioneer  
Dr. R. Bell, Ag. Reliant  
Dr. B. Garet, Limagrain  
Dr. D. Nordick, Dow  
Dr. D. Anderson, Monsanto/Holdens  
Dr. R. Nelson, Thurston Genetics  
Dr. L. Behrens, SGI Genetics  
Dr. G. Smelser, MBS Genetics, LLC  
Dr. G. Geske, Quality Seed Genetics  
Dr. P. Gregoire RAGT Semences, France

**Referred Publications (2005-2006)**

Guimarães, E.P., E. Kueneman, and M.J. Carena. 2006. Assessment of National Plant Breeding and Biotechnology Capacity in Africa and Recommendations for Future Capacity Building. Accepted in Hort. Sci.

- Sonnino, A., M.J. Carena, and E. P. Guimaraes. 2006. Utilization of Molecular Markers in Developing Countries. Current Status, Assessment, and Revision of National Priorities. FAO Chapter. Accepted.
- Carena, M.J. and Z.W. Wicks III. 2006. Maize population hybrids: an exploitation of U.S. temperate public genetic diversity in reserve. Accepted in *Maydica*. Invited paper for a commemorative issue.
- Carena, M.J. 2005. Registration of NDSAB(MER-FS)C13 maize Germplasm. *Crop Sci.* 45: 1670-1671.
- Carena, M.J. 2005. Book review. *Travels in the genetically modified zone*. By Mark L. Winston. Cambridge: Harvard University Press, 2005. 280 pp., ISBN 0-674-01529-0. In: *Agricultural History* (Accepted in June 2005).
- Carena, M.J. 2005. Exploitation of maize genetic diversity in the northern U.S. Corn Belt. Proceedings of the XII Eucarpia Genetic Resources Section Meeting, Castelsardo, IT.
- Carena, M.J. 2005. Maize commercial hybrids compared to improved population hybrids for grain yield and agronomic performance. *Euphytica* 141(3): 201-208.
- Melani, M.D. and M.J. Carena. 2005. Alternative heterotic patterns for the northern Corn Belt. *Crop Sci.* 45:2186-2194.
- Hyrkas, A. and M.J. Carena. 2005. Response to long-term selection in early maturing maize synthetic varieties. *Euphytica* 143(1-2):43-49.