

Germplasm Needs of Oilseed Crops¹

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Several United States crops are grown principally for their seed oils, including soybean, peanut, sunflower, safflower, rape and related mustards, as well as some new oilseed crops of promise. Although corn and cotton are both important sources of seed oils, they are primarily grown for other purposes.

Oilseed crops are not different from other crops we grow in terms of their origins. All our commercial oilseed crops, except sunflower, came to us from other parts of the world. We have no native cereal—even corn (maize) came from south of our borders; our food legume crops (beans, peas, lentils, chickpeas) are all introduced; the same for our vegetable crops. We do have some native fruit and nut crops. So meeting the germplasm needs of our oilseed crops requires the same functional activities, in sequence, as our other major crops species.

These sequential activities are: 1) Eco-geographic studies on distribution of genetic diversity. 2) Acquisition of germplasm—through foreign exploration and through exchange with other countries. 3) Maintenance—acquired material must be maintained with the major objective of avoiding loss of genetic diversity. 4) Germplasm enhancement—to be used, germplasm must be shown to be useful. Useful genes must be transferred from exotic or wild types into agronomically acceptable backgrounds. 5) Evaluation—once genetic diversity is incorporated into useful backgrounds, it can be manipulated through all kinds of breeding techniques; screened under arrays of environmental conditions to assess its value in terms of quality, physical and biological stress tolerances, and yield characteristics. 6) Research on maintaining genetic diversity—this activity pervades the whole spectrum of activities from collection of samples through to the use of that germplasm on farmers' fields.

From the time of the first English settlers in Jamestown (1607) to the rediscovery of Mendel's laws of inheritance (1900), plant introduction in what is now the United States was motivated by the desire to avoid starvation or severe economic deprivation. Colonists who survived the first grim winters learned to cultivate Indian corn (maize), squashes, and beans, which Indians had earlier introduced from what is now Mexico and Central America. They also learned to send urgent messages back to Europe that more seeds of more crop plants should be priority cargo of ships coming to the New World.

About 200 yr later, government got involved with plant introduction when (in 1819) the Secretary of the Treasury requested American consuls stationed abroad to send useful plants back to the United States. It was around this program nucleus, which in 1836 had been placed in the office of the Patents Commissioner, that the U.S. Department of Agriculture (USDA) was crystallized in 1862. From then until about the turn of the century, plant exploration led to the introduction of

¹ Received 15 March 1983; accepted 29 April 1983.

Presented at the Symposium on the United States Oilseed Industry from Germplasm to Utilization at the Twenty-third Annual Meeting of the Society for Economic Botany, University of Alabama, 14–16 June 1982; symposium organized by Dr. L. H. Princen.

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wheats, sorghums, and other cereals, oilseed and fiber crops, such as flax, olives, tung trees, cotton, and sesame, and many fruit trees, including the navel orange, date palm, persimmon, and numerous varieties of apples, pears, cherries, and peaches.

In 1898, this expanding activity was centered in a new unit of the USDA, the Section of Seed and Plant Introduction. Two years later, the rediscovery of Mendel's laws triggered the development of plant breeding as a science. This in turn gradually changed plant introduction objectives, from transplanting crops from other parts of the world into U.S. agriculture to supplying sources of genes to meet crop breeding objectives.

We now have a National Plant Germplasm System (NPGS) that provides access to over 400,000 accessions of seed and clonal germplasm (Jones and Gillette, 1982). This represents a good start on acquiring and preserving the genetic diversity of economic plants and their wild relatives. The NPGS is pursuing an accelerated program to acquire, maintain, and evaluate for use as wide as possible a range of genetic diversity of these plants before these resources are lost forever because of man's adverse impact on natural environments and changes being made in agricultural patterns and practices.

NEED FOR GENETIC DIVERSITY

The title of this Symposium is "The United States Oilseed Industry from Germplasm to Utilization." I would add: . . . "and Beyond," for we will, hopefully, never reach a point where germplasm of our crop plants is no longer useful or pertinent to our needs. The genetic engineering "band wagon" has standing room only. There are few doubters that this major new thrust area in biology will produce novel and proficient technology for manipulating genes to accomplish a wide range of objectives. Even with these new scientific approaches, there appears to be unanimous agreement that we will continue to need "natural" genes and wide-ranging diversity among these genes for classical plant breeding and genetic engineering alike to fulfill their destiny.

