

**U.S. Germplasm Enhancement for Maize (GEM)
Executive Summary Report by Wilfredo Salhuana
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History and initiation of GEM Program

The genetic diversity of maize in U.S. is decreasing due to the fact that we are using only two races of the 359 races that exist around the world. As the Latin American Maize Project (LAMP) was nearing its conclusion in 1992, there was concern among maize germplasm scientists that unless an organized effort was put into place to enhance the best tropical and temperate LAMP accessions, hybrids, lines and improved populations they were unlikely to be used in breeding programs.

SOURCE	LAMP	Number of accessions:		
		GEM	TESTED	NOT TESTED
Tropical HYBRID		7	7	0
TEMPERATE				
accessions	78	30	23	7
TROPICAL accessions	100	36	25	11
Tropical lines		13	2	11
Tropical composite		3		3
Total	178	89	57	32
Highland accessions	92			
TOTAL	270			

In August of 1994, project and breeding protocols (using a modified pedigree breeding procedure) were sent to all American Seed Trade Association (ASTA) companies with maize breeding programs asking for their willingness to participate in GEM. Participation as a private-sector collaborator in this project involved signing an agreement and following the GEM protocol. The protocol required them to:

- Contribute in-kind support for the breeding effort (winter and summer nursery rows, yield trial plots, and disease observation rows, significant industry scientist time and effort to support the project)
- Cross exotic accessions assigned by the coordinator to their proprietary inbred lines and return the crosses to the coordinator
- The crosses were shared but based on precise protocol and could not be distributed to others.

This is a unique example of collaboration among public entities and private seed companies are working together with the objectives of increasing the productivity and genetic diversity of maize grown in the U.S. It is somewhat similar to when the industry and public sector research had significant

cooperation in developing inbred and hybrids from the US open pollinated varieties in the 20's-30's. The implementation of delivering hybrid corn dramatically enhanced corn productivity in the United States and established the corn seed industry.

Funding of GEM

1. Public

GEM has received \$500,000 from the federal government each year since the U.S. Congress's appropriation in the 1995 budget. After overhead, the Ames location received approximately \$300,000 and Raleigh received approximately \$150,000 each year. Of this amount, approximately \$60,000 from Ames has gone each year to help support public cooperators. A comparable amount has been used from the Raleigh budget to help support southern public cooperators. The budget was increased though the years due to the lobbying effort done by members of private companies and Universities.

2. Private

Used of proprietary inbred line.

The value of one line can be calculated on basis of the contribution in sales units of the commercial hybrids that the line was involved in. The estimated range in value of the contribution of the use of one line in GEM is from 3 to 50 millions dollars. The lines are capitalizing 70 years of breeding and selection, transferring useful blocks of genes that add value to the genetic pools.

Field support

In-kind support from private cooperators for the last year provides approximately summer nursery rows, winter nursery rows, and disease observation rows. Over rows of yield test plots throughout the eastern, southern, and Corn Belt sections of the USA provide a wide diversity of environments. This represents more than dollars.

Lobbying

The persons assigned to this task from the Technical Steering Group (TSG) prepared documentation that they presented in Washington to the Legislators and ARS administrative persons.

Attendees to TSG meetings

In the TSG there are representatives of nine companies. The members need to attend to 2 meetings a year and prepare documentation for discussion of certain topics assigned to them. They also spend significant time working the material in nurseries, as well as intellectual time on how to effectively develop the material into useful commercial products.

Organization.

The functional organization for this project will consist of Cooperators, Technical Steering Group (TSG), and the Coordinator.

Mission of GEM

The mission of the GEM (Germplasm Enhancement of Maize) Project is to effectively increase the diversity of U.S. maize germplasm utilized by producers, global end-users and consumers. The mission will be achieved through a collaborative effort between USDA-ARS, public, and private research scientists by utilizing exotic, public, and proprietary maize germplasm. The resulting germplasm, derived via the incorporation of favorable alleles for prioritized traits from exotic sources, will be utilized in private and public breeding programs and will ultimately increase the diversity of corn hybrids, improve performance, and provide new and better products. In addition, the GEM project will provide opportunities for the training of plant scientists in the enhancement and utilization of un-adapted germplasm. This contributes to the global sustainability of agricultural production, economic stability and the nutrition and well being of society.

Plan of work

To fulfill the objectives the Technical Steering Group (TSG) established a GEM protocol and selection procedure. Also, they settle priorities in important traits.

Some outstanding results

Through the years several GEM lines in testcrosses were not significantly different than the commercial checks.

This year there are several lines developed from [redacted] that in testcrosses are better than the best commercial hybrids. These 6 lines showed a % advantage when comparing percent of check mean to a set of leading commercial corn hybrids, which were included to measure yield and agronomic performance. There are [redacted] lines that are not significantly difference to the best checks.

Also, in the [redacted] there are [redacted] lines that have no significant difference with the best commercial check in hybrid combination.

A line from a particular breeding cross has a total protein of % and total oil level of %. It is unique to find this level of increase for both of these traits in the same line, and this line has a potential for food and feed applications.

The [redacted] are lines that was register developed from GEM germplasm GEMS001, GEMS002, DE3, DE4 ,,,,,,.....

There are other outstanding results in insect and disease resistance, drought and heat tolerance, fusarium that was doing by Public Cooperators. (SUMMARY OF THE BEST RESULTS)

Benefits

1.- Benefits for the companies that support the project.

Business opportunities:

By transfer new useful genes to the two heterotic groups that is the source in product development will increase the probability of obtaining productive varieties for use in agriculture in a greater diversity of ecological environments.

Public Relations:

The combinations of LAMP and GEM, provide an model for how the private sector can assist genetic resources, and how public and private breeders can join to effectively utilize that diversity. Public / private interaction represented by:

- a. Use of proprietary germplasm to evaluate exotics
- b. Positive intellectual interaction: public/public, public/private, and private/private

2.- Benefit for the participating cooperators and farmers.

- Identified "unique" useful germplasm for several traits:
 - Yield
 - Disease / insect resistance traits
 - Grain traits
- Increased use of exotic germplasm in public and private research programs
- The exchange of germplasm between northern and southern Corn Belt corn programs of U.S. and also with the Southern Hemisphere will result in germplasm with better yield and resistance to abiotic and biotic stress.
- New improved germplasm sources can be identified to add to the value of the grain to better meet industrial, livestock, poultry and human product needs.
- Reduce the threat of new disease epidemics or pests by reducing the genetic vulnerability of the U.S. maize crop.

3. Benefit to USDA/ARS.

- This model of LAMP and GEM will show how genetic resource enhancement and utilization can be accomplished and funded in the future, especially important at this time of change. There are several opportunities to gain maximum publicity from any announcements of continued funding and commitment to genetic resource that will result in

- lower or constant food cost for the consumer with ever-reducing land availability.
- The value of genetic resources maintained by ARS will be enhanced by their utilization.
 - GEM has existing and projected data of the quantity and quality to take the lead in database development for germplasm utilization.
 - GEM provides an excellent means to help insure the broadening of the maize germplasm base in public and private plant breeding programs. The immigration of beneficial genes serves to lessen the risk of having a crop failure due to a biotic or abiotic factor in a narrow genetic diversity population.

Key Future Opportunities

1. Model for public / private interaction and sharing of genetic resources
Popcorn GEM is an example of a new program modeled after GEM
2. Expand internationally
Include other LAMP countries like Brazil, Argentina and Peru
3. Generate sources of material for basic research
Genomics (unique traits for research studies)
Plant biology (e.g., drought tolerance)
4. Develop greater public awareness of benefits of improved diversity / plant improvement to enhance support and understanding of society benefits
5. Provide additional intellectual exchange (data management methods and non-proprietary information exchange) Public/public, public/private, and private/private

GEM Requires

- Additional support for at least \$2 million in ARS funding
- Continue in kind support from private industry - should factor in contribution of use of proprietary material as well as field plots and other support.
- Greater publicizing of the useful GEM products
- Expand customer base to include end users, biotechnology researchers as well as plant breeders
- Public/private understanding and funding to meet long-term goals
- Effective engagement of commercial and public researchers to continually improve project