I am impressed with the simple, meaningful logotype registered by the American Seed Trade Association (ASTA): "*first—the seed*[®]." It speaks eloquently in 3 monosyllabic words of the priority and importance of plant germplasm in the world's scheme of things. For it is the genetic resources (germplasm) carried in the seed that convey this great importance to it. We can expect a seed to germinate under a given set of environmental conditions because it is genetically programmed to do so. We can expect the seedling to develop in a predictable time frame through a series of predictable stages, forms, and habits to sexual maturity and production of seed for the next generation.

However, we must also emphasize that the seed has a built-in capacity for change. Random segregation of chromosomes to the spores in meiosis and their random recombination in the zygote at fertilization provide for genetic diversity among the offspring of a given set of parents. It is this genetic diversity that permits species to survive the biological and environmental stresses that vary within normal limits. When a stress factor varies beyond normal limits, then too many individuals in a population (or crop) may be eliminated or rendered non-productive. We then tag that population or crop as being genetically vulnerable

TABLE 1. 1979/1980 PRODUCTION OF ANNUAL OILSEED CROPS.^a

Crop	U.S.	World
	1,000 MT	
Soybean	61,722	93,701
Sunflower	3,409	15,421
Peanut	1,800	17,184
Rapeseed	(not given)	10,073
Flaxseed	305	2,640
Safflower	185	1,149

^a Agricultural Statistics, 1981.

as far as that stress factor is concerned, and we set about to find, among our germplasm collections, genotypes having greater resistance to that stress factor.

OILSEED CROPS

In that we cannot as yet predict the occurrence, severity, or even the nature of future stress situations with acceptable levels of confidence, we must have in our germplasm collections, in usable form, as wide a range of genetic diversity as we can assemble and develop to useful status in germplasm pools. The oilseed crops are no exception. As we plan and implement projects for the improvement of our oilseed crops and their products, or for the discovery and development of entirely new sources of seed oils, we will be dependent on having and evaluating genetically diverse collections of germplasm.

The United States is a great user and exporter of oilseeds and their products. It is also a great importer of germplasm for oilseed crops. There is one major exception—sunflower (*Helianthus annuus* L.). And even for this crop, we are an importer of “enhanced” germplasm that has completed a number of round trips to the U.S.S.R. over a 200-yr span. But now sunflower is no longer a minor crop in this country. From a mere 102 mill lb of sunflower seed for oil produced in the United States in 1967, we have climbed to 3.6 bill lb in 1980; more than a 35-fold increase in 13 yr. It is now second only to soybean (*Glycine max* (L.) Merrill) in the United States as a producer of vegetable oil. But in addition to sunflower and soybean, we must also consider peanut (*Arachis hypogaea* L.), the oilseed *Brassica* species (rapeseed), safflower (*Carthamus tinctorius* L.), and flaxseed (*Linum usitatissimum* L.).

I would like to take up 6 oilseed crops or crop groups in descending order of importance in U.S. agriculture. Table 1 presents data for 1979, the last year for which actual production figures are available (Agricultural Statistics, 1981) and shows the comparative magnitude of these crops.

The world production figures in Table 1 tell nothing about distribution of that production by country; nor do they give us any clue as to center(s) of origin (or center[s] of diversity) of the crop in question. Table 2 lists major production areas and presumed centers of origin or diversity.

It has been pointed out that modern centers of production of food and nonfood crops alike are often far removed from their centers of origin (Hodge and Erlanson, 1955). The oilseed crops tend to support this observation.

TABLE 2. PRODUCTION AREAS AND ORIGIN OF MAJOR OILSEED CROPS.

Crop	Major production areas	Centers of origin or diversity ^a
Soybean	U.S., Brazil	Eastern Asia
Sunflower	U.S.S.R., Argentina	North America
Peanut	India, China, U.S.	Southern cone of S. America
Rapeseed	India, Pakistan, China, Canada	E. Asia?
Flaxseed	India, U.S.S.R., Argentina	Europe?, E. Asia?
Safflower	India, Mexico	Middle East

^a After Vavilov, 1949-1950.

What about distribution of major collections of germplasm of these oilseed crops? The United States leads the list for many crops and these oilseed crops are no exception. This country has little choice but to acquire and maintain large collections of germplasm of crops from many parts of the world, because as mentioned above, the sunflower is the only major crop that originated within our borders.

Table 3 lists the number of germplasm accessions held in working collections of oilseed crops in the United States. For the most part, backup samples are in the long-term, or base collection of the National Seed Storage Laboratory, Fort Collins, CO.

These numbers of accessions tell us little about the total genetic diversity represented in our collections of each crop. Neither do they tell us what gaps we have in our collections. In our soybean samples, for example, only 1,200 of over 9,000 accessions in a total are from China, the center of diversity of this crop. This table does tell us that our collections are poor in terms of species related to the principal crop species.

TABLE 3. GERMLASM ACCESSIONS IN U.S. COLLECTIONS.

Crop	Locations	Number of accessions	Additional information
Soybean	Urbana, IL; Stoneville, MS	9,874	9,246 <i>Glycine max</i>
Sunflower	College Station, TX	1,366	582 <i>Helianthus annuus</i> ; 784 in 62 other species
	Ames, IA	740	<i>H. annuus</i> 733 from 35 countries; 7 other species from U.S.
Peanut	Experiment, GA	4,802	4,761 <i>Arachis hypogaea</i> from 103 countries; 41 accessions of 16 other species from Argentina, Uruguay, Brazil
	Stillwater, OK	2,951	All wild <i>Arachis</i> spp. in U.S. working collections, 60+ species
Rapeseed	Ames, IA	980	15 species of <i>Brassica</i>
Safflower	Pullman, WA	1,197	<i>Carthamus tinctorius</i>
Flaxseed	Fargo, ND	2,485	<i>Linum usitatissimum</i> ; 50 wild species

PROSPECTS FOR MEETING FUTURE GERMPLASM NEEDS

In general, the future is bright. There is a worldwide awakening to the fact that as spaceship Earth rockets into the unknown of cosmic time and change, it must take its seeds with it. A shorter time frame dictates that we will have to feed a burgeoning world population. These concerns are sharpened by an increasingly clear realization that the world's plant genetic resources are being eroded rapidly, that man is the principal agent of genetic erosion, that only man can check this loss, if he is determined to do so, and that he must move rapidly and vigorously toward this goal.

Internationally, the world has responded through the establishment of a network of crop and genetic resources organizations. The center having principal responsibility for catalyzing and mobilizing worldwide action in collection, preserving, evaluating, and using plant germplasm is the International Board for Plant Genetic Resources (IBPGR Annual Report, 1981): The Board operates with a modest annual budget of about \$3.5 mill, it must give highest priority to the major food crops, and it is using its funds and influence to stimulate awareness and action among developing and developed countries around the world. Germplasm of all economic plants is getting more attention. Collection and exchange activities are greater than ever before. More gene banks are being built and used, and more research is conducted on how best to preserve seed and clonal materials while minimizing loss of genetic diversity.

In the past 8 yr, budgets for plant germplasm in the United States have about tripled—and an awareness of need and urgency has been established and commitments made to assure a strong national program (federal, state, private sectors) for plant germplasm.

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Meeting Notice

The Society for Economic Botany will hold its 25th annual meeting at Texas A & M University, College Station, TX, 10–13 June 1984. Dr. Hugh Wilson is chairman of the local arrangements committee and Dr. Robert Bye, University of Colorado and Universidad Nacional Autonoma de Mexico, is the symposium chairman. The symposium theme is "Ethnobotany of the Greater Southwest; Past, Present, and Future."

In 1985, the Society will meet in August with AIBS at the University of Florida, Gainesville